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Już 55 lat …

Mija ponad pół wieku od ukazania się pierwszego zeszytu naukowego „Prac Instytutu Technologii Drewna". Ich kontynuatorem jest czasopismo „Drewno. Prace naukowe. Doniesienia. Komunikaty", będące ważnym forum wymiany informacji o najnowszych dokonaniach i wynikach badań prowadzonych dla szeroko pojętego drzewnictwa.

Dzięki współpracy przedstawicieli środowiska naukowego i praktyki gospodarczej, staramy się upowszechniać w nim dorobek myśli naukowej i jednocześnie umacniać jego pozycję jako środka transferu wiedzy w skali europejskiej.

Wszystkim, którzy wspierają nas w realizacji naszych dążeń, serdecznie dziękujemy za dotychczasową współpracę. Mamy nadzieję, że będziemy mogli na nią liczyć również w przyszłości.

Zapraszamy do aktywnego współtworzenia naszego czasopisma, promującego badania naukowe w drzewnictwie, postrzeganym przez nas jako dziedzina atrakcyjna, o dużych możliwościach wdrażania innowacyjnych rozwiązań.

Miło nam poinformować, że od roku 2008 wszystkie artykuły publikowane w czasopiśmie „Drewno" są dostępne w wersji elektronicznej na stronie www.itd.poznan.pl/pl/drewno.

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It has been 55 years already…

It has been over a half of a century since the first issue of scientific periodical "Prace Instytutu Technologii Drewna" was published. The successor of that periodical is journal "Wood. Research papers. Reports. Announcements." which is an important forum of exchange of information on the latest achievements and results of research conducted in the wood industry and science sensu largo.

Thanks to co-operation of the representatives of scientific community and business practice we are trying to disseminate achievements of scientific thought and, at the same time, strengthen the position of the journal as a means of knowledge transfer at the European scale.

To all those who support us in pursue of our goals we would like to give our thanks for their former co-operation. We do hope that we can count on that co-operation in the future as well.

Please feel invited to actively create our journal that promotes scientific research in the wood industry and science which is considered by us an attractive domain with great possibilities of implementation of innovative solutions.

We are happy to inform you that since 2008 all the articles published in "Wood" are available in electronic form on the following web site: www.itd.poznan.pl/pl/drewno.

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PRACE NAUKOWE – RESEARCH PAPERS

Martino NEGRI, Jakub SANDAK, Grzegorz KOWALUK, Bartosz PAŁUBICKI

FORM AND MASS CHANGES OF COMPOSITE PANELS UNDER VARIABLE ENVIRONMENT HUMIDITY

The aim of this study was to determine the influence of relative humidity on the form and mass of composite panels produced from wood-based panels covered with aluminium plate on one side. Part of the samples was additionally covered with aluminium foil on the side opposite to aluminium plate. HDFs, MDFs and particleboards were used as base material. The results of experiments show that relative humidity changes cause geometrical deformations and mass changes of composite fibre-based panels. The largest permanent form changes (i.e. that remained after the cycle of air relative humidity changes was finished) were observed for material moderately reacting to humidity changes.

Keywords: composite, wood-based panel, HDF, MDF, particleboard, aluminium plate, relative humidity, form

Introduction

Modern furniture designers and producers are seeking new materials that are rarely used in furniture production today. Firstly, the intention is to create an

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outstanding and innovative product. On the other hand, the objective can be also reduction of furniture part thickness, while the strength needed for safe use of the final product is retained. An example of such material can be the composite of wood-based panel and aluminium plate. It is easy to imagine shelves or side walls of furniture made of wood-based panels covered with a thin aluminium plate on one side or both sides. Even if the concept is rather simple, there are many engineering problems connected with such composites, including bonding method for two different materials or optimisation of strength/thickness ratio. Performance of this kind of composites under variable environmental and exploitation conditions (such as humidity) must be investigated, especially if asymmetrical use of the aluminium component is considered.

Hammoum and Audebert's [1999] model of (visco)-plastic behaviour of wood under moisture change is useful to modelling of stresses of wooden structural elements exposed to variable humidity using the finite elements method. This model is not useful in the case of wood-based panels covered with aluminium plate on one side. The investigations conducted by Ganev et al. [2003] show that the equilibrium between environment humidity and moisture content increase with MDF density increase. According to Niemz and Poblete [1996] the degree of MDF swelling under variable humidity is lower than respective values for particleboards. There is a gap in information on behaviour of the wood-based panel – aluminium plate composite under variable environment humidity.

The aim of the investigations was to determine the influence of environment relative humidity on the form and mass of composite panels made of wood-based panels one-sidedly covered with aluminium plate.

Materials and methods

Materials

In the tests 8 different wood-based panels were used as a base of the composite: 2 different thicknesses of fibreboard (HDF), 5 different thicknesses of particleboard, including 2 types of particleboard produced from poplar wood, and one MDF panel. The specification of the panels is presented in table 1.

Composites of the dimensions of 500 × 500 mm were produced. A 0.5 mm thick aluminium plate as well as aluminium foil (the so-called "kitchen foil") were used for part of the samples. The narrow surfaces of all samples of the composite were uncovered. To glue the aluminium plates to the panels Henkel Terostat-MS 930 glue was used. This adhesive is an industrial sealant based on modified silane polymers. On applying glue on the elements, they were joined together in a cold press keeping the parameters recommended by the glue producer.

Table 1. The specification of panels used as base material in composites
Tabela 1. Specyfikacja płyt użytych jako materiał bazowy w kompozytach

Marking *Oznaczenie*	Panel type *Rodzaj płyty*	Thickness [mm] *Grubość [mm]*
1	fibreboard (HDF) *płyta pilśniowa (HDF)*	4
2	fibreboard (HDF) *płyta pilśniowa (HDF)*	6
3	particleboard *płyta wiórowa*	6
4	particleboard *płyta wiórowa*	8
5	particleboard *płyta wiórowa*	10
6	(poplar) particleboard *płyta wiórowa z wiórów topolowych*	10
7	(poplar) particleboard *płyta wiórowa z wiórów topolowych*	14
8	fibreboard (MDF) *płyta pilśniowa (MDF)*	15

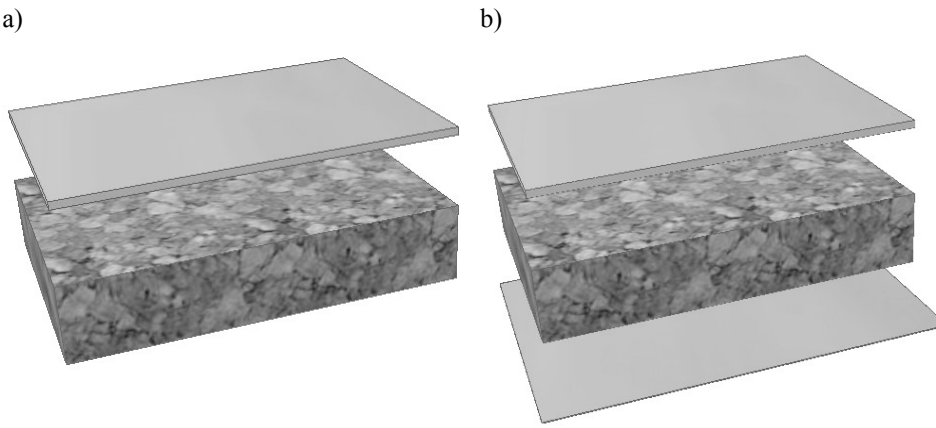

Fig. 1. Construction of the composite of aluminium and wood-based panel: a) composite without aluminium foil; b) composite with aluminium foil
Rys. 1. Konstrukcja kompozytu aluminium-płyta drewnopochodna: a) kompozyt bez folii aluminiowej; b) kompozyt z folią aluminiową

Methods

The 500 × 50 mm samples of the composite materials were stored in a climate room in the temperature of 20°C. The samples were put in special tight boxes equipped with fans to move the air inside the boxes. On the bottom of the boxes different water solutions (e.g. saturated solution of table salt) were placed to achieve the assumed environment relative humidity.

Table 2. Phases of changes in storage conditions of tested material
Tabela 2. Etapy zmian warunków przechowywania badanego materiału

Phase *Etap*	Duration [days] *Czas trwania [doba]*	Environment relative humidity [%] *Wilgotność względna otoczenia [%]*
1	7	room humidity *wilgotność otoczenia*
2	7	60
3	7	76
4	7	44
5	7	60

A simple but effective stand with Mitutoyo digital gauge was used to measure deflection of the samples (fig. 2). The span between supports was 450 mm and the digital gauge was placed in the middle of the span. The digital gauge accuracy was 0.01 mm. Data from the gauge was collected in the computer. Before each cycle of measurements the device was reset to zero on a Mitutoyo laboratory standard flat surface in natural seasoned granite stone (certified free from significant deterioration or dimensional change over time). During the measurement the surface covered with aluminium plate was directed towards the

Fig. 2. A sample's deflection measurement
Rys. 2. Pomiar zniekształcenia próbki

measuring device (the uncovered/aluminium foil covered surface was opposite to the measuring device). A positive deflection value means sample convexity and negative deflection value (–) means sample concavity.

Results and discussion

The results of measurements of deflection of samples not covered with aluminium foil after their storage under different environment relative humidity are shown in fig. 3. The largest total deflection (the largest minus room humidity deflection) was observed for thin fibreboards (no. 1 and 2: deflection –23.38 and –22.27 mm, respectively), and the smallest for MDF panel (no. 8: –2.44 mm). Thin fibreboards and thin particleboards also were characterised by the largest residual deflection after the last phase of storage (compared to the first phase of storage under 60% relative humidity – r.h.): from –6.96 mm for sample no. 2 to –5.69 mm for sample no. 4. The smallest residual deflection was observed for MDF panel (no. 8: –0.38 mm) and for sample no. 1 (–0.36 mm). Interestingly, after the last phase of the cycle (60% r.h.) all tested samples were characterised by final deflection larger than the deflection observed after the first phase of storage under the same humidity conditions without getting back to the previous shape. However, on comparing the relative residual deflection, calculated as residual/maximal deflection ratio, it was noted that samples with average values of maximal deflection were characterised by the highest residual/maximal deflection ratio: sample no. 4 – 56%, sample no. 6 – 35%. In this case sample no. 1 was characterised by the smallest value of the above-mentioned ratio, i.e. 2%. The smaller deflection of the 15 mm thick MDF (sample no. 8) compared to 14 mm thick particleboard (sample no. 7) confirms Niemz and Poblete's [1996] conclusion that the degree of swelling of MDF under variable humidity is lower than the respective values for particleboards.

The results of measurements of deflection of samples covered with aluminium foil after their storage under different environment relative humidity are presented in fig. 4. The largest relative deflection (the largest minus room humidity deflection) was observed for thin fibreboards and thin particleboards: –14.38 mm for sample no. 1 and –11.87 mm for sample no. 4. The smallest relative deflection was noted for sample no. 7 –2.76 mm and no. 8 –3.07 mm. The largest residual deflection (after the last phase of storage under 60% r.h. compared to the first phase of storage under that r.h.) was observed for sample no. 3 (–6.04 mm) and the smallest residual deflection for sample no. 7 (–0.49 mm). The relative residual deflection was also the highest (for samples not covered with aluminium foil) in the case of panels characterised by average maximal deflection, i.e. sample no. 5 – 50% and no. 3 –43%, and the smallest for samples no. 7 –18% and 8 –21%.

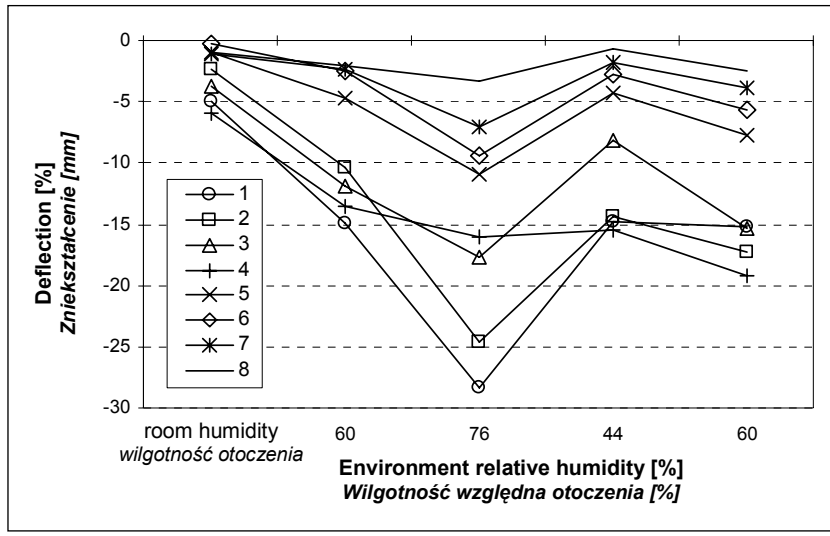

Fig. 3. Deflection of samples not covered with aluminium foil stored in variable environment relative humidity

Rys. 3. Zniekształcenie próbek niepokrytych folią aluminiową przechowywanych w zmiennych warunkach względnej wilgotności powietrza

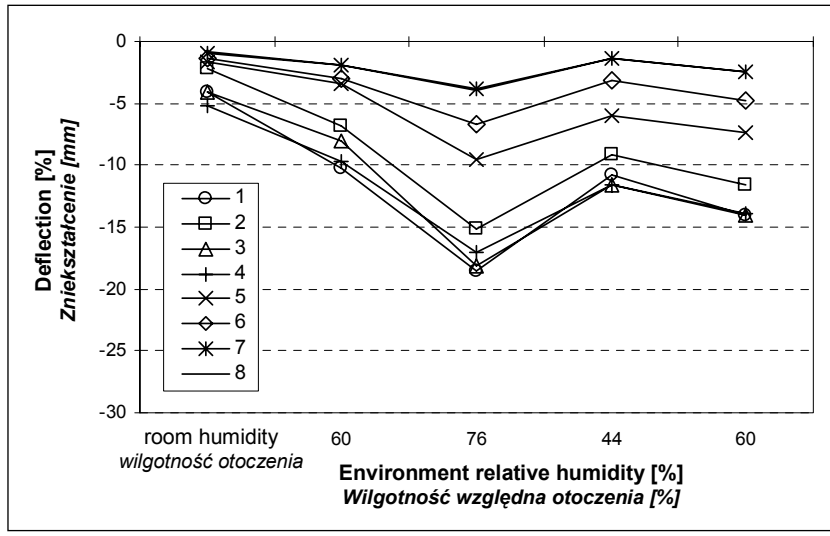

Fig. 4. Deflection of samples covered with aluminium foil stored in variable environment relative humidity

Rys. 4. Zniekształcenie próbek pokrytych folią aluminiową przechowywanych w zmiennych warunkach względnej wilgotności powietrza

Relative mass changes (compared to the initial mass) of samples not covered with aluminium foil stored in variable environment relative humidity are displayed in fig 5. Samples produced from fibres were characterised by the largest mass changes (samples no. 1, 2) like thin particleboards (sample no. 4). Thicker panels were more resistant to mass change (sample no. 6). After all changes of the environment relative humidity the mass of the samples was bigger than before.

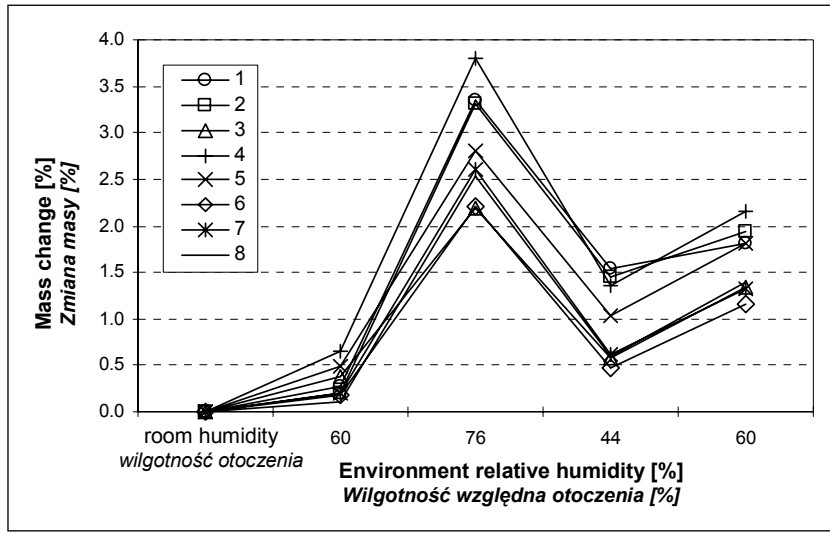

Fig. 5. Mass changes of samples not covered by aluminium foil stored in variable environment relative humidity
Rys. 5. Zmiana masy próbek niepokrytych folią aluminiową przechowywanych w zmiennych warunkach względnej wilgotności powietrza

Relative mass changes (compared to the initial mass) of samples not covered with aluminium foil stored in variable environment relative humidity are displayed in fig. 6. In this case panels produced from fibreboards and thin particleboards were more susceptible to mass changes (samples no. 2, 4, 5 and 8). The smallest mass changes were observed for 10 and 14 mm thick poplar particleboard.

Fig. 7 presents comparison of maximum mass changes of samples covered and uncovered with aluminium foil stored in variable environment relative humidity. The general tendency of panels produced from fibres towards high mass changes is confirmed. Also sample no. 4 (8 mm thick particleboard) was characterised by high moisture uptake. The influence of the aluminium foil cover is clearly visible: except sample no. 8 all covered samples were characterised by smaller mass changes compared to uncovered samples.

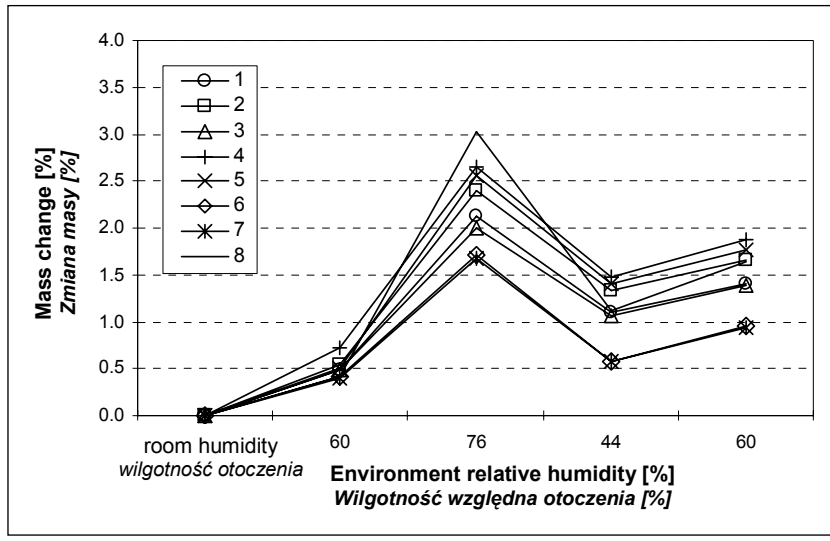

Fig. 6. Mass changes of samples covered with aluminium foil stored in variable environment relative humidity
Rys. 6. Zmiana masy próbek pokrytych folią aluminiową przechowywanych w zmiennych warunkach względnej wilgotności powietrza

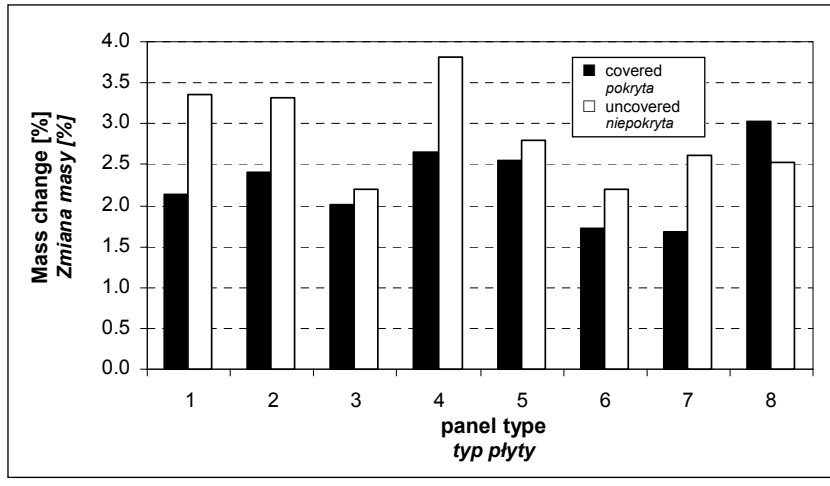

Fig. 7. Comparison of maximum mass changes of samples covered and uncovered with aluminium foil stored in variable environment relative humidity
Rys. 7. Porównanie maksymalnej zmiany masy próbek pokrytych i niepokrytych folią aluminiową przechowywanych w zmiennych warunkach względnej wilgotności powietrza

Conclusions

Conducted research shows that there is a general tendency that samples produced from fibres are characterised by bigger deflection and mass changes after storage under different environment relative humidity. Interestingly, samples with average deflection were characterised by the largest relative residual deflection. Covering of samples with aluminium foil causes smaller changes of samples' shape and mass under different environment relative humidity changes, however, those changes still exist.

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ZMIANY KSZTAŁTU I MASY PŁYT KOMPOZYTOWYCH POD WPŁYWEM ZMIENNEJ WILGOTNOŚCI OTOCZENIA

Streszczenie

Celem badań było określenie wpływu zmian względnej wilgotności otoczenia na kształt i masę płyt kompozytowych, wytworzonych z płyt drewnopochodnych jednostronnie pokrytych blachą aluminiową. Część próbek po stronie przeciwległej do blachy aluminiowej pokryto folią aluminiową. Jako materiał bazowy zostały użyte płyty HDF, MDF oraz płyty wiórowe. Badania wykazały, iż zmiana względnej wilgotności otoczenia wywołuje największe zmiany kształtu i masy w materiałach opartych na płytach włóknistych (HDF oraz MDF). Największe resztkowe zmiany kształtu (trwałe po zakończeniu całego cyklu zmian wilgotności) towarzyszyły materiałom, które na owe zmiany wilgotności reagowały z przeciętną intensywnością.

Słowa kluczowe: kompozyt, płyta drewnopochodna, HDF, MDF, płyta wiórowa, blacha aluminiowa, wilgotność względna, kształt

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Grzegorz KOWALUK, Dorota FUCZEK

PVAc GLUE AS A BINDING AGENT IN PARTICLEBOARDS

The increasing demands concerning formaldehyde content in/emission from particleboards force search after alternative bonding agents. One of such bonding agents can be polivinyloacetate (PVAc) glue. Unfortunately its high viscosity makes it difficult to apply the glue using methods for urea-formaldehyde glues. The viscosity change as dry mass decreases can be the reason for low strength of particleboards produced with such glue. The results show that bending strength and internal bond strength of particleboards produced with the use of PVAc glue is lower than for panels produced with the use of UF resin.

Keywords: particleboard, glue, pvac

Introduction

The most common adhesives used during wood-based panel production are amino resins based on urea-formaldehyde condensation. According to Warcok [2007] urea-formaldehyde (UF) and melamine-urea-formaldehyde (MUF) resins have the biggest share in the production of wood composites, even up to 90%. This situation is caused by low price and the most beneficial functional features of the above-mentioned resins. However, the main disadvantage of those resins is their principal component, i.e. formaldehyde that is considered carcinogenic. The second important adhesive for wood-based panel production is phenolic resin used mainly in products intended for exterior applications. Unfortunately, the price of phenol which is a petrochemical by-product is strongly connected with oil prices. Since early 1970s the interest in 4,4-methylenediphenyl isocyanate (MDI) binder, generally sold as PMDI (polymeric MDI) and EMDI (a water emulsion of PMDI), has been growing. Composite panels bonded with those resins are characterised by high strength, moisture resistance, and low swelling [Papadopoulos et al. 2002].

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Nowadays, so as to reduce the dependence of wood composite industry on petrochemical by-products and meet stricter requirements concerning formaldehyde emission, much research is focused on development of alternative binders.

Many investigations on modification UF or PF resins with the use of various natural derived materials like tannin, lignin, cellulose, crude pyrolysis oil of wood, and soy have been carried out. At the same time they were promoting nontoxic, environmentally friendly materials from renewable resources [Pizzi, Scharfetter 1982, Athanassiadou et al. 2002; Ballerini et al. 2005; Papadopoulou et al. 2008; Yang et al. 2006]. According to Markessini [2000] substitution of 50% phenol in PF resin with different natural products can lead to reduction of an adhesive cost up to 10%. To improve the efficiency of production lines, mechanical properties or water resistance of particleboard, another interesting modification of phenolic resin with alkylresorcinols or isocyanate resin was proposed by Dziurka et al. [2006 a,b].

Although there are many achievements in the field of wood adhesives, modified or new alternative products still cause some inconveniences. Either they have colour which limits the number of applications or they are toxic at some level [Despres et al. 2009]. A common issues also are low reactivity, difficulty in coating, high cost of some components (e.g. tannin, MDI) or more complicated production procedure. The great interest in that and related areas results from the importance of adhesives in the production of wood-based panels. The cost of adhesives is at the same level as wood, i.e. around 7% of the whole production cost.

In this study an attempt to investigate the possibilities of polivinyloacetate (PVAc) glue use in particleboard production was made. The knowledge about the use of this type of glue is insufficient and so far there was not many experiments devoted to this topic. The main attribute of polivinyloacetate glue is lack of harmful formaldehyde and relatively low cost compared to other formaldehyde free adhesives. In the research a typical commercially available polivinyloacetate glue as well as industrial wooden chips for particleboard production were used.

Materials and methods

A typical commercial PVAc glue was used in tests. Dry mass content in the glue was 46 %. The glue viscosity, measured with the use of RheoTec RC 01/02 viscosimeter based on the Brookfield method, was strongly connected to temperature (fig. 1). In the temperature of 25°C the viscosity of the glue was about 14400 mPas, and decreased when the temperature increased; in the temperature of 90°C the viscosity was about 6600 mPas. Compared to industrial urea-formaldehyde resins the above – mentioned viscosity is very high. According to

Drouet [1992] the viscosity of U-70 resin is about 1000–2000 mPas and of Silekol-W1 resin 400–800 mPas. The optimal glue viscosity for particleboard production, suggested by Drouet, should be in the range of 50–200 mPas. To reduce viscosity, PVAc glue was diluted with water in the proportion of 2:1 (2 mass portion of glue:1 mass portion of water).

The research was carried out using three different variants (table 1) of particleboards. In all variants three-layer particleboards were 16 mm thick and their assumed density was 600 kg/m^3. The particleboards were produced from industrial chips resinated with UF or PVAc glue. In fig. 2 the difference between the methods of bonding can be observed. Production parameters (pressing time factor, pressure, temperature, resination) were close to industrial conditions. Produced panels were tested for bending strength (EN 310) and internal bond strength perpendicular to the plane of the board (EN 319).

Table 1. Variants of particleboard production
Tabela 1. Warianty produkcji płyt wiórowych

Variant *Wariant*	1	2	3
Glue for bonding of chips *Klej do zaklejania wiórów*	UF	PVAc	PVAc
Bonding method *Metoda łączenia*	3-layer particleboard produced in one phase *trzywarstwowa płyta wiórowa wyprodukowana w jednym etapie*	3-layer particleboard with two face layers pressed in hot press and core layer pre-pressed in cold press. Separately created layers were joined with PVAc glue and left in cold press for about 12 h. *Trzywarstwowa płyta wiórowa o dwóch warstwach zewnętrznych prasowanych na gorąco oraz warstwie środkowej wstępnie prasowanej na zimno. Oddzielnie wytworzone warstwy zostały połączone przy użyciu kleju PVAc i pozostawione w prasie zimnej na około 12 h.*	3-layers particleboard with two face layers separately pressed in hot press and bonded with core layer formed without pre-pressing. Produced particleboard was left in cold press for about 12h. *Trzywarstwowa płyta wiórowa o dwóch warstwach zewnętrznych oddzielnie prasowanych na gorąco i połączonych z wartą środkową uformowaną bez prasowania wstępnego. Wytworzoną płytę wiórową pozostawiono w prasie zimnej na około 12 h.*

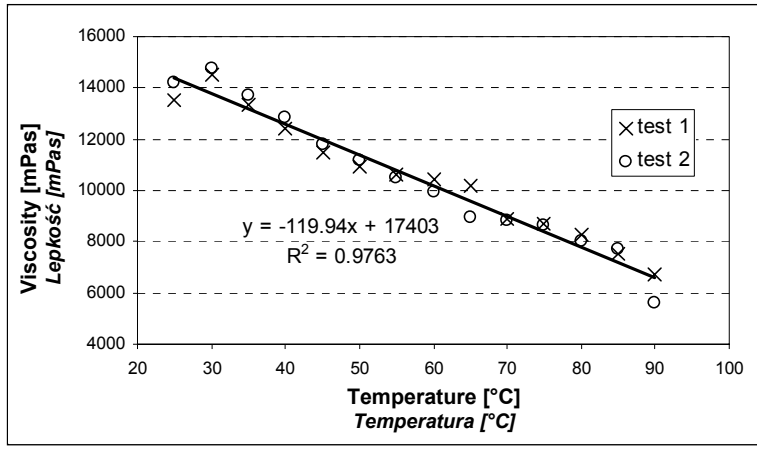

Fig. 1. The dependence of PVAc glue viscosity on temperature
Rys. 1. Zależność lepkości kleju PVAc od temperatury

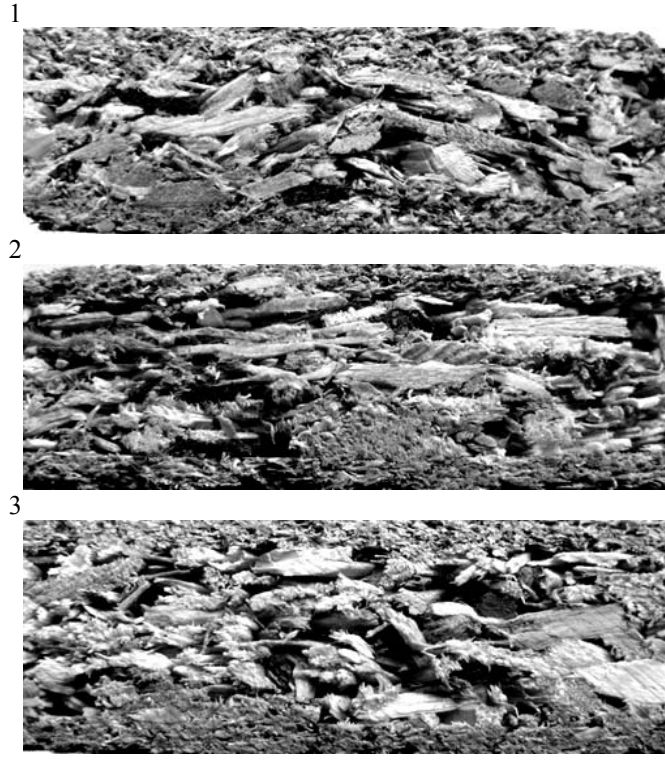

Fig. 2. Cross-sections of tested particleboards
Rys. 2. Przekroje badanych płyt wiórowych

Results and discussion

The results of measurement of tested particleboards' density profile are presented in fig 3. The density profile of panel no. 1 have a typical "M" shape. There is no clear border between the face and core layer. The other panels no. 2 and 3 were characterised by a clear border between the face and core layers (see also fig 2). In the case of panels no. 2 and 3 the face layers' density was about 900 kg/m^3, which means that the assumed density was achieved.

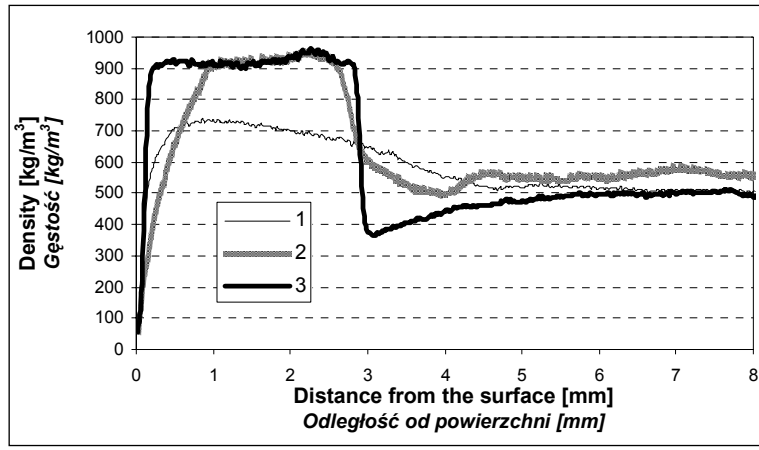

Fig. 3. Density profiles of tested panels
Rys. 3. Profile gęstości badanych płyt

Bending strength of tested panels is shown in fig. 4. According to fig. 4, the highest bending strength was observed for panel no. 1 and the lowest for panel no. 2. The bending strength of panel no. 2 constitutes 59 % of the strength of panel no. 1, and the bending strength of panel no. 3 is 70 % of the strongest panel's strength.

Internal bond strength of tested panels is presented in fig. 5. The internal bond of panels no. 2 and 3 is the same and amounts to 0.27 N/mm^2, which means that it is 53% of the internal bond strength of panel no. 1.

The aim of bonding separately prepared layers to achieve a 3-layer panel was to increase bending strength by increasing density of face layers. It is well known that face layers are responsible for bending strength of bent materials. The research shows that even with such technology modification bending strength of panels bonded with PVAc glue is much lower than the strength of panels produced with the use of UF resin. The reason for this can be lower content of dry mass in PVAc glue, which is about 31 %, when typical dry mass

content in UF resin is about 65 %. In conducted tests the same mass amounts of glues (UF and PVAc) were used to avoid introducing additional water into panels.

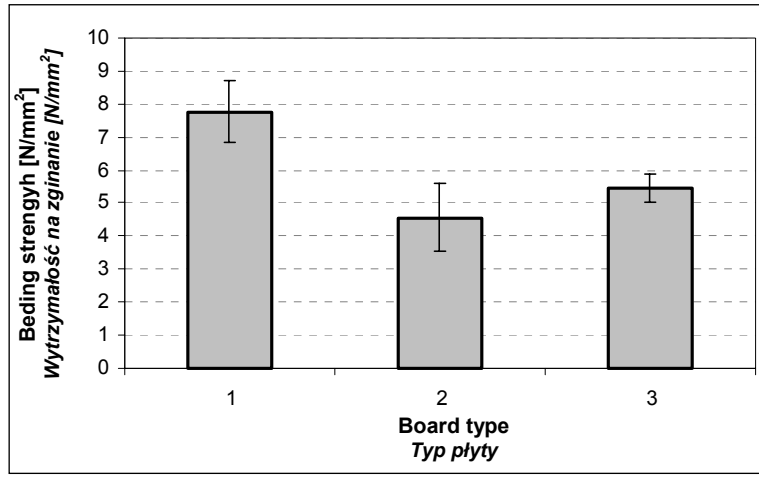

Fig. 4. Bending strength of tested panels
Rys. 4. Wytrzymałość na zginanie badanych płyt

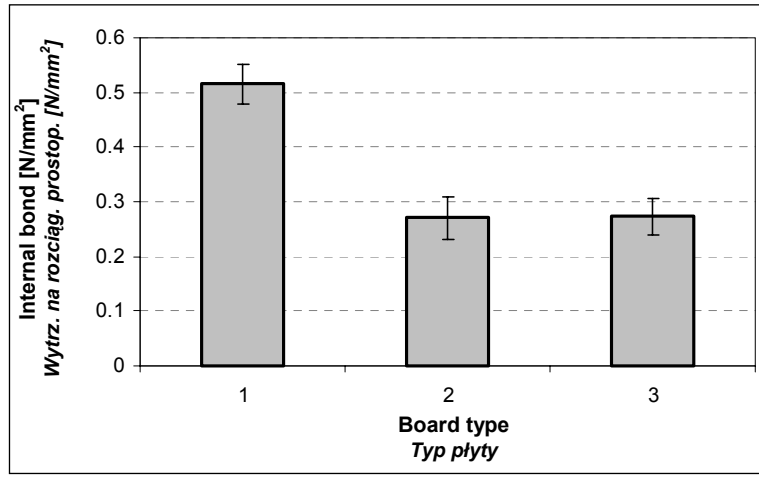

Fig. 5. Internal bond strength of tested panels
Rys. 5. Wytrzymałość na rozciąganie prostopadłe badanych płyt

Conclusions

The use of PVAc glue in particleboard production is uncommon. However, taking into account the increasing demands concerning formaldehyde content in/emission from panels, research on new binders for particleboard production is substantiated. The important issue connected with the use of such glue is its high viscosity which, as a matter of fact, decreases as temperature increases but still is too high to apply the glue using the method typical for UF resin. An addition of water results in lower viscosity but, on the other hand, dry mass content in glue decreases. The results show that bending strength and internal bond strength of particleboards produced with the use of PVAc glue are lower than in the case of panels produced with the use of UF resin.

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KLEJ PVAc JAKO SPOIWO W PŁYTACH WIÓROWYCH

Streszczenie

Rosnące wymagania dotyczące zawartości oraz emisji formaldehydu z płyt wiórowych zmuszają do poszukiwań alternatywnych środków wiążących. Jednym z takich klejów może być klej polioctanowinylowy. Niestety jego wysoka lepkość utrudnia nanoszenie metodami stosowanymi dla klejów mocznikowo-formaldehydowych. Zmiana lepkości poprzez obniżenie zawartości suchej masy kleju może być powodem niskiej wytrzymałości płyt wiórowych wytworzonych z udziałem takiego kleju. Wyniki badań wykazały, iż wytrzymałość na zginanie, jak również wytrzymałość na rozciąganie prostopadłe płyt wytworzonych z użyciem kleju PVAc jest niższa niż dla płyt wytworzonych z użyciem żywicy UF.

Słowa kluczowe: płyta wiórowa, klej, pvac

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COMBUSTION OF SOLID RECOVERED FUELS MADE FROM POST-CONSUMER WOOD WASTE IN A POWER INSTALLATION OF LOW POWER

The aim of the work was to identify the influence of chosen waste wood materials of assumed technical properties on the change of the course of basic parameters of their combustion process. To achieve the set aim, fuel mixtures of industrial and post-consumer wood waste were prepared. In the research the assessment of prepared solid recovered fuels was made and tests of their combustion in a laboratory heating installation of low power were conducted. The positive results of tests let us hope that previously used wood fuels originating from forest may be substituted with solid recovered fuels produced from wood waste.

Keywords: wood waste, solid recovered fuels, waste managements, thermal conversion of waste with energy recovery, emissions of gaseous products of combustion

Introduction

In economic practice there are many types of wood waste of very diverse properties. The waste is created during harvesting of wood raw material, its processing, and in households, e.g. worn-out and useless wood items. In recent period the last named type of waste has been attracting ever greater interest of people and institutions dealing with waste management. Relatively large overall dimensions of post-consumer products, application of many materials in their production and often unknown origin of those materials make this type of waste a huge problem for municipal service. Research conducted in the Wood Technology Institute in Poznan showed that only in 2002 around $5 \cdot 10^6$ m^3 of various types of post-consumer wood materials were produced in Poland [Ratajczak et al. 2003]. However, only insignificant part of it was deposited at municipal landfills. In the

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case of Poznan agglomeration this part amounted to as little as 2 400 Mg (approximately 6%[1] in 2008. Choosing a rational way of utilisation of this waste, one should take into account the quantity of different types of ballast substances in wood material.

One of the right lines of management of those materials is combustion of the so-called solid recovered fuels produced from them [Cichy 2007]. According to the definition presented in a technical specification [CEN/TS 15357:2006] the name of solid recovered fuels encompasses materials intended for combustion and produced from waste, different from hazardous, with a view of using them for energy recovery in suitable installations, whilst those materials fulfil requirements of CEN/TS 15359. The literature proposes a series of different names for that type of materials such as alternative fuels, fuels from waste [Wandrasz, Nadziakiewicz 1997, 1999, 2001; Wandrasz, Pikoń 2003, 2005, 2007] or formed fuels [Wandrasz, Wandrasz 2006]. However, in the authors' opinion terminology introduced by the European Committee for Standardization (CEN) seems to be the most universal. According to that terminology initial preparation of wood waste consisting in mixing of its various types in set proportions may be called production of fuels, and fuel materials obtained in this way may be called solid recovered fuels (acc. to CEN/TS 15357:2006). The share of wood in those fuels may be as high as 90%, which allows considering those materials biomass [Rozporządzenie… 2005, 2008] like it is abroad [Glowacki, Cichy 2007].

When the demand for solid biofuels is increasing (which also is connected with the international commitments of Poland), manufacture of a new type of fuel materials produced from wood waste is an especially desired activity [Cichy 2007]. However, the available literature lacks information on behaviour of such fuels during power combustion [Ściążko, Zuwała 2007; Rybak 2006; Wandrasz, Nadziakiewicz 1997, 1999, 2001; Wandrasz, Pikoń 2003, 2005, 2007, Wandrasz, Wandrasz 2006]. Therefore, it is necessary to conduct deepened research aimed at identification of phenomena occurring in real hearth that may have a significant influence on both the very process of combustion of solid recovered fuels made from wood waste and creation of products of their combustion that are dangerous to the environment. The issue is of special importance in the present legal situation when that waste should be processed before it is deposited at landfills. Previous experience indicates the possibility of burdening wood waste with different types of chemical preparations. In this case the process of production of recovered fuels should consist in such selection of their parameters so as to obtain as a result a solid combustible substance that may be used in power installations.

[1] Source: Information obtained from the Waste Management Plant in Poznan.

It seems that due to relatively low supply of wood on the domestic market and legal restrictions on the use of forest wood in the power industry the increased demand for biomass fuels may not be satisfied [Rozporządzenie… 2008]. Discovery of a renewable energy carrier that would be an alternative to wood could be at least a partial solution to that acute problem. However, it seems necessary to correctly define parameters of production process of such type of fuels in terms of their combustion properties, and especially limitation of possibilities of creation of adverse combustion products.

Aim and scope of research

The aim of the research was to identify the influence of essential properties of chosen chemically contaminated wood materials on changes in the course of basic parameters of their combustion process.

To achieve the set goal and on the basis of previous experiments [Cichy, Wróblewska 2003; Cichy 2007] tests consisting in energy processing of recovered fuels produced from wood waste were planned. Three types of post-consumer waste materials were used in the tests:

- post-consumer furniture,
- worn-out exterior builder's carpentry and joinery elements (exterior door),
- worn-out telecommunications poles,
- industrial waste – sawmill softwood sawdust.

The selected materials were subjected to the following laboratory analyses so as to evaluate their fuel properties and possible hazards during combustion:

- determination of moisture and ash content,
- determination of content of the so-called "volatile components",
- determination of heat of combustion and calculation of calorific value,
- determination of content of basic elements (C, H, N, S).

In the body of research tests at testing station consisting of low power boiler adjusted to wood combustion were conducted. Combustion experiments were carried out in the laboratory boiler room consisting of:

- boiler of power of 20 kW intended for combustion of wood and other solid fuels,
- heat accumulator,
- heat exchanger,
- central heating circulating pumps,
- heat gauge,
- exhaust discharging installation with chimney.

During tests, conducted maintaining optimum parameters of the boiler's performance, temperatures inside the test hearth and the boiler's heat efficiency

were controlled. The composition of released combustion gases was the observed factor.

Research methodology

Four types of wood waste were obtained for tests, of which three were post-consumer waste and one was industrial waste:

- telecommunications poles obtained from a telecommunications company. The poles originated from telecommunications network systems set up in the period 1930÷1960 and traces of mechanical wear were visible. In almost 90% the poles were preserved with an oily agent – impregnation oil (creosote oil),
- exterior doors originated from a building set up some 45 years ago. The body of the doors consisted of door leaf panels made of furniture panel. Due to the age of the doors, it should be assumed that furniture panels were manufactured using classical glues made from natural raw materials, i.e. casein or gluten. Throughout the whole period of exploitation tested elements were exposed to atmospheric factors. Traces of wood-decaying fungi were visible on the obtained samples as well as trace quantities of paints (enamel paints); therefore, characteristics of this waste were similar to those of natural wood,
- post-consumer furniture manufactured at the turn of 1970s and 1980s. It is typical box furniture made of particleboards, plywood or fibreboard (around 80%) and solid wood (around 20%). The external surfaces of particleboards were covered with paper foil, whilst solid elements and plywood or fibreboards were finished with layers of paints or lacquers,
- sawmill softwood sawdust was obtained from a WITAR Company sawmill in Porażyn.

To conduct the planned tests of combustion processes, the obtained waste wooden elements were reduced to the form of small chips. Chipping was carried out using mechanical disintegrator used in the technology of production of fuel briquettes from biomass. Approximately 100 kg of each type of raw material was prepared. Chipped material was packed into sacks and stored in a dry storeroom until the tests started. This way a similar level of moisture content of the analysed material was achieved.

Recovered biofuel production process consisted in preparation of appropriate mixtures of waste differing in chemical composition. Selected wood materials were mixed with each other in proportions given in table 1. The authors were especially interested to know the influence of the share of ballast substances (like binding, finishing, and preservative substances) on the amount of emission of gaseous products of combustion that have the influence on possible hazards to the environment. The use of a 1-percent share of chemically burdened waste in

the formed fuel stemmed from legal regulations effective in Poland that allow combustion of waste other than hazardous in the amount not exceeding 1% mixed with conventional fuel in typical power installations [Rozporządzenie… 2005].

Table 1. The share of particular types of waste in produced recovered fuels
Tabela 1. Udział poszczególnych rodzajów odpadów w wytworzonych paliwach wtórnych

No. *L.p.*	Post-consumer furniture *Meble poużytkowe*	Softwood sawdust *Trociny iglaste*	No. *L.p.*	Telecommunications poles *Słupy teletechniczne*	Exterior doors *Drzwi zewnętrzne*
	[%]			[%]	
1.	50	50	6.	50	50
2.	25	75	7.	25	75
3.	15	85	8.	15	85
4.	5	95	9.	5	95
5.	1	99	10.	1	99

Samples for laboratory analyses were taken from the prepared recovered wood fuels. Sampled material was reduced using a laboratory mill of Pulverisette 14 type and a laboratory mill of Pulverisette 15 type by Fritsch. Next, in order to characterise the obtained material in detail, the following characteristics were determined:

- elementary composition in the scope of content of carbon, hydrogen, nitrogen, and sulphur using an analyser of EA 1108 type by Carlo Erba Instruments. The scale of the analyser was 0.01÷100%. Analysed samples were dried in the temperature of 60°C until they reached constant mass. Sulphanilic acid was used as an external standard,
- basic fuel properties that were determined using appropriate procedures developed for the assessment of municipal waste properties:
  - moisture content (PN-Z-15008-02:1993),
  - ash content (PN-Z-15008-03:1993),
  - content of the so-called "volatile components" (PN-G-04516:1981),
  - calorific value (PN-Z-15008-04:1993),
- calorific value of fuel mixtures (solid recovered fuels) that was calculated based on proposals of Wandrasz and Wandrasz [2006] acc. to the following formulas:

$$W_d = u_1 \cdot (W_d)_{11} + u_2 \cdot (W_d)_{12} + \ldots + u_n \cdot (W_d)_{1n} \qquad \text{[J/g]} \qquad (1)$$

and

$$\sum_i u_i = 1 \qquad (2)$$

where:

W_d – mixture calorific value [J/g]
$(W_d)_{1\,n}$ – n component calorific value [J/g]
$u_1 \ldots u_n$ – mass share of components $1 \ldots n$.

Combustion experiments in a quarter-technical scale were conducted according to an own procedure developed on the basis of previous research [Cichy 2004, 2007]. Prepared samples of fuels were combusted at a test station consisting of a set of devices making up a laboratory boiler room. The main element of the station is a central heating boiler with water curtain of Futura Bio 25 type with thermal efficiency of 25 kW produced by CHT – Cichewicz. The boiler is intended for combustion of crumbled wood biomass. Technical characteristic of the laboratory boiler room devices is presented in table 2.

Table 2. Technical parameters of the boiler installed at the test station intended for investigation of processes of combustion of solid recovered fuels made of wood waste

Tabela 2. Parametry techniczne kotła wchodzącego w skład stanowiska badawczego przeznaczonego do badań procesów spalania stałych paliw wtórnych wytworzonych z odpadów drzewnych

No. *Lp.*	Parameter *Parametr*	Unit *Jednostka*	Futura Bio 25 boiler *Urządzenie kotłowe Futura Bio 25*
1.	Nominal thermal power *Nominalna moc cieplna*	kW	25
2.	Water maximum temperature *Maksymalna temperatura wody*	°C	95
3.	Water capacity *Pojemność wodna*	dm^3	105
4.	Fuel consumption (nominal) *Zużycie paliwa (nominalne)*	kg/h	2÷5
5.	Fuel bunker capacity *Pojemność zasobnika paliwa*	dm^3	500
6.	Combustion chamber capacity *Pojemność komory spalania*	dm^3	–
7.	Permissible working pressure *Dopuszczalne ciśnienie robocze*	bar	2
8.	Exhaust temeprature *Temperatura spalin*	°C	> 120
9.	Boiler's efficiency *Sprawność urządzenia*	%	79÷83

Exhaust from both boilers is passed through an exhaust collector to a chimney of height of around 6 meters and diameter of 250 mm. The heat generated during combustion of analysed materials is collected in a buffer accumulator of capacity of 3000 dm^3. Measurement ferrules for measuring composition of combustion gases and exhaust temperature were installed in the exhaust collector. Circulation of heating medium (water) in the installation was forced thanks to the use of two pumps installed in a pipeline feeding a heat distributor. Reception of generated heat was assured by an air heater. The heating medium circulation installation was fitted with a vane water meter with sensors that were connected to a calorimeter, thus made it possible to take energy measurements.

The body of the study was research on combustion process of the prepared recovered wood fuels. The main aim of the research was to measure emission of combustion gases produced during that process. The analysis of combustion gases was carried out using an exhaust analyser of Lancom Series II type by Land Combusion. Parameters and scale of that device are shown in table 3. During combustion process measurements of temperatures inside the test hearth were taken as well using temperature sensors (of NiCrSi-NiSi type) and digital temperature gauge of DT 16 type by Metrol. Temperature was measured every 2 minutes and analysis of composition of combustion gases was being carried out at the same time. Apart from the above-mentioned measurements, thermal effects of the process in the laboratory central heating installation were recorded.

Table 3. Measurement scale and basic parameters of exhaust analyser of Lancom Series II type
Tabela 3. Zakres pomiarowy i podstawowe parametry analizatora spalin Lancom Series II

Measured parameter *Mierzony parametr*	Unit *Jednostka*	Measurement scale *Zakres pomiarowy*	Accuracy *Dokładność*	*Resolution* *Rozdzielczość*
O_2	%	0 … 25	± 1%	± 0,1
$CO_{wysoki/high}$	ppm	0 … 40.000	± 2%	± 100
NO	ppm	0 … 2.000	± 2%	± 1
NO_2	ppm	0 … 100	± 2%	± 1
SO_2	ppm	0 … 2.000	± 2%	± 1
C_xH_y	ppm	0 … 50.000	± 2%	± 100
CO_2	%	0 … 25	± 2 %	± 0,1
NO_x	ppm			
Combustion efficiency *Sprawność spalania*	%			
Air surplus coefficient *Współczynnik nadmiaru powietrza*	–			

Those measurements were taken using an electronic calorimeter of CE 3 type, by PoWoGaz S.A., that allows readings such as: heating medium energy (GJ), temperatures of feed and return (°C), momentary power (kW), momentary flow of the heating factor (m^3/h). The measurement procedure consisted of the following elements:

- setting fuel in the hearth alight and combustion of fuel under the boiler until optimum combustion process parameters are reached,
- period of reaching stable conditions of the process (3 hours),
- stabilisation of the process with assumed working conditions (around 1 hour),
- analysis of combustion process:
  - measurement of temperatures inside the hearth,
  - measurement of concentration of gaseous combustion products,
  - measurement of combustion parameters,
  - measurement of energy parameters of the process,
- extinguishing the hearth,
- preparation of the station for next analyses.

Tests were carried out using an operating installation and keeping heat power close to 75% of the nominal power. The operators saw to it that during the whole measurement period there was no significant fluctuation in an average value of parameters. Obtained results of chimney emission were converted into normal conditions and into 11-percent content of oxygen [PN-ISO 8756:2000], whilst NO_x concentration was given after conversion into nitrogen dioxide (NO_2).

Test results

Basic properties of tested recovered fuels

Table 4 presents results of determinations of elementary composition of the initial waste materials. As it follows from the presented data, the content of carbon in tested materials was changing in the range from 48.43% (post-consumer furniture) to 52.99% (telecommunications poles). The content of hydrogen was running similarly: from 6.80% in post-consumer furniture to 7.05% in telecommunications poles. Such state of affairs resulted from specific chemical composition of evaluated materials, and mainly from the nature of ballast substances: in the case of telecommunications poles the substance was impregnation oil (creosote oil) that is a mixture of hydrocarbons – products of dry distillation of hard coal; in the case of post-consumer furniture the substance was amine resins used as binding agents (glues) and finishing agents (components of artificial veneers). Significant differences were noted also when nitrogen content

was evaluated. In accordance with expectations, the highest amounts of that element were found in furniture (3.19%), which resulted from a considerable share of particleboards and plywood in the total mass of that waste. In the other materials the level of nitrogen content was similar to the level found in natural wood (0.09÷0.21%). In none of the analysed samples any share of sulphur was found (within the limits of the method determinability). The differences in oxygen content in tested materials mainly resulted from their burdening with ballast substances and so the lowest content of that element was found in telecommunications poles (39.36%), and the highest in softwood sawdust (41.87%). From the above comparison also it follows that chemical composition of samples obtained from exterior doors was similar to the composition of natural, "pure" wood (C – 49.72%, H – 6.98%, N – 0.21%, and O – 41.18%). The above-described raw materials served for preparation of fuel mixtures (production of solid recovered fuels from wood waste). The purpose of the authors was to prepare mixtures in which contaminated materials (post-consumer furniture, and telecommunications poles) would be "diluted" with pure materials or materials of low content of chemical contaminants (sawdust, post-consumer door). Table 5 presents basic elementary composition of those mixtures. Obtained fuel mixtures (solid recovered fuels from wood waste) were subjected to further tests.

Table 4. Content of basic elements in the initial waste materials used in the tests
Tabela 4. Zawartość podstawowych pierwiastków w wyjściowych materiałach odpadowych wykorzystanych w doświadczeniach

Name of the sample *Nazwa próbki*	Element content *Zawartość pierwiastka*				
	Carbon *Węgiel*	Hydrogen *Wodór*	Nitrogen *Azot*	Sulphur *Siarka*	Oxygen*) *Tlen**)*
	[%]				
Post-consumer furniture *Meble použytkowe*	48.43	6.80	3.19	n.d. *n.w.*	40.30
Post-consumer doors *Drzwi použytkowe*	49.72	6.98	0.21	n.d. *n.w.*	41.18
Telecommunications poles *Słupy teletechniczne*	52.99	7.05	0.19	n.d. *n.w.*	39.36
Softwood sawdust *Trociny iglaste*	50.45	6.87	0.09	n.d. *n.w.*	41.87

*) value determined by calculation
*) *wartość wyznaczona z obliczeń*

n. d. – not detected
n.w. – nie wykryto

Table 5. Content of basic elements in fuel mixtures prepared for tests
Tabela 5. Zawartość podstawowych pierwiastków w mieszankach paliwowych przygotowanych do badań

Type of waste – mixture composition *Rodzaj odpadów – skład mieszanki*		Element content *Zawartość pierwiastka*				
		Carbon *Węgiel*	Hydrogen *Wodór*	Nitrogen *Azot*	Sulphur *Siarka*	Oxygen *Tlen*
[%]						
Post-consumer furniture *Meble pożytkowe*	Softwood sawdust *Trociny iglaste*					
50	50	49.44	6.84	1.64	n.d. *n.w.*	41.09
25	75	49.95	6.85	0.87	n.d. *n.w.*	41.48
15	85	50.15	6.86	0.56	n.d. *n.w.*	41.63
5	95	50.35	6.87	0.25	n.d. *n.w.*	41.79
1	99	50.43	6.87	0.12	n.d. *n.w.*	41.85
Telecommunications poles *Słupy teletechniczne*	Post-consumer doors *Drzwi pożytkowe*					
50	50	51.36	7.02	0.20	n.d. *n.w.*	40.27
25	75	50.54	7.00	0.21	n.d. *n.w.*	40.73
15	85	50.21	6.99	0.21	n.d. *n.w.*	40.91
5	95	49.88	6.98	0.21	n.d. *n.w.*	41.09
1	99	49.75	6.98	0.21	n.d. *n.w.*	41.16

n.d. – not detected
n.w. – nie wykryto

Table 6 shows results of determinations of basic fuel properties of the initial wood materials. From presented data it follows that tested waste materials were characterised by low moisture content (6.79÷10.18%) and high content of volatile components (78.61÷84.98%). Evaluated fuels were also characterised by diverse ash content – relatively low for sawmill sawdust and telecommunica-

tions poles (0.72 and 0.39%, respectively) and little higher for post-consumer furniture and post-consumer doors (1.24 and 1.87%, respectively). A relatively high burdening of evaluated materials with ballast substances accounts for such state of affairs (sand in sawdust and telecommunications poles, mineral pigments in veneers of post-consumer furniture, remains of fittings and nails in remnants of post-consumer doors).

Table 6. Basic fuel properties of the initial waste materials
Tabela 6. Podstawowe właściwości paliwowe wyjściowych materiałów odpadowych

Type of waste *Rodzaj odpadów*	Determination type *Rodzaj oznaczenia*		
	Moisture content *Wilgotność*	*Ash* *Popiół*	Volatile components *Części lotne*
	[%]		
Post-consumer furniture *Meble pożytkowe*	6.79	1.24	78.61
Post-consumer doors *Drzwi pożytkowe*	8.51	1.87	80.49
Telecommunications poles *Słupy teletechniczne*	10.18	0.39	84.98
Sawmill sawdust *Trociny tartaczne*	9.16	0.72	82.85

Table 7 presents results of determinations of moisture content and ash for prepared fuel mixtures. In accordance with expectations, obtained results are resultants of initial parameters of waste materials. Table 8 compares results of determinations of heat of combustion and calculations of calorific value in analytical state, on "as received" basis, and on "dry and ash-free" basis for the initial wood materials. Chemical contaminants in analysed samples of post-consumer wood did not have any radical influence on calorific value of burnt materials. The heat of combustion fluctuated around 19.5 MJ/kg (19.264÷19.703 MJ/kg), and only in the case of waste telecommunications poles this value was higher (21.569 MJ/kg), which was undoubtedly a result of the content of creosote oil characterised by high calorific value. Because most of evaluated waste was characterised by relatively low moisture content, calorific value calculated for working state was changing insignificantly from 17.685 to 18.076 MJ/kg, and in the case of telecommunications poles it was 19.861 MJ/kg. Having taken into account moisture content and ash content in burnt materials, higher diversity of calorific value was observed. Calorific value calculated on "dry and ash-free" basis was changing in the range from 18.808 to 19.455 MJ/kg (for telecommunications poles calorific value was 21.675 MJ/kg).

Table 7. Basic fuel properties of recovered fuels made of wood waste
Tabela 7. Podstawowe właściwości paliwowe paliw wtórnych wytworzonych z odpadów drzewnych

Type of waste – mixture composition *Rodzaj odpadów – skład mieszanki*		Determination type *Rodzaj oznaczenia*	
		Moisture content *Wilgotność*	Ash *Popiół*
[%]			
Post-consumer furniture *Meble poużytkowe*	Sawmill sawdust *Trociny tartaczne*		
50	50	7.98	0.98
25	75	8.57	0.85
15	85	8.80	0.80
5	95	9.04	0.75
1	99	9.14	0.73
Telecommunications poles *Słupy teletechniczne*	Post-consumer doors *Drzwi poużytkowe*		
50	50	9.35	1.13
25	75	8.93	1.50
15	85	8.76	1.65
5	95	8.59	1.80
1	99	8.53	1.86

Table 8. Basic fuel properties of the initial waste materials
Tabela 8. Podstawowe właściwości paliwowe wyjściowych materiałów odpadowych

Type of waste *Rodzaj odpadów*	Determination type *Rodzaj oznaczenia*			
	Heat of combustion *Ciepło spalania*	Calorific value *Wartość opałowa*		
		in analytical state *w stanie analitycznym*	"as received" basis *w stanie roboczym*	dry and ash-free basis *w stanie suchym i bezpopiołowym*
	[kJ/kg]			
Post-consumer furniture *Meble poużytkowe*	19 264	17 685	17 070	18 808
Post-consumer doors *Drzwi poużytkowe*	19 412	17 746	17 167	19 447
Telecommunications poles *Słupy teletechniczne*	21 569	19 861	19 078	21 675
Sawmill sawdust *Trociny tartaczne*	19 703	18 076	17 223	19 455

Table 9. Calorific value of recovered fuels made of wood waste
Tabela 9.Wartość opałowa paliw wtórnych przygotowanych z odpadów drzewnych

Type of waste – mixture composition *Rodzaj odpadów – skład mieszanki*		Calorific value in working state *Wartość opałowa w stanie roboczym*
[%]		[kJ/kg]
Post-consumer furniture *Meble poużytkowe*	Sawmill sawdust *Trociny tartaczne*	
50	50	17 147
25	75	17 185
15	85	17 200
5	95	17 215
1	99	17 221
Telecommunications poles *Słupy teletechniczne*	Post-consumer doors *Drzwi poużytkowe*	
50	50	18 123
25	75	17 645
15	85	17 454
5	95	17 263
1	99	17 186

Table 9 presents numerical data on calorific value for every of prepared fuel mixtures. In accordance with expectations, only insignificant changes of that parameter (up to 74 kJ/kg) were observed in the case of mixtures of sawdust and furniture, whilst in the case of mixtures of post-consumer doors and telecommunications poles the difference between extreme values was over 900 kJ/kg, which stemmed from high diversity of that parameter for the initial materials (17.167 MJ/kg and 19.078 MJ/kg, relatively). From the above comparisons of fuel properties and basic chemical composition of raw materials prepared for tests it unambiguously follows that evaluated materials are characterised by very good properties which make it possible to use those materials as biomass fuels, i.e. solid recovered fuels from wood waste.

Experiments of combustion of tested wood materials

The actual tests were preceded with initial experiments in which combustion conditions optimal for a given type of fuel were determined. The determined parameters of combustion process are: fuel granulation, amount of air dosed, and amount of fuel dosed. After the parameters of boiler operation were standardised, a measured out amount of tested fuel was added to a bunker and at the same time recording of the following measured parameters was started:

– the amount of emission of gaseous combustion products to the atmosphere (CO, CO_2, NO, NO_2, C_xH_y, O_2),
– combustion process efficiency,
– air surplus coefficient.

Simultaneously the following thermal parameters, produced during operation of the laboratory boiler system, were recorded:

– unit amount of heat generated by the system,
– total amount of heat generated by the system during combustion of a defined amount of tested fuel.

Combustion of fuels formed from sawdust and post-consumer furniture

Fig. 1÷10 present compared data on fuels obtained from waste of pure wood (softwood sawdust) and composite wood products (post-consumer furniture). Figure 1 shows changes of air surplus coefficient during combustion of analysed fuel mixtures. As it follows from the compared data, combustion parameters (the amount of fuel and air dosed into the hearth chamber) for all types of tested recovered fuels were set in such way so as to have the air surplus coefficient λ fluctuate between 2.00 and 4.00. In few cases an aberration from that rule was observed. That was caused by some heterogeneity of the size of burnt particles, i.e. the fuel contained both fine wood particles of size close to microchips from particleboards and much bigger particles of shape similar to chips used in OSB technology. Such state of affairs caused the situation when the capacity of fuel fed into the hearth was the same at any time of analysed process, but the mass of the fuel portion was different (various fed mass). It cannot be ascertained that composition of fuel mixture (the share of post-consumer furniture in burnt fuel) directly influenced the value of calculated air surplus coefficient.

Fig. 2 presents changes in exhaust temperature measured in flue during combustion of analysed fuel mixtures. During the measurements temperature was changing in the range 100÷400ºC and most often it ranged from 250 to 350ºC. As regards the value of air surplus coefficient λ, it may be said that the value of coefficient λ drops as temperature of combustion gases rises and contrarily: a drop in exhaust temperature is observed as an increase in air surplus coefficient. Like in the former case, it cannot be ascertained that composition of analysed formed fuels directly influenced the height of temperatures measured in the flue. Fig. 3 and 4 present changes in temperatures inside the test hearth. Combustion of fuel in the boiler used in tests is carried out in the so-called trough hearth made of ceramic materials and fitted with suitable air delivering nozzles. Fuel is fed to the trough hearth using a worm conveyor. Temperature sensors showing changes inside the hearth are installed at the beginning and end of the trough hearth. In the first part of the trough hearth biomass fuel is subjected to initial thermal processing. As a result of this processing water contained in the fuel is evaporated and then the so-called volatile components are

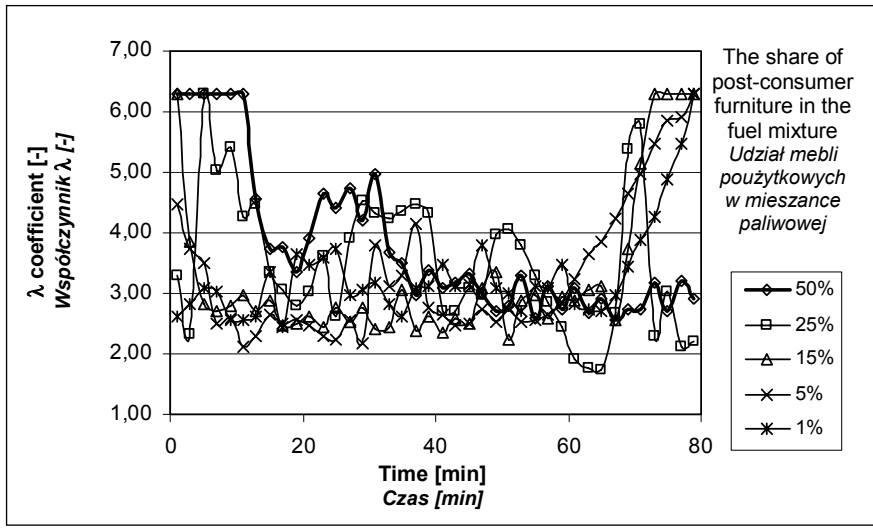

Fig. 1. The value of air surplus coefficient during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture
Rys. 1. Wielkość współczynnika nadmiaru powietrza w trakcie spalania mieszanek paliwowych trociny iglaste – meble pożytkowe

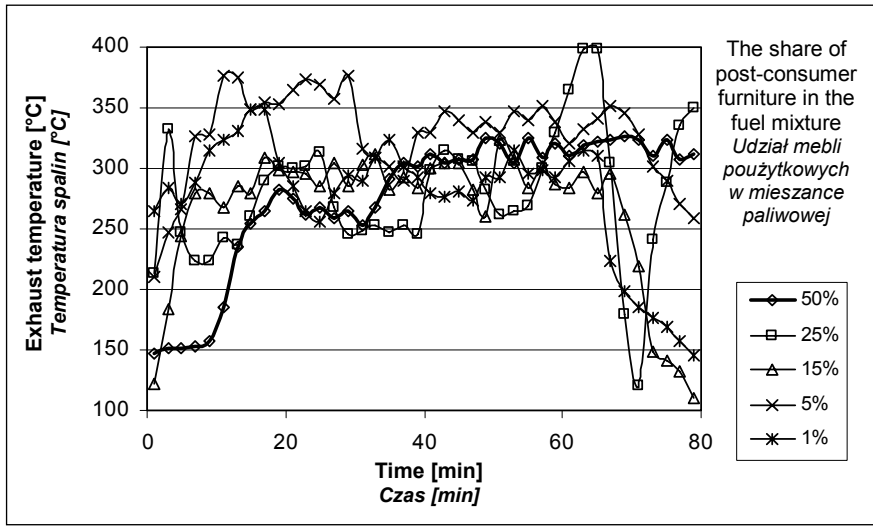

Fig. 2. Changes in temperatures of combustion gases during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture
Rys. 2. Zmiany temperatur gazów spalinowych w trakcie spalania mieszanek paliwowych trociny iglaste – meble pożytkowe

degassed. Those are endothermic changes, and changes in the second part of the trough hearth are the source of heat necessary for endothermic changes to happen. This is the place where actual oxidisation of earlier released volatile components happens as well as burning out of produced carbonisate. Those changes are exothermic.

Fig. 3 shows data from the first measurement point located in the place where fuel is introduced into the hearth. Presented data shows that temperature in that place oscillated around 450ºC and ranged from 300ºC to 650ºC. Insignificant deviations in the initial and final period of experiments most probably were caused by observed heterogeneity of fuel, and thus smaller combustion mass delivered to the hearth grill in the analysed moment. Much higher temperatures (approximately 800ºC) in the first measurement point observed when fuel with a 15-percent share of post-consumer furniture was burnt presumably were caused by the fact that the front of burnt fuel was moved towards the bunker. It does not seem that that action had a significant influence on the course of the process of combustion of evaluated fuel mixture. The course of combustion process also does not indicate that chemical composition of assessed fuel mixtures had a significant influence on diversity of temperatures recorded in that measurement point. Observed changes resulted from the nature of operation of the controller supervising work of the fuel feeder. Fig. 4 presents changes of temperatures recorded in the second (2) measurement point of the hearth. As it follows from presented data, recorded temperatures were changing within the range from 400 to 800ºC. Observed deviations from those values were caused by cyclic operation of fuel feeder, like it was in the case of the first (1) measurement point. It does not seem that composition of fuel mixture delivered to the hearth grill had a significant influence on the value of temperature recorded in this point (2). Dynamic changes were observed in the trough hearth and on the hearth grill. Portions of fuel delivered to the trough hearth by the worm conveyor underwent previously described physical and chemical changes. Turning on of the feeder resulted in delivery of a new portion of fuel to the trough hearth. This fuel falls on already burning wood particles and produced incandescing carbonisate. As a result the new portion of fuel was moved and mixed with burning particles. The effect of those actions was a cyclic drop of temperature. After few minutes temperature rose rapidly, which was an effect of the new portion of fuel being set alight. Described course of combustion process is a result of simple constructional solutions applied in the power device of low power intended for combustion of solid biofuels.

Changes of temperature of circulating water measured by a sensor installed in the boiler of the test installation are presented in fig. 5. Compared data shows that the temperature increase connected with energy delivered to the system was quite regular. Tests of most of analysed samples of fuels were started when the temperature of water in the boiler fluctuated between 42 and 52ºC. Only in the

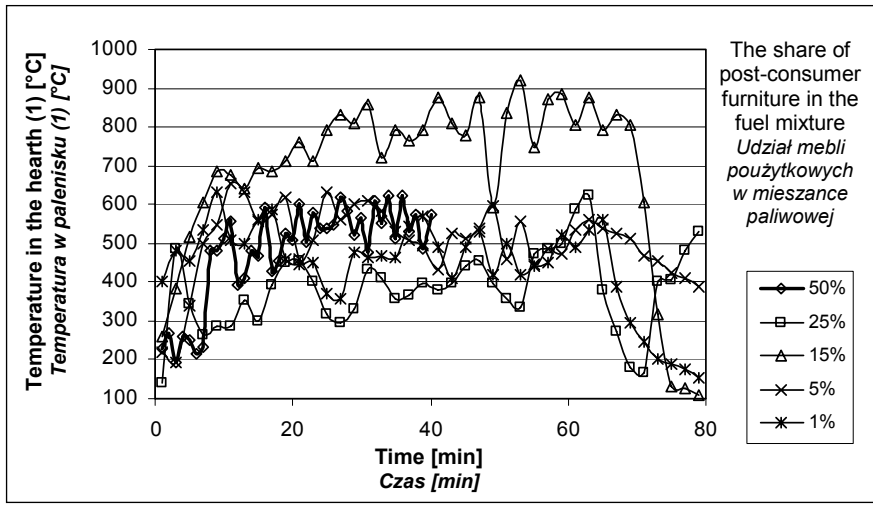

Fig. 3. The course of changes in temperatures recorded in the first measurement point of the hearth during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture

Rys. 3. Przebieg zmian temperatur rejestrowanych w pierwszym punkcie pomiarowym paleniska przy spalaniu mieszanek paliwowych trociny iglaste – meble poużytkowe

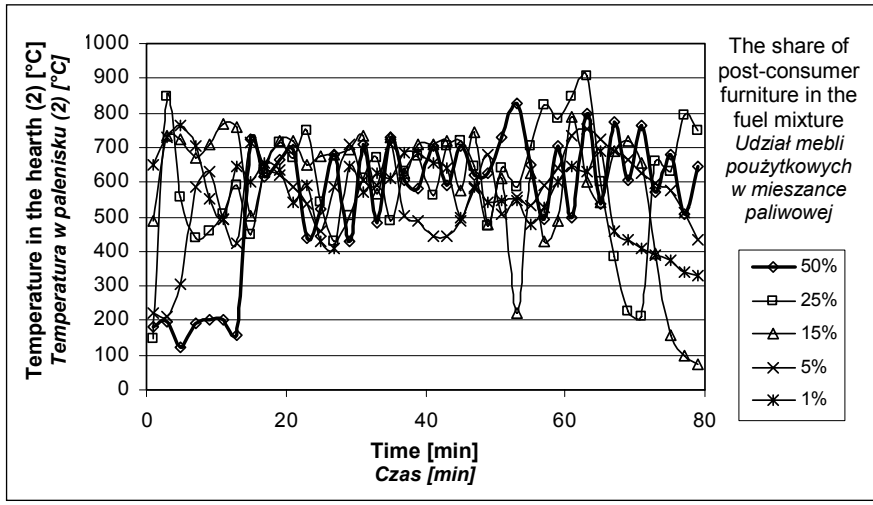

Fig. 4. The course of changes in temperatures recorded in the second measurement point of the hearth during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture

Rys. 4. Przebieg zmian temperatur rejestrowanych w drugim punkcie pomiarowym paleniska przy spalaniu mieszanek paliwowych trociny iglaste – meble poużytkowe

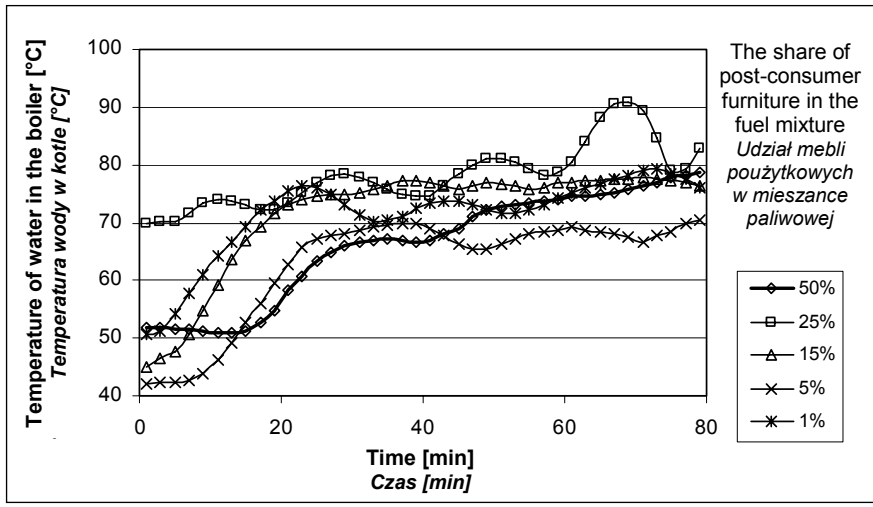

Fig. 5. Changes in the temperature of boiler water recorded in the boiler during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture

Rys. 5. Zmiany temperatury wody kotłowej rejestrowane w kotle w trakcie spalania mieszanek paliwowych trociny iglaste – meble poużytkowe

case of fuel with a 25-percent share of post-consumer furniture it was necessary to start measurements when the temperature reached 70ºC, which was the reason why in the final period of measurements the temperature in the boiler was higher than 90ºC. Large inertia of the system, i.e. steel boiler and heating medium (water), allowed for much levelling of temperature curves in relation to temperatures measured inside the hearth that were changing in the range of around 200ºC. It cannot be said that composition of fuel mixtures directly influenced changes of water temperatures measured inside the boiler.

Much greater fluctuations were recorded during evaluation of changes of boiler's momentary power during tests of combustion of fuel mixtures consisting of softwood sawdust and post-consumer furniture. The changes are presented in fig. 6. Compared data shows that at the beginning of tests thermal power of the boiler installation was changing in the range from 1.5 to 4.5 kW. After around 30 minutes the system reached the power ranging from 9.5 to 11.0 kW, which was approximately 50% of the nominal power of the boiler. Undoubtedly, high changeability of this parameter was influenced by changes in the flow of combustion mass in the trough hearth recorded as changes of temperatures inside the hearth (fig. 3 and 4). Presented data does not justify a statement that composition of fuel mixtures influenced the value of momentary power in the thermal system on which tests were conducted.

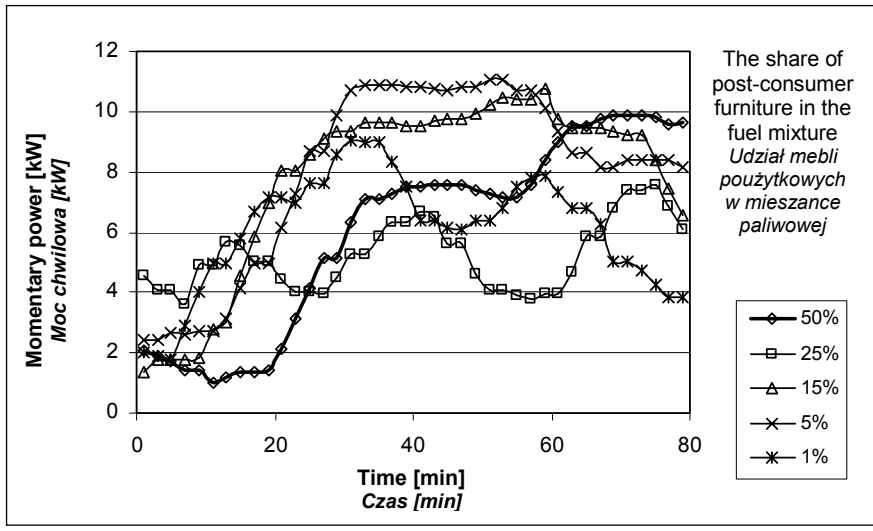

Fig. 6. Changes in momentary power of the boiler installation recorded during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture

Rys. 6. Zmiany mocy chwilowej instalacji kotłowej rejestrowane w trakcie spalania mieszanek paliwowych trociny iglaste – meble pożytkowe

Next chart (fig. 7) presents values of energy generated by the thermal installation during tests of combustion of prepared fuel mixtures. As it follows from presented data, similar amounts of energy ranging from 43 to 53 MJ were obtained during combustion of the same mass of fuel in similar thermal conditions of combustion process. Observed differences in the value of generated energy mainly resulted from unequal course of combustion process, heterogeneity of fuel, and cyclic operation of the controller supervising delivery of fuel to the hearth. Neither any significant differences in calorific values of evaluated fuel mixtures (17.15÷17.22 MJ/kg), nor any influence of chemical composition of those mixtures on the amount of energy produced by the measured system were noted.

Fig. 8÷10 present the amount of emission of gaseous products of the process during tests of combustion of analysed fuel mixtures (formed fuels) made from softwood sawdust and post-consumer furniture. Fig. 8 demonstrates changes in the amount of emission of carbon oxide during combustion of fuel mixtures consisting of sawdust and post-consumer furniture. From presented data it follows that the amount of emitted CO decreased as temperature in the hearth rose, and so in the initial period of the hearth work (when the fire kindled) the emission amount was around 9 g/m^3, and in the final period it dropped to around 2 g/m^3. It seems that the main factor that influenced the amount of emission of

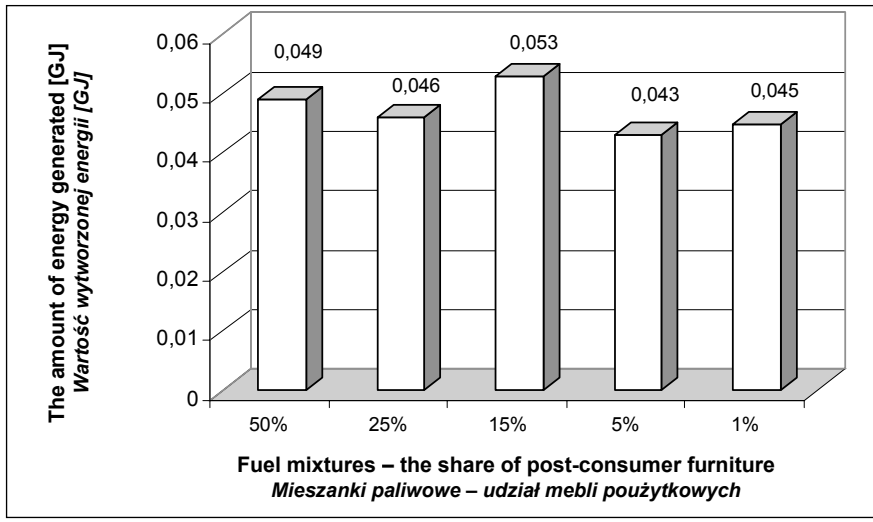

Fig. 7. The value of thermal energy generated in the boiler installation during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture
Rys. 7. Wartość wytworzonej energii cieplnej w instalacji kotłowej w trakcie spalania mieszanek paliwowych trociny iglaste – meble pożytkowe

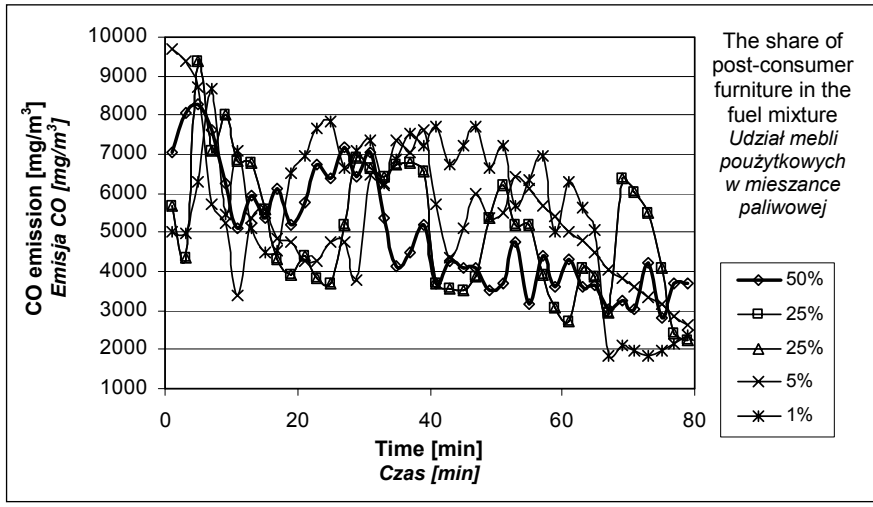

Fig. 8. Carbon oxide emission converted into 11% O_2 during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture
Rys. 8. Emisja tlenku węgla w przeliczeniu na 11% O_2 w trakcie spalania mieszanek paliwowych trociny iglaste – meble pożytkowe

that gas was temperature reached in a given moment in the hearth. A low value of that parameter, i.e. approximately 200÷400ºC, caused a situation when effectiveness of oxidisation of volatile components produced in the hearth was relatively low. An increase in temperature to the level of 600÷900ºC was the reason why significant part of produced gases was burnt. The increase of temperature in the hearth was caused by released energy coming from combustion of carbon oxide. Despite some differentiation between curves of CO content in exhaust in relation to composition of fuel mixture, it cannot be unambiguously said that the share of contamination in burnt fuel directly influenced the amount of carbon oxide emission.

Fig. 9 depicts the content of carbon dioxide in combustion gases during combustion of analysed fuel mixtures. As it follows from presented data, the amount of CO_2 emission during tests of combustion was fluctuating between around 2 to 9%. The high content of carbon dioxide in exhaust (approximately 9÷10%) proved correct course of combustion process. As a result of it an increase in temperature inside the hearth was recorded (fig. 3 and fig. 4) as well as a reduction in carbon oxide emission (fig. 8). Like in the case of curves illustrating changes in the amount of carbon oxide emission, despite differences, it is hard to unambiguously ascertain that the share of contamination in burnt fuel mixtures influenced the content of carbon dioxide found in exhaust.

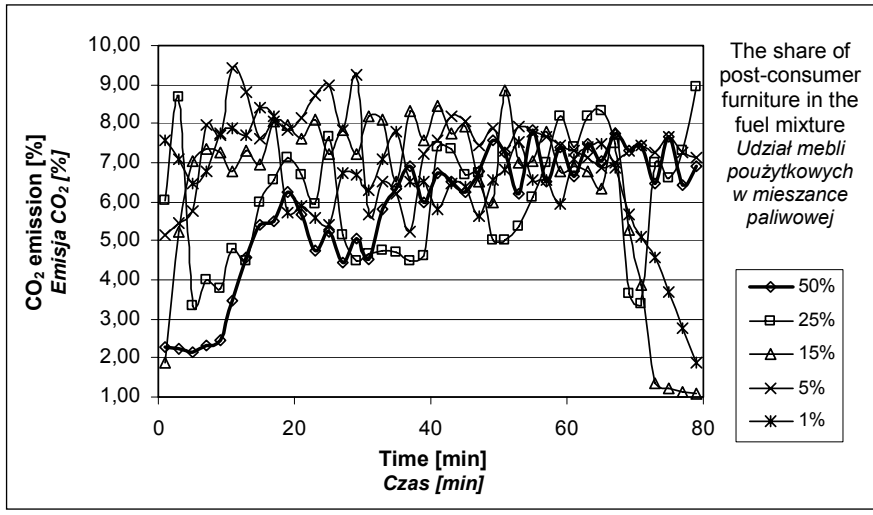

Fig. 9. Carbon dioxide emission during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture

Rys. 9. Emisja ditlenku węgla w trakcie spalania mieszanek paliwowych trociny iglaste – meble poużytkowe

Changes in the emission of nitrogen oxides (NO_x) during combustion of analysed fuel mixtures are illustrated in fig. 10. To present this process in a reliable way, results of nitrogen oxide (NO) emission and nitrogen dioxide (NO_2) emission obtained during measurements were converted into nitrogen dioxide (NO_2) in accordance with applicable procedures. Next, the obtained data was converted into 11-percent content of O_2 in combustion gases. From presented data (fig. 10) it stems that the level of NO_x emission was closely connected with composition of fuel mixtures, and especially with the share of post-consumer furniture in them. The content of nitrogen in evaluated mixtures was ranging from 0.12% in fuel with 1-percent share of post-consumer furniture to 1.64% in fuel with 50-percent content of furniture waste (table 5). According to expectations, the highest level of NO_x emission was observed in the case of exhaust produced during combustion of fuel containing 50% of post-consumer furniture. Obtained data oscillated around the value of 1080 mg of NO_x in 1 m^3 of combustion gases. In the case of the other mixtures levels of the emission of nitrogen oxides were, respectively: 25% of post-consumer furniture – 600 mg/m^3, 15% – 350 mg/m^3, 5% – 290 mg/m^3, and 1% – 200 mg/m^3.

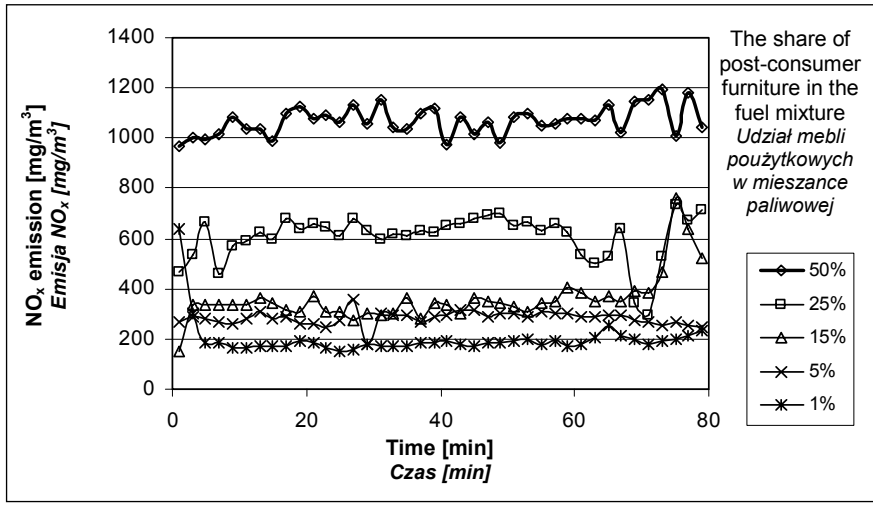

Fig. 10. Emission of nitrogen oxides converted into NO_2 with reference to 11% O_2 during combustion of fuel mixtures made from softwood sawdust and post-consumer furniture

Rys. 10. Emisja tlenków azotu w przeliczeniu na NO_2 w odniesieniu do 11% O_2 w trakcie spalania mieszanek paliwowych trociny iglaste – meble poużytkowe

Considerable fluctuations in the values of NO_x emission, noticeable especially at the beginning and at the end of measurement cycle, resulted from conversion of relatively low emission values into 11% O_2 when the content of gaseous products in exhaust is low (O_2 content close to 20.9%). Unequal course of combustion process showed the phenomenon described in former studies [Cichy 2004], i.e. reactions of oxidisation and reduction with carbon oxide and nitrogen oxides. On the one hand, a result of that process is reduction of created fuel nitrogen oxides and on the other hand, oxidisation of a product of incomplete combustion of organic fuel, i.e. CO. It stems from the above that limitation of the emission of nitrogen oxides using primary methods (gradation of dosing of air into hearth) is possible also in low power hearths of much simplified construction.

During experiments of combustion of fuel mixtures consisting of sawmill sawdust and post-consumer furniture no presence of hydrocarbons in exhaust above the determinability level of the applied analytical method, i.e. around 0.01%, was observed. However, a conclusion that no light hydrocarbons are present in exhaust when such type of fuel mixtures is burnt should not be drawn from the above. That situation indicates only that combustion is relatively high efficient and introduction of an additional combustion level probably would make it possible to burn out produced carbon oxide and make the process even more efficient.

Combustion of solid recovered fuels from waste post-consumer doors and worn-out telecommunications poles

In the second part of research tests of combustion of fuels mixtures made of crumbled telecommunications poles and crumbled wooden elements of exterior doors were carried out. Post-consumer exterior wooden doors were made of furniture panels and solid wood elements. In connection with the above, those materials were considered composite wood products. Crumbled elements of telecommunications poles were an addition of waste materials containing hazardous substances. Such actions are substantiated by provisions of the Act on waste (2001)[2] and the Regulation of the Minister of the Environment on standards of emission from installations [2005].

The process of combustion of fuel mixtures containing post-consumer doors and telecommunications poles was carried out keeping parameters of operation of the boiler's devices the same as in the case of the mixtures consisting of sawmill sawdust and post-consumer furniture. Results of measurements made during combustion experiments are illustrated in charts (fig. 11÷21).

[2] The Act of 27 April 2001 on waste – article 11(2) "It is allowed to mix hazardous waste of different types and hazardous waste with waste other than hazardous with a view to improving safety of recovery processes or neutralising waste created as a result of mixing, if those processes will not result in increasing danger to human life and health or the environment".

Changes in air surplus coefficient λ that characterises the course of combustion process in boiler are presented in fig. 11. Compared results show that in the main combustion process the value of coefficient λ changed within the range 2.0÷3.5. Essential aberrations from those values were recorded in the initial and final period of measurement cycle. Such state of affairs was connected with uneven filling of the hearth that was observed at the beginning of measurement period when fuel was delivered to the hearth in smaller portions, as well as at the end of the period when the worm conveyor was not anymore fully filled with fuel. Some inconvenience that had a bearing on coefficient λ increase was heterogeneity of granulation of burnt fuels. The content of too big particles in overall mass of fuel caused a situation when the portion of fuel dosed to the hearth contained less mass of combustible substances. However, no significant influence of composition of fuel mixtures on the value of air surplus coefficient during analysed measurement cycles was noted.

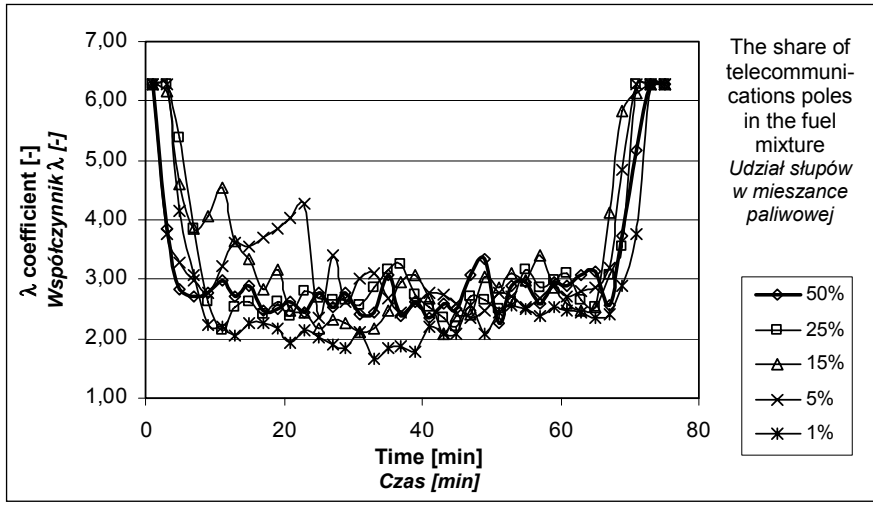

Fig. 11. The value of air surplus coefficient during combustion of fuel mixtures made from telecommunications poles and post-consumer doors
Rys. 11. Wielkość współczynnika nadmiaru powietrza w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi pożytkowe

Fig. 12 presents changes in temperature of combustion gases that occur during combustion of fuel mixtures containing telecommunications poles and post-consumer doors. As it follows from compared data, exhaust temperature in the main measurement period fluctuated between around 270ºC and around 400ºC. Like in the case of coefficient λ, lower exhaust temperatures were recorded at the beginning and at the end of measurement cycle, which resulted from

the necessity of heating up the boiler installation (beginning of the cycle) and reduction of fuel portions delivered to the hearth grill (end of measurement cycle). Despite some differentiation, the influence of composition of fuel mixtures on exhaust temperature in analysed measurement cycles cannot be ascertained unambiguously.

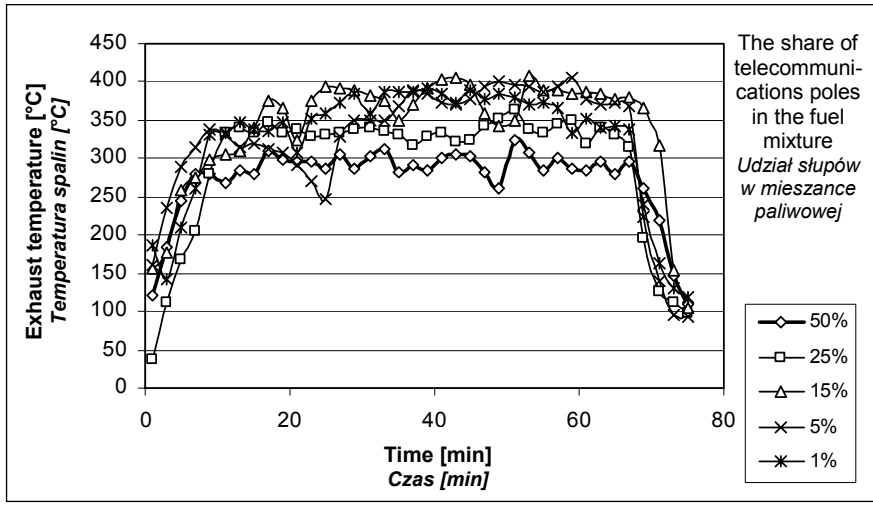

Fig. 12. Changes in temperatures of combustion gases during combustion of fuel mixtures made from telecommunications poles and post-consumer doors
Rys. 12. Zmiany temperatur gazów spalinowych w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

Fig. 13 illustrates changes of temperatures inside the hearth that are recorded in the first measurement point. Presented data shows that in the body of the measurement cycle temperature in measurement point no. 1 changed within the range from around 550ºC to around 900ºC. Most probably observed changes resulted from changing geometry of burning fuel whose prism on the grill grows when the feeder is on, pours down due to gravitation, and dwindles due to combustion. As a result, recorded temperature of flame changes as well. Like in the case of the exhaust temperature, in the initial period an increase in temperature from approximately 180ºC to a maximum temperature was observed. This was a result of gradual heating up of the boiler's system. A decrease in temperatures in the final period of the cycle was caused by gradual reduction of fuel portions delivered to the hearth grill. It cannot be ascertained unambiguously that composition of fuel mixtures significantly influenced values of temperatures recorded in point 1.

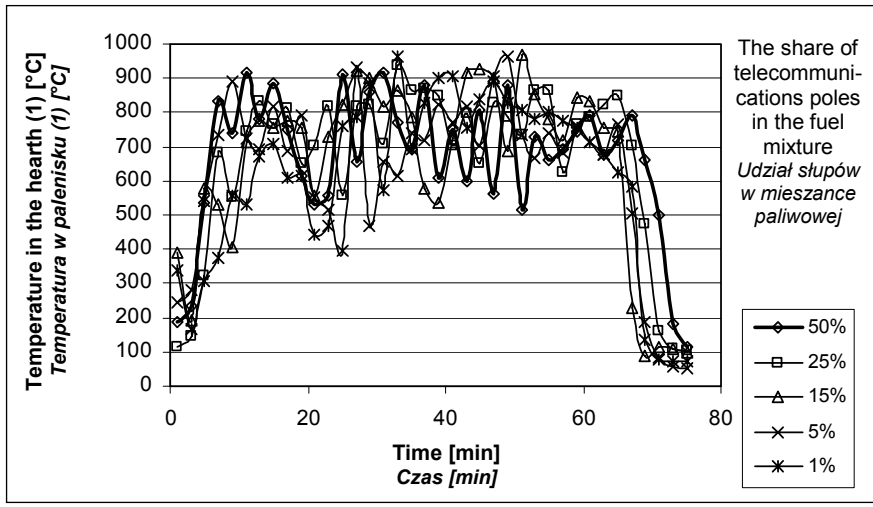

Fig. 13. The course of changes in temperatures recorded in the first measurement point of the hearth during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 13. Przebieg zmian temperatur rejestrowanych w pierwszym punkcie pomiarowym paleniska przy spalaniu mieszanek paliwowych słupy teletechniczne – drzwi pożytkowe

Fig. 14 illustrates changes of temperatures inside the hearth and recorded in measurement point no. 2. Values of temperatures measured in that point changed in the main period of the measurement cycle in the range from around 500ºC to around 750ºC. Like in the case of point 1, a rapid growth of temperature at the beginning of the measurement cycle (till maximum temperature for a given sample was reached) caused by heating up of the cold installation was observed in this case as well. On the other hand, a drop of temperature at the end of the cycle was caused by gradual reduction of fuel portion delivered for combustion, which resulted from gradual emptying of the fuel bunker. Also in this case the influence of composition of fuel mixtures on values of combustion temperatures recorded in this point could not be ascertained unambiguously.

Changes of temperature of circulating water recorded in the boiler during combustion of tested fuel mixtures are compared in fig. 15. Due to inertia of the system, the course of recorded changes was more linear compared to the course of temperatures recorded inside the hearth. Presented data shows that temperature of the heat carrier (water) was changing in the range from approximately 30ºC to 80ºC. During combustion of each of evaluated mixtures the system reached nominal working parameters after period of time ranging from around 18 to around 30 minutes. It is impossible to ascertain unambiguously that there is an interrelation between composition of fuel mixtures and temperature of boiler water reached during investigated measurement cycles.

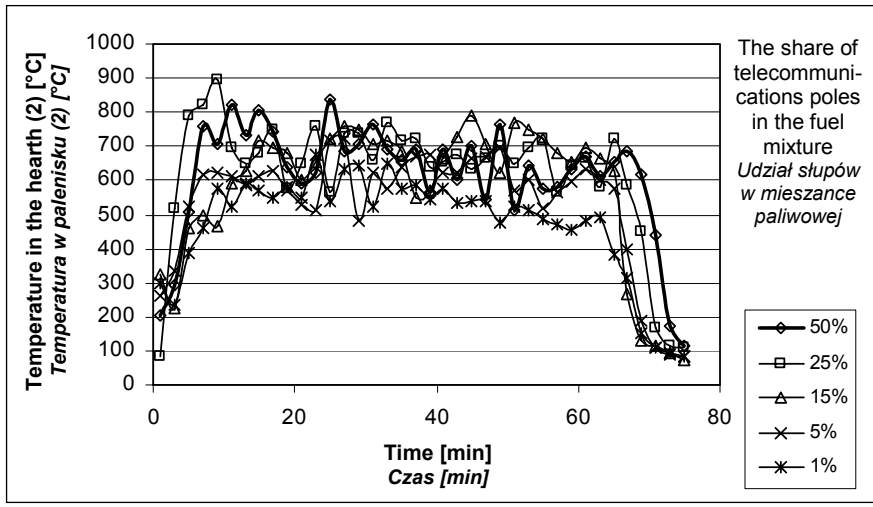

Fig. 14. The course of changes in temperatures recorded in the second measurement point of the hearth during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 14. Przebieg zmian temperatur rejestrowanych w drugim punkcie pomiarowym paleniska przy spalaniu mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

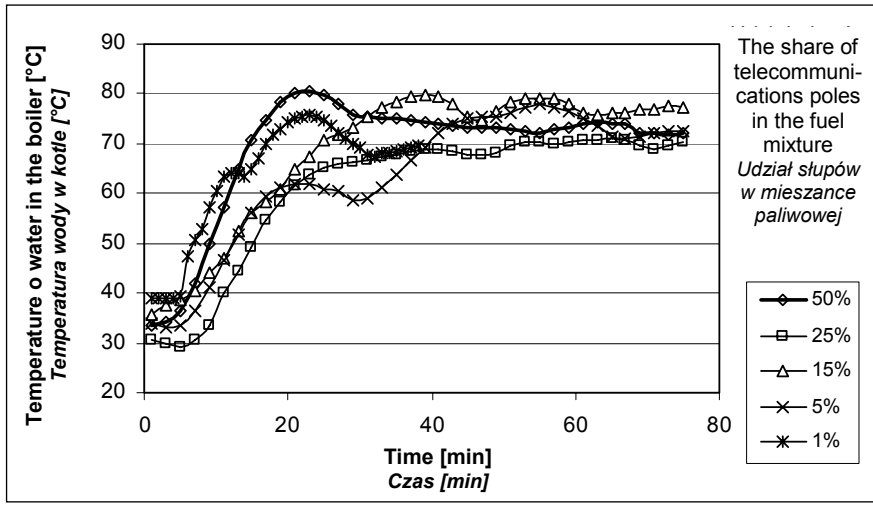

Fig. 15. Changes in the temperature of boiler water recorded in the boiler during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 15. Zmiany temperatury wody kotłowej rejestrowane w kotle w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

Fig. 16 illustrates changes of thermal momentary power of the test boiler installation recorded during tests of fuel mixtures consisting of telecommunications poles and post-consumer doors. An equable course of changes of momentary power indicates correct operation of the boiler and central heating installation co-operating with it. Analysis of compared results shows that from the moment when measurements were started there was a systematic increase in the value of momentary power of the boiler from the level of approximately 1÷4 kW to the level of 11÷16.5 kW. On reaching a maximum power for every measurement cycle, momentary power oscillated around the nominal value, which ranged from around 10 kW to approximately 14 kW. Reaching of an appropriate power level depended on few parameters. One of major parameters was the hearth operation dynamics that was influenced by mass of fuel delivered to the grill in a given moment, which was closely connected with heterogeneous granulation of the fuel mixture. Another important factor was the ability of boiler installation to give off created heat.

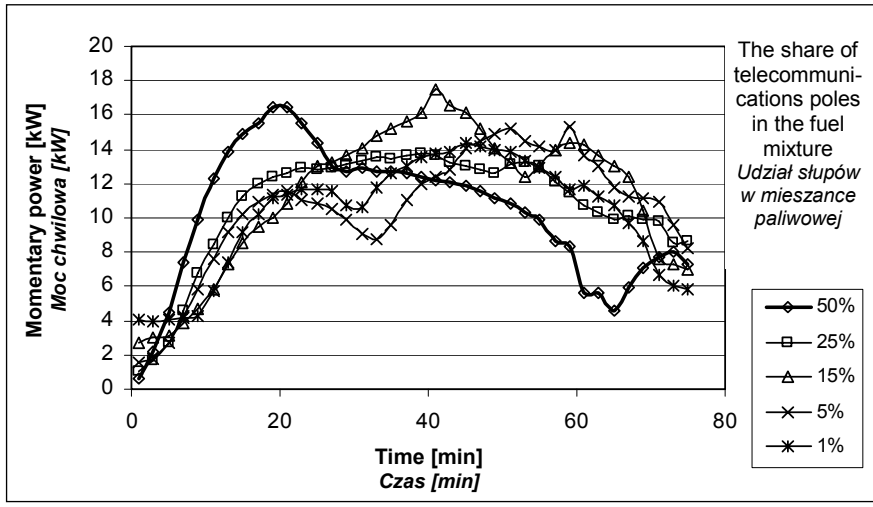

Fig. 16. Changes in momentary power of the boiler installation recorded during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 16. Zmiany mocy chwilowej instalacji kotłowej rejestrowane w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi pożytkowe

Next factor recorded during measurements and presented in fig. 17 was the amount of energy generated by the boiler system during combustion of evaluated fuel mixtures. As it follows from the above comparison, values of generated energy differed insignificantly between each other. The difference between

extreme values (mixtures with 50-percent and 1-percent share of telecommunications poles) was 15%. It stems from presented data that calorific value of evaluated fuel decreased as the share of wood impregnated with creosote oil in fuel mixture dropped.

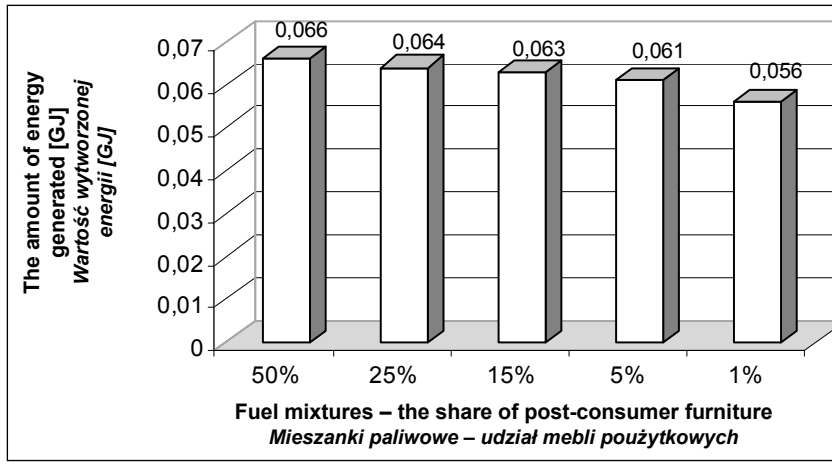

Fig. 17. The value of thermal energy generated in the boiler installation during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 17. Wartość wytworzonej energii cieplnej na instalacji kotłowej w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

Fig. 18 compares results of measurements of carbon oxide emission during combustion of fuels mixture formed from crumbled telecommunications poles and post-consumer doors in conversion into 11-percent content of oxygen in exhaust. Compared data shows that in the case of all analysed samples CO content in exhaust was fluctuating between approximately 1000 and 9000 mg/m^3. The highest values of carbon oxide emission during combustion of evaluated fuels were recorded at the beginning and at the end of the test cycle, which was connected with starting and ending of the test cycle. In the body of the test cycle the highest content of carbon oxide in exhaust (3÷4 g/m^3) was observed during combustion of mixtures with 50-percent share of telecommunications poles. 25-percent share of impregnated wood in burnt fuel caused reduction of that parameter to the level of approximately 1.7 g/m^3. Carbon oxide emission during combustion of the other fuel mixtures was at a similar level and it was around 1.2 g/m^3. Analysis of presented results proved that in analysed conditions of combustion process carbon oxide content in combustion gases rose as the share of wood containing creosote oil in burnt fuel increased.

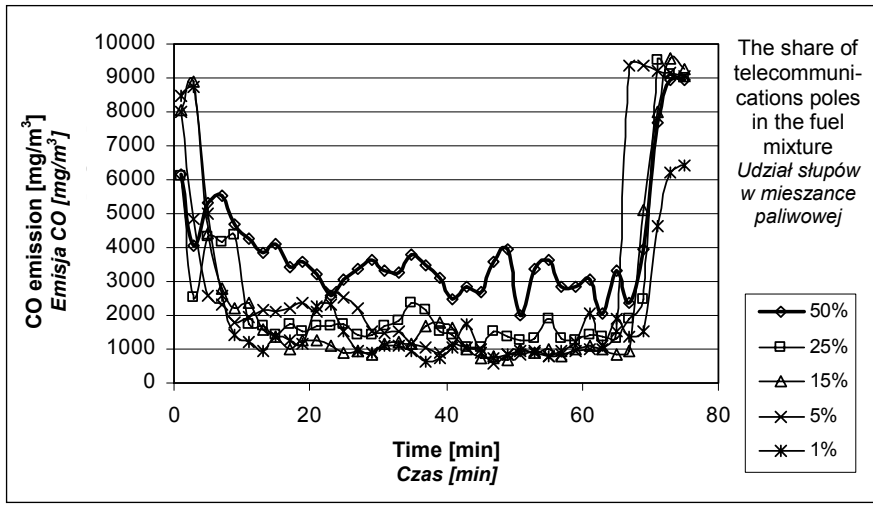

Fig. 18. Carbon oxide emission converted into 11% O_2 during combustion of fuel mixtures made from telecommunications poles and post-consumer doors
Rys. 18. Emisja tlenku węgla w przeliczeniu na 11% O_2 w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

A different situation was observed during analysis of carbon dioxide content in gaseous products of combustion of fuel mixtures containing wood form telecommunications poles and post-consumer doors. This situation is depicted in fig. 19. In this case the highest values of CO_2 (6.5÷10.5%) were observed during combustion of mixtures with the lowest share of impregnated wood (1÷15%). During combustion of the other mixtures (25 and 50% share of pole wood) carbon dioxide emission was at the level of around 6.5÷8.5%. Contrarily to the case of carbon oxide, the beginning and end of the measurement cycle was characterised by the lowest emissions of CO_2, i.e. from 0.5 to 8.5%. As it follows from former experiments, a well conducted process of combustion of wood materials generates CO_2 emissions at the level from 8% to 12%, thus evaluated fuel mixtures were not completely burnt. It seems that an important reason for such state of affairs was significant content of impregnation oil in burnt fuel, which oil was a mixture of mainly aromatic compounds.

Fig. 20 shows changes in the emission of nitrogen oxides presented as nitrogen dioxide after conversion into 11-percent content of oxygen in exhaust during combustion of tested fuel mixtures consisting of telecommunications poles and post-consumer doors. Presented data shows that the amount of NO_x emission was ranging from around 180 to 400 mg/m^3. The highest content of nitrogen oxides (average values around 350 mg/m^3) was observed during combustion of fuel mixtures with 50-percent share of crumbled poles. A bit less amounts of

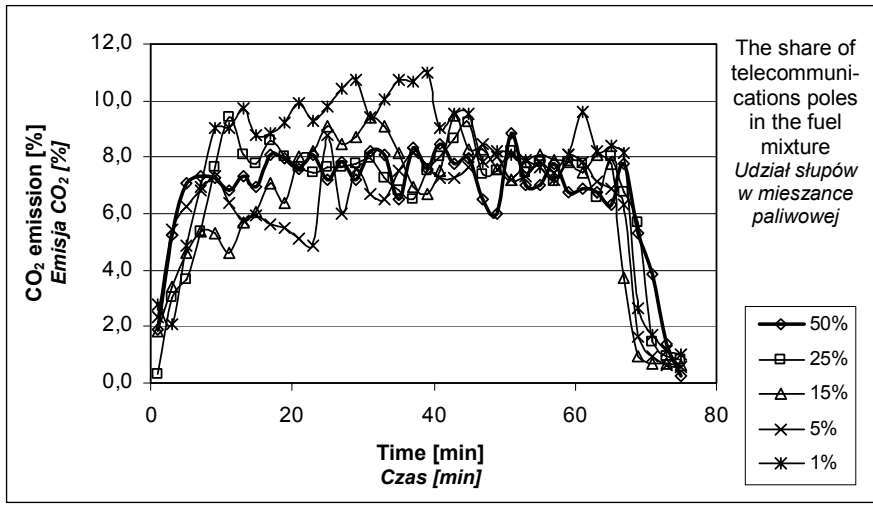

Fig. 19. Carbon dioxide emission during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 19. Emisja ditlenku węgla w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

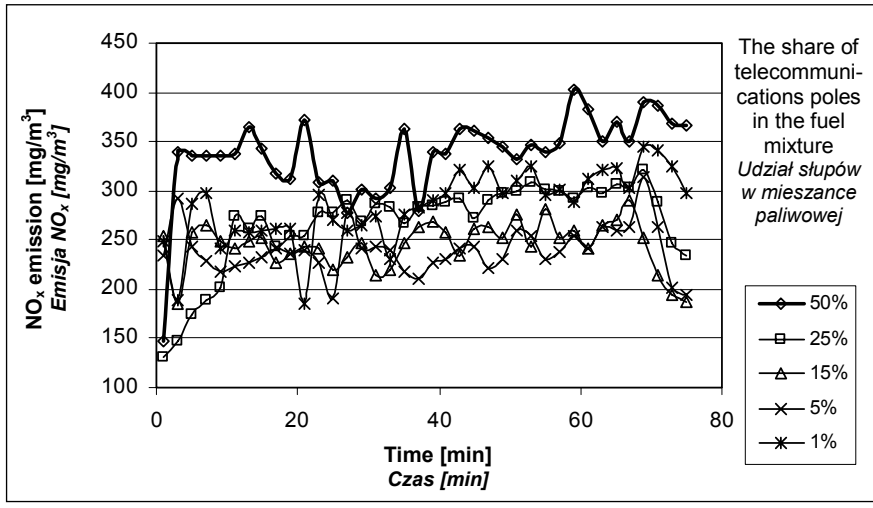

Fig. 20. Emission of nitrogen oxides converted into NO_2 with reference to 11% O_2 during combustion of fuel mixtures made from telecommunications poles and post-consumer doors

Rys. 20. Emisja tlenków azotu w przeliczeniu na NO_2 w odniesieniu do 11% O_2 w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

those substances (around 270 mg/m^3 on average) were found in gaseous products of combustion of mixtures containing 25% of telecommunications poles. During combustion of the other mixtures NO_x content ranged from 190 to 330 mg/m^3. Because evaluated fuel mixtures did not much differ between one another in nitrogen content (table 5), one should think that the source of elevated emissions of those substances was nitrogen contained in atmospheric air delivered to the hearth. As a matter of fact, temperatures recorded in the hearth[3] did not exceed 900ºC, however, one cannot exclude the possibility that, taking into account relatively high calorific value of evaluated samples (17.186÷18.123 MJ/kg) and relatively large capacity of the hearth, in some points of the hearth there could have been temperatures exceeding 1250ºC (beyond measurement points), in which thermal nitrogen oxides may be created very dynamically (Marutzky, Seeger 1999). A proof confirming this hypothesis may be the high temperature of exhaust recorded in the flue, i.e. 280÷400ºC (fig. 12), during measurements of combustion of analysed fuel mixtures.

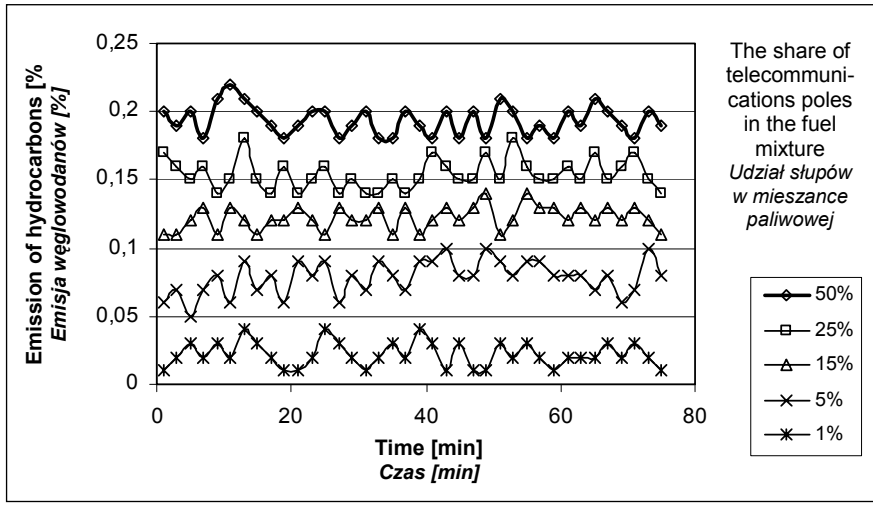

Fig. 21. Emission of hydrocarbons with reference to 11% O_2 during combustion of fuel mixtures made from telecommunications poles and post-consumer doors
Rys. 21. Emisja węglowodorów w odniesieniu do 11% O_2 w trakcie spalania mieszanek paliwowych słupy teletechniczne – drzwi poużytkowe

[3] Temperatures were recorded in fixed measurement points located in the hearth.

Next picture (fig. 21) presents changes in the emission of light hydrocarbons during combustion of fuel mixtures consisting of telecommunications poles and post-consumer doors. As it follows from data presented in this chart, the amount of C_xH_y emission oscillated around values depending on the share of crumbled pole wood in burnt fuel mixture. During combustion of fuel with 50-percent share of poles the emission of hydrocarbons oscillated around 0.18%. An average value of emission connected with combustion of fuel containing 25% of wood impregnated with creosote was approximately 0.15%. In the case of 15-percent share of crumbled poles in fuel, C_xH_y emission was at the level of 0.12%. 5-percent content of impregnated wood in fuel resulted in the emission of hydrocarbons during combustion of fuel at the level of approximately 0.08%, whilst during combustion of mixture with 1-percent share of telecommunications poles the level of C_xH_y emission was 0.02%. From the above description it stems that combustion of wood containing an additional portion of hydrocarbons in the form of impregnation oil is not complete. Some amounts of not burnt organic compounds together with exhaust are emitted to the atmosphere. Amount of those emissions depends on creosote (impregnation) oil content in burnt fuel mixture and on combustion manner.

Summary

Comparing properties of fuel mixtures obtained by mixing sawmill sawdust with crumbled post-consumer furniture, and crumbled post-consumer doors with telecommunications poles, and also courses of their combustion process, a series of differences and similarities between them was observed. All analysed fuel wood materials were characterised by similar elementary composition as regards the content of carbon, hydrogen, nitrogen, and sulphur, which resulted from over 90% share of natural wood in their overall mass. Significant differences were observed only in nitrogen content in mixtures of post-consumer furniture with sawmill sawdust. In this case the share of post-consumer furniture in the mixture was directly reflected in nitrogen content in evaluated fuel. On comparing fuel properties of prepared recovered fuels from waste, significant differences were noted only for their calorific values. An addition of post-consumer furniture to fuel caused a decrease in calorific value, whilst an addition of telecommunications poles resulted in insignificant increase in calorific value of prepared mixtures. Such situation stemmed from the character of ballast substances contained in the initial fuel components. Impregnation oil (creosote oil) is a mixture of substances of aromatic character, which in the nature of things are characterised by higher heat of combustion, whilst amine glue resins, which are the adhesive of wood particles in wood-based materials, are characterised by lower heat of combustion. As a result, one of the ballast substances (creosote)

raised calorific value of evaluated fuel, whilst the other (amine resins) reduced it.

Differences were noted also when the conditions of combustion process were evaluated. Insignificant discrepancies were observed during combustion of mixtures with the share of wood from poles and post-consumer doors, and post-consumer furniture and sawdust. The first criterion of evaluation was comparison of air surplus coefficient λ for both types of burnt mixtures. For fuels formed with the share of pole wood this coefficient ranged from 2 to 3, whilst during combustion of mixtures containing post-consumer furniture the values of λ were higher and fluctuated between 2.5 and 4.5. Described phenomenon should not be accounted for by higher stoichiometric demand for oxygen, but only by the need for better mixing of fuel with oxidiser and transport of products of partial decomposition and combustion of fuels containing amine resins. This hypothesis may be confirmed by lower content of the so-called "volatile components" in post-consumer furniture waste compared to wood from telecommunications poles.

Relatively high temperatures of exhaust and temperatures recorded in the hearth during combustion of mixtures with the share of telecommunications poles may be explained by their higher calorific values in comparison with fuels containing post-consumer furniture. Those phenomena resulted also in higher energy parameters from combustion tests, i.e. higher energy generated from the same mass of fuels and higher momentary power recorded. The process of combustion of fuels mixtures containing pole wood was more equable compared to post-consumer furniture and, as a result, there was a marked decrease in generated energy as the share of creosote oil in burnt fuel decreased.

Better energy effects obtained during experiments consisting in combustion of mixtures containing telecommunications poles were also reflected in the level of recorded emissions of gaseous products of combustion compared to fuels formed with the share of post-consumer furniture. The level of carbon oxide emission was much lower for fuels containing creosote oil. The situation was similar in the case of evaluation of the content of nitrogen oxides in exhaust. However, in that case the reason for many times higher emission of NO_x was a considerable share of nitrogen in post-consumer furniture waste. This factor was the reason why in the case of mixtures containing 50% of post-consumer furniture recorded emissions were at over three-time higher level than in the case of fuels containing 1% of that waste. A more correct course of the process of combustion of fuels containing pole wood was confirmed by higher content of carbon dioxide in combustion gases. A factor, that may have a considerable influence on evaluation of tested fuels, is the emission of hydrocarbon products of combustion. Substances that were recorded during experiments are a mixture of compounds of which part is classified as hazardous substances. During comparison of products of combustion of fuels with the share of post-consumer

furniture and poles, it was observed that when the former was burnt the emission of hydrocarbons did not exceed determinability level of the applied analytical method, whilst combustion of mixtures containing pole wood was accompanied by higher emissions of C_xH_y that rose as the share of creosote oil in burnt fuels increased. The level of those emissions was quite equal for every type of fuel mixture.

In Poland, effective legal regulations concerning installations intended for combustion of waste order keeping applicable emission standards during processes of thermal conversion of waste with or without recovery of generated energy [Rozporządzenie… 2005]. From among substances named in the Regulation conducted tests took into account carbon oxide, whose permissible content in combustion gases is 100 mg/m^3, and nitrogen oxides expressed as nitrogen dioxide, whose permissible emission level is 400 mg/m^3. In accordance with provisions of the Regulation, all analysed substances were converted to 11-percent content of oxygen in exhaust.

Having compared the amount of emission of gaseous products of combustion of fuel mixtures formed with the share of wood from telecommunications poles and post-consumer furniture, it was noted that in the case of carbon oxide the content of analysed gas many-times exceeded the level permitted by the emission standards required for waste combustion installations. During combustion of mixtures of wood from poles and post-consumer doors it was observed that standards were exceeded by 10÷40-times, whilst reduction of impregnated wood share in the mixture resulted in a decrease in carbon oxide content in exhaust. On the other hand, combustion of fuels with the share of post-consumer furniture was accompanied by emissions of CO that exceeded requirements set forth in the Regulation [2005] by 20÷80-times.

The content of nitrogen oxides in exhaust from combustion of evaluated fuels was a little different. During combustion of mixtures with the share of sawdust and post-consumer furniture the emission of NO_x depended on the amount of furniture waste added to formed fuel. A 1÷15-percent content of post-consumer furniture in the mixture had no influence on exceeding the emission standards concerning waste combustion. However, at a 25-percent share of furniture waste in fuel, those standards were exceeded by 1.5-times, and a 50-percent content of furniture waste in fuel resulted in NO_x emissions 2.5 higher than the effective standards. A reason for such state of affairs should be ascribed to processes of oxidisation of nitrogen contained in fuel. Such situation is not encountered in fuel mixtures containing wood from post-consumer doors and telecommunications poles. In this case permissible standards of the emission of nitrogen oxides were not exceeded. However, an increase in the share of creosote oil in burnt fuel caused also an increase in NO_x emission. In that case, however, a reason for creation of higher amounts of nitrogen oxides

presumably was the elevated temperature inside the hearth causing oxidisation of nitrogen contained in atmospheric air [Cichy 2004].

The amount of the emission of hydrocarbons was not determined in the emission standards concerning waste conversion ins[allations (Rozporządzenie… 2005]; however, the content of hydrocarbons in combustion gases may be determined by correctness of thermo-oxidisation processes inside the hearth. When fuels formed with the share of post-consumer furniture were burnt no content of hydrocarbons in exhaust was observed. One should bear in mind, that in this case the determinability level was 100 mg/m^3. One of the reasons for such state of affairs might have been phenomena of oxidisation and reduction which, with much probability, occur inside the hearth between C_xH_y and nitrogen oxides in conditions of oxygen deficiency. On the other hand, during combustion of formed fuels containing pole wood it was observed that the share of hydrocarbons in exhaust increased as creosote content in the fuel rose. However, in this case observed cyclic leaps of C_xH_y concentrations stemmed from the nature of the ballast substance, i.e. creosote oil that is a mixture of hydrocarbons that are products of dry distillation of hard coal. As it follows from presented data, those hydrocarbons in working conditions of the hearth do not undergo full decomposition and oxidisation, and in a result they become part of combustion gases emitted to the atmosphere.

Conclusions

Described experiments and follow-on deliberation allow formulation of the following statements and conclusions:

1. During combustion of fuel mixtures produced from post-consumer furniture and sawmill sawdust and from post-consumer doors and wood from telecommunications poles a considerable amount of usable thermal energy is generated. An increase in the share of post-consumer furniture in the mixture has no significant influence on the amount of energy generated (on average 0.050 GJ from mass unit of fuel), whilst an increase in the share of wood from telecommunications poles improves energy effect of combustion process (a growth from 0.056 to 0.066 GJ from mass unit of fuel).
2. Nitrogen, in the form of amine resins, contained in recovered fuels produced from post-consumer furniture directly influenced the amount of the emission of nitrogen oxides during combustion of those fuels in power installations of low power.
3. Combustion at the test station of recovered fuels obtained by mixing post-consumer furniture with sawmill sawdust caused the following effects:
   – 1-percent share of furniture waste in obtained fuel did not cause any repercussions in the form of elevated emissions of nitrogen oxides from the installation (below 200 mg of NO_2/m^3),

- when the content of post-consumer furniture in fuel ranged from 5 to 15% elevated emissions of nitrogen oxides to the atmosphere (around 300 and 350 mg of NO_2/m^3) were observed; however, the emission did not exceed effective emission standards,
- when the share of post-consumer furniture was at the level of 50% and 25%, emissions of NO_x considerably exceeded the emission standards (around 1100 and 600 mg of NO_2/m^3).

4. No emission of hydrocarbons above the determinability level of the applied analytical method was observed during combustion of recovered fuel mixtures produced from post-consumer furniture and sawmill sawdust, whilst carbon oxide emissions considerably exceeded the emission standards for burnt waste (2000÷8000 mg of CO/m^3).
5. During combustion, the content of creosote oil in fuel mixtures obtained from crumbled wood from post-consumer doors and telecommunications poles caused emissions of carbon oxide exceeding the emission standards, i.e. 800÷4000 mg of CO/m^3. The highest emissions of CO were observed in the case of mixtures containing 50-percent share of telecommunications poles.
6. An average content of light hydrocarbons in combustion gases produced during combustion of recovered fuels produced from wood from telecommunications poles and post-consumer doors increased from around 0.03 to 0.20% as the content of poles in burnt fuel mixture rose. The highest values of the content of light hydrocarbons in combustion gases were observed when the share of pole wood in the mixture was 50 percent.
7. Emissions of nitrogen oxides recorded for combustion of fuel mixtures produced from post-consumer doors and telecommunications poles did not exceed the emission standards permissible at waste combustion. No influence of mixture composition on the amount of NO_x emission was observed.

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SPALANIE STAŁYCH PALIW WTÓRNYCH WYTWORZONYCH Z POUŻYTKOWYCH ODPADÓW DRZEWNYCH NA INSTALACJI ENERGETYCZNEJ MAŁEJ MOCY

Streszczenie

Przy obróbce mechanicznej materiałów drzewnych powstają znaczne ilości materiałów odpadowych. Przepisy prawa polskiego i europejskiego nakazują utylizację wytworzonych odpadów zgodnie z odpowiednimi procedurami, co generuje dodatkowe koszty. Jednym z kierunków zagospodarowania drzewnych materiałów odpadowych jest odzyskiwanie zawartej w nich energii. Przysposobienie odpadów polegające na przygotowaniu paliw roboczych o odpowiednich właściwościach palnych nazywa się wytwarzaniem paliw, a otrzymane materiały stałymi paliwami wtórnymi. Wytworzone w taki sposób paliwa drzewne można zaliczyć do paliw z biomasy.

Celem pracy było poznanie wpływu zasadniczych właściwości wybranych materiałów drzewnych zanieczyszczonych chemicznie o ustalonych właściwościach technicznych na zmiany przebiegu podstawowych parametrów procesu ich spalania.

Do badań wybrano materiały palne z grupy odpadów poużytkowych. Z wytypowanych odpadów przygotowano mieszanki paliwowe o ściśle określonym składzie ilościowym: 1, 5, 15, 25 i 50% udziału odpadów zanieczyszczonych w ogólnej masie paliwa. Składnikami wytworzonych paliw wtórnych były trociny tartaczne i meble poużytkowe oraz drzwi poużytkowe i słupy teletechniczne. W otrzymanych mieszankach określono podstawowe właściwości paliwowe (wartość opałową, zawartość popiołu, wilgotność) i oznaczono zawartość pierwiastków elementarnych (C, H, N, S). Przygotowane paliwa spalano w laboratoryjnej instalacji kotłowej małej mocy. W trakcie prób rejestrowano parametry pracy kotła, parametry instalacji c.o. oraz wielkość emisji gazowych produktów spalania.

Stwierdzono, że oceniane paliwa cechowały zbliżone właściwości (słupy teletechniczne mają wyższą wartość opałową). Udział zanieczyszczeń w ogólnej masie spalanego paliwa nie wpływał w znaczący sposób na wartości parametrów cieplnych procesu spalania i laboratoryjnej instalacji energetycznej. Różnice stwierdzono przy ocenie wielkości emisji gazowych produktów spalania. W przypadku mieszanek: trociny tartaczne – meble poużytkowe wraz ze wzrostem udziału odpadów meblowych wzrastała emisja tlenków azotu. Nie odnotowano natomiast znaczących różnic w emisji pozostałych składników spalin. Podobną tendencję stwierdzono przy ocenie emisji węglowodorów w trakcie spalania mieszanki paliwowej: drzwi poużytkowe – słupy teletechniczne.

Pozytywne wyniki prac badawczych mogą dać nadzieję na wdrożenie tych produktów do praktyki przemysłowej i zastąpienie części stosowanych dziś w energetyce „czystych" paliw biomasowych stałymi paliwami wtórnymi wytworzonymi z odpadów drzewnych.

Słowa kluczowe: odpady drzewne, stałe paliwa wtórne, gospodarka odpadami, termiczne przekształcanie odpadów z odzyskiem energii, emisje gazowych produktów spalania

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SURVEY OF ATTITUDES TOWARDS FOREST AND CHAIN OF CUSTODY CERTIFICATION IN THE SLOVAK REPUBLIC

The main aim of this paper is to examine the attitudes towards forest certification and certification of chain of custody in Slovakia. It presents the existing situation and analyses the potential development of certified wood and wood product market from the viewpoint of forest owners and wood industry representatives. A questionnaire was used to collect data on general attitudes as well as specific factors influencing present and future development of certification in the SR.

Keywords: forest certification, chain of custody, questionnaire survey, certified wood market

Introduction

Sustainable forest management

Forests represent an important element within the conception of sustainable development. They fulfil essential ecological, economic and social functions and create environment for people, flora and fauna. They contribute to the rural development and globally play an important role in the global carbon cycle. As forests cover almost one third of the Earth's surface, ensuring sustainable forest management is necessary if global sustainable development is to come true.

The state forest policy of the Slovak Republic defines forests as national wealth that needs to be protected and maintained. Sustainable forest management has a long-term tradition in Slovakia dating back to the imperial period of Mary Therese. The present principles of forest management are based on those historical roots. The principles of sustainable forest management are related to

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forestry legislation, protection of forest ecosystems, nature protection, protection of gene resources of forest trees, support and protection of biological diversity, rational use of multipurpose forest functions for the development of social, cultural and other needs of society.

The present principles of sustainable forest management (SFM) are based on the strategic objectives and aims defined in the global and Pan-European processes. The Ministerial Conferences on the Protection of Forests in Europe (MCPFE) have been held regularly since 1990 when the first conference was organised in Strasbourg. The last Ministerial Conference on the Protection of Forests in Europe "Forests for Quality of Life" was held on 5–7 November 2007 in Warsaw, Poland. The Conference highlighted the importance of contemporary challenges and decisions to assure that Europe's forests continue to be managed sustainably and provide benefits to the best of their potential. The Ministerial Declaration and two Warsaw Resolutions embraced requirements for political response to and decisions on the issues of promotion of wood as a renewable energy carrier and the role of forests in water protection in the context of climate change [MCFPE, 2008].

The Council Resolution of 15 December 1998 on a Forestry Strategy for the European Union established a framework for forest-related actions in support of sustainable forest management. The strategy is based on co-ordination of the forest policies of the Member States and Community policies and initiatives relevant to forests and forestry and it takes into account the commitments made by the EU and its Member States in the relevant international processes such as the UNCED and MCPFE conferences.

The forestry strategy in Slovakia is based on the principles of sustainable forest management following the conclusions of the MCPFE and the Improved Pan-European Indicators for SFM adopted in Vienna in 2003. The Slovak Republic as a signatory state has committed itself to [Novotný et al., 2003]:

- implementing criteria and applied indicators as a basis for elaboration of international reports on the state and development of the forests,
- supporting elaboration of the national criteria and indicators considering the specific conditions,
- assessing the complexity, importance and financial significance of indicators, assuring their continuation and improvement mainly in the connection with the assessment of forest functions that are not sufficiently covered by the indicators,
- assessing the ongoing progress of SFM for a certain period of time using the national criteria and indicators

All forests shall be professionally managed according to the principles of sustainable forest management. The forest management plans represent the main tool of implementation of those principles.

Following the vision and strategic objectives of the EU action plan for forests a Conception of agriculture development for the years 2007–2013 – part: Forestry was elaborated. This document defines the basic strategic objectives, aims and priorities of the agricultural sector in the middle term till 2013. The following strategic objective is formulated for forestry: Ensuring sustainable forest management based on the appropriate use of economic, ecological and social functions of forests for the development of society and mainly for rural areas. In 2007 the Government of the Slovak Republic adopted the National Forestry Program, the conception which is an important tool of ensuring sustainable forest management.

Forest certification

In recent years forest certification has become a worldwide issue and one of the most frequently discussed topics on forests. It does not only affect producers of wood raw material but also buyers, processing companies and users of wood and wood products. According to Hansen and Juslin [1999] forest certification can be defined as a method by which an independent, third party performs a valuation to determine whether forest management satisfies pre-established ecological, economic, and social standards and verifies it through a written document. The certificate, awarded by an independent party, verifies that the forests are managed according to the principles of sustainability. From the customer's point of view, forest certification assures that certified products come from sustainably managed forests that have been subject to independent third party auditing.

Forest certification has been created as a tool of promoting sustainable forest management all around the world. It comprises requirements on sustainability in economic, ecological and social aspect. It is also a tool of satisfying the needs of customers in the market that can help them to make decisions about consumption supporting sustainable development. Finally, forest certification is a marketing tool. Companies consider certification as one of their values and integrate it with marketing decisions [Paluš 2000; Šulek, Šálka 2003].

Certification process is applied at two levels:

1. certification of sustainable forest management (SFM) aimed at assessment of forest stands (site of origin of forest based products),
2. chain of custody certification (C-o-C) aimed at supply chain from forests to end users (tracing the origin of forest based products).

For a couple of years forest certification has been broadly supported worldwide and several certification schemes have been developed to internationally accepted standards. Until May 2009 over 308 M ha of world forests (over 7.8% of the total forest area) was certified. Sustainable forest management and chain of custody certification is an issue that has a significant impact on the participating stakeholders. However, the motives for taking part in certification can

significantly differ among the participants at different stages of certification process. While forest owners would probably certify their forest to gain some economic benefit, broaden their markets or improve forest management practices, wood processing companies would try to fulfil the needs of their consumers and to satisfy the increased demand for certified products, as well as to increase their good-will and reputation in the market. The consumers will probably buy certified products to support sustainable forest management and sustainable development [Kaputa, Paluš 2006].

Public demand for certified timber has significantly influenced forest product markets in some European countries, mainly in the UK, the Netherlands, Denmark, France, and Germany. Those countries have implemented public procurement policies with the objectives defining government requirements for suppliers of timber to declare its origin from legal and sustainable sources. The policies incorporate criteria that are in favour of procuring certified timber and thus allowing companies to gain preferences in public tenders [Paluš 2006].

In Europe, the development process and implementation of different national schemes as well as different structure of issued C-o-C certificates vary among the countries. In Slovakia, the recent forest certification activities are connected with certification of forests according to the requirements of the national certification scheme (Slovak Forest Certification System) endorsed by PEFC in 2005. In May 2009, the area of PEFC certified forest reached over 1 220 576 ha. In February 2009, the area of FSC certified forests was 174,083 ha. At present there are 33 FSC and 17 PEFC C-o-C certificates issued for trading and wood processing companies in the Slovak Republic (www.fscslovakia.sk, www.pefc.sk).

One of the important objectives of certification is to link environmentally and socially sensitive consumers with the forest product producers who try to satisfy the consumers' needs. Certified timber placed on the market represents a new product with the properties that can satisfy social and environmental needs of society under the conditions that:

- consumers can appreciate ecological and social properties of the products and they will be influenced by product differentiation,
- producers will react to positive market signals demanding environmental and social attributes of the products,
- new and differentiated products allow producers to charge differentiated price,
- there will be increased international efficiency and competitiveness due to the interest in environmental and social issues.

Certification process is closely related to the cost of certification. Even if participation in certification process is voluntary the related cost can significantly influence the decisions of stakeholders to participate in this process. In

general, three kinds of cost connected with forest certification can be distinguished [Paluš 2004]:
1. fixed cost (e.g. initial audit fees),
2. variable cost (e.g. relating to certified area),
3. cost related to changes in forest management resulting from adaptation of forest management to certification requirements.

Methods

Forest certification is primary linked to the assessment of forest management processes while C-o-C certification is aimed at the assessment of product properties from the viewpoint of transfer of information on the origin of the raw material included in the final products. Owing to the different objectives on both levels it can be assumed that attitudes, motives and factors influencing decision making regarding certification will differ for timber producers and timber industry representatives. This assumption has been tested by means of a questionnaire survey carried out among forest owners and wood processing companies in Slovakia.

The research on the attitudes towards forest and chain of custody certification among forest owners and industry representatives in the Slovak Republic was carried out in the years 2005-2008. The representatives of forest owners and managers in all regions of Slovakia, regardless of the ownership category and their participation in certification process, were questioned. The timber industry was represented by respondents from companies dealing with primary and secondary wood processing. The research did not cover the category of end users of final wood and paper products. Non-probability sampling (purposive sampling) with the aim to cover as much forest owners and wood processing companies as possible and to cover all forest ownership categories and types of wood processing was used to collect data. The questionnaires were mainly distributed directly to the respondents at different seminars and expert events as well as sent out by e-mail. Totally there were 33 forest owners (representing over 70% of total forest land) and 20 companies dealing with primary and secondary wood processing (representing over 70% of total timber processed in Slovakia).

There were two kinds of questionnaires of identical structure: one for the forestry sector and the other for the wood processing industry. Structure of the questionnaires partially followed the methodology applied in a similar survey by Pajari, Peck and Rametsteiner [1999]. Questions were divided into four sections:
- identification and basic information questions for respective groups,
- questions regarding forest certification,
- questions regarding C-o-C certification,
- general questions regarding certification.

The following questions were used:

a) i. Identification of forest owners:
   - ownership type,
   - region,
   - forest area,
   - annual felling,

   ii. Identification of wood processing companies
   - sector,
   - region,
   - company size (number of employees),
   - annual production of the three most important products,

b) Forest certification
   - motives influencing decisions about participation in certification process,
   - factors hindering the development of forest certification,

c) Chain of custody certification
   - factors influencing procurement of raw material input by companies,
   - factors limiting certified product markets,
   - factors motivating companies to supply certified forest products,

d) General questions on certification
   - drivers of forest certification / factors creating favourable conditions for the development of forest and C-o-C certification,
   - factors which supported process of forest certification in Slovakia,
   - forest and chain of custody certification as a market tool.

The data obtained from the survey was transformed into electronic form for further analyses. As the collected data was qualitative, it was necessary to convert it into quantitative form. Owing to the use of purposive sampling the methods of descriptive statistics were applied. The frequency analysis was used for primary statistical analysis of data. Frequency tables illustrated absolute and relative occurrences. In accordance with the defined research objectives the attitudes of both groups of respondents were analysed separately, and consequently a mutual comparison of attitudes between the two categories was evaluated (e.g. what is the opinion of forest owners on the needs of wood processing industry to buy certified raw material). This approach helped us to identify similarities and differences in the attitudes of timber producers and wood processing companies.

The percentage values illustrated in the result tables represent a share of respondents who defined the respective factor as the most important.

Results

The comparison of results of the two respondent groups enables the identification of forestry and timber industry sectors. Part of the obtained results can be used for comparison of responses of both groups to the same questions aimed particularly either at timber producers or timber buyers and thus identify cross-sector attitudes.

Both groups of respondents have different motives to become certified. "Sustainable forest management" is the main factor influencing forest owners while the industry is influenced by possibilities to gain "market access". Over one half of respondents from each group consider "improvement of marketing and business relations" and "environmental image" to be important motivation factors. As it follows from the results, the term "sustainable development" is closely tied to the term "forest certification" as far as decisions on participation in certification process is considered (table 1).

Table 1. Comparison of opinions on motives influencing decisions about participation in certification process
Tabela 1. Porównanie opinii dotyczących motywów wpływających na decyzje o uczestnictwie w procesie certyfikacji

Factor *Czynnik*	Share of respondents marking the respective factor to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Market access *Dostęp do rynku*	57.6%	75.0%
Improved communication *Lepsza komunikacja*	18.2%	0.0%
Environmental image *Środowiskowy wizerunek firmy*	57.6%	60.0%
Improved marketing and business relations *Lepszy marketing i relacje biznesowe*	54.5%	50.0%
Pressure of NGOs *Nacisk ze strony organizacji pozarządowych*	9.1%	0.0%
Expected decrease in revenues *Spodziewany spadek dochodów*	3.0%	0.0%
Expected price premium *Oczekiwana premia cenowa*	24.2%	0.0%
Sustainable forest management *Zrównoważona gospodarka leśna*	69.7%	35.0%

According to forest owners the main factors limiting the development of certification are "lack of forest owner interest" followed by "lack of mutual recognition" and "cost level" associated with certification of forest stands. "Lack of domestic demand", "lack of forest owner interest" and "lack of export demand" are considered by wood industry companies to be the most limiting factors. The most important limiting factors determined by both groups of respondents are interlinked as "lack of forest owner interest" originating from the "lack of domestic demand" from the wood industry. Respondents pointed out the mutual relations between the producers and buyers of certified wood. Weak activity of both sides can finally hinder the development of certification (table 2).

Table 2. Comparison of opinions on factors hindering the development of forest certification
Tabela 2. Porównanie opinii dotyczących czynników utrudniających rozwój certyfikacji lasów

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Lack of domestic demand *Brak popytu krajowego*	33.3%	65.0%
Cost level *Poziom kosztów*	39.4%	25.0%
Lack of mutual recognition *Brak wzajemnej uznawalności*	45.5%	10.0%
Lack of forest owner interest *Brak zainteresowania za strony właścicieli lasów*	54.5%	55.0%
Conflicting interests *Sprzeczne interesy*	27.3%	10.0%
Lack of institutional frameworks *Brak ram instytucjonalnych*	15.2%	10.0%
Practical difficulties *Trudności praktyczne*	30.3%	20.0%
Lack of export demand *Brak popytu eksportowego*	12.1%	30.0%
Inability to promote SFM with certification *Niemożność promowania zrównoważonej gospodarki leśnej wraz z certyfikacją*	27.3%	0.0%
Government attitudes *Poglądy rządu*	0.0%	10.0%

Both groups of respondents are convinced that purchasing of certified wood by wood processing companies can contribute to the "enhancement of image" of a company. Nearly half of the forestry respondents believe that buyers gain a "competitive advantage" by purchasing certified wood. Interestingly, the same share of buyers assume enhancing "options for consumers". "Social responsibility" and other factors are of little importance to the respondents (table 3).

Table 3. Comparison of opinions on drivers of demand for certified forest products
Tabela 3. Porównanie opinii dotyczących czynników napędzających popyt na certyfikowane produkty drzewne

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Image enhancement *Poprawa wizerunku*	57.6%	55.0%
Options for consumers *Opcje oferowane konsumentom*	39.4%	45.0%
Competitive advantage *Przewaga konkurencyjna*	48.5%	40.0%
Social responsibility *Odpowiedzialność społeczna*	9.1%	20.0%

Both groups of respondents consider the possibility of gaining "market access" to be the most important factor for selling certified products. "Creating credibility" and "environmentally responsible image" are among the other important factors. All those three factors are considered by more than a half of respondents to be important for supplying certified products (table 4).

A "lack of premiums" is the main factor limiting the certified wood market. Forest owners are also convinced that market is limited by "limited industry involvement" in relation to "limited demand" for those products (table 5).

According to the forest owner representatives the fact that "certification is important in SFM" is the factor most favourable for certification development. This fact is closely related to the strategic objectives of forestry that aim at sustainable development and require other non-production function to be fulfilled by the forests. "Well arranged stakeholder participation" is also considered to be important. The representatives of wood processing industry are focused on selling possibilities as "export demand" is considered to be the most important for favourable development of forest certification (table 6).

Table 4. Comparison of opinions on reasons for supplying certified forest products
Tabela 4. Porównanie opinii dotyczących powodów dostarczania certyfikowanych produktów drzewnych

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Market access *Dostęp do rynku*	66.7%	80.0%
Environmentally responsible image *Wizerunek firmy odpowiedzialnej środowiskowo*	54.5%	50.0%
Credibility creation *Budowanie wiarygodności*	57.6%	50.0%
Differentiation of the products *Zróżnicowanie produktów*	30.3%	25.0%
Intention to get premiums *Zamiar pobierania premii*	33.3%	30.0%

Table 5. Comparison of opinions on factors limiting the development of market in certified forest products
Tabela 5. Porównanie opinii dotyczących czynników ograniczających rozwój rynku certyfikowanych produktów drzewnych

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Lack of premiums *Brak premii*	78.8	55.0
Limited demand *Ograniczony popyt*	51.5	15.0
Limited industry involvement *Ograniczone zaangażowanie przemysłu*	75.8	30.0
Lack of supply *Brak podaży*	39.4	30.0

Table 6. Comparison of opinions on drivers of forest certification
Tabela 6. Porównanie opinii dotyczących czynników napędzających certyfikację lasów

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Favourable government *Sprzyjający rząd*	18.2	30.0
Certification important in SFM *Certyfikacja istotna dla zrównoważonej gospodarki leśnej*	69.7	55.0
Well arranged stakeholder participation *Dobrze zorganizowany udział interesariuszy*	57.6	25.0
Export demand *Popyt eksportowy*	51.5	60.0
Benefits exceeding costs *Korzyści przeważające nad kosztami*	45.5	45.0
Domestic demand *Popyt krajowy*	21.2	10.0

Table 7. Comparison of opinions on factors which supported process of forest certification in Slovakia
Tabela 7. Porównanie opinii dotyczących czynników, które wspomogły proces certyfikacji na Słowacji

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Government of the SR *Rząd Słowacki*	24.2	0.0
Forest owners *Właściciele lasów*	45.5	40.0
Domestic retailers *Detaliści krajowi*	45.5	20.0
Environmental groups *Ugrupowania środowiskowe*	57.6	20.0
Domestic industrial customers *Krajowi odbiorcy przemysłowi*	18.2	30.0
Domestic final consumers *Krajowi użytkownicy końcowi*	21.2	10.0
Export demand *Popyt eksportowy*	66.7	75.0

The most important factor stimulating the development of forest certification in Slovakia preferred by all respondents is the "export demand". This is because the export markets for the Slovak products are more developed as far as certification is considered, which, on the other hand, stimulates domestic supply of certified products. However, over a half of respondents believe that development of forest certification in Slovakia was supported by environmental groups (table 7).

There are differences in the views of both groups on SFM and C-o-C certification once certification as a tool ensuring certain objectives has been taken into account. Forest owners consider forest certification to be primarily "economic" and secondary "environmental" tool, while wood processing companies believe that certification is primarily "environmental" and then "economic" tool. The opinion that certification is a "social" tool is insignificant (table 8).

Table 8. Comparison of opinions on certification as a tool
Tabela 8. Porównanie opinii dotyczących certyfikacji jako narzędzia

Factor *Czynnik*	Share of respondents marking the respective factors to be the most important (%) *Udział respondentów, zdaniem których poszczególne czynniki są najważniejsze (%)*	
	Forest owners *Właściciele lasów*	Wood industry companies *Firmy drzewne*
Environmental *Środowiskowy*	42.4	50.0
Economic *Ekonomiczny*	51.5	35.0
Social *Społeczny*	6.1	0.0

Both respondent groups prefer development of PEFC certification to FSC and other certification schemes. Neither respondent showed negative attitude towards forest and chain of custody certification.

Discussion

Based on the research results and published information on the attitudes towards forest and chain of custody certification, it is possible to state that there are two main and at the same time opposite attitudes towards certification. Those attitudes relate to the economic and environmental aspect of certification. The environmental aspect is supported by opinions pointing out the feature of certifi-

cation as a tool needed for ensuring sustainable development through its contribution to the sustainable forest management. As follows from the research results, some of the respondents considered environmental aspect being a part of their social responsibility policies to be an important factor of their participation in certification process. It is generally known that the environmental approach is one of the main pillars of social responsibility policies.

At the same time it is necessary to mention that the demand for certified wood and wood products principally does not originate from the end users but mainly from the initiatives of environmental and other stakeholders that create pressure on individual elements of the chain of custody within the entire supply chain. Many companies try to utilise the environmental aspect of certification in order to build environmental image for their consumers, partners, and public and other stakeholders. The economic aspect principally is expressed through the opinions on certification as a marketing (in a broad sense economic) tool. Certification is perceived as an additional mechanism in trade activities based on the premise of improvement of the company's position in the wood and wood products market. It is a market aspect of certification that is emphasised. By participating in certification companies make effort to improve market access and communication with stakeholders, build image etc.

The comparison of selected attitudes of respondents pointed out some interesting conclusions. On the one hand, representatives of wood processing companies consider "market access" to be the main incentive for participating in certification process, while certification is considered as an "environmental" tool. On the other hand, forest owners believe that certification principally is an "economic" tool; however "sustainable forest management" is the main factor deciding their participation in certification. Based on that it is possible to conclude that the term "sustainable forest management" is closely linked with forest certification; however certification itself is considered to be an economic tool, i.e. forest certification is not necessary to ensure sustainable forest management in Slovakia, but rather it is considered to be a marketing tool supporting sales of wood on the market. Results also show that sustainable forest management and export demand are the most important factors pointed out by the respondents and they are significant in relation to further development of forest certification in Slovakia.

Price premium is the most important factor limiting certified wood product market. It represents a financial addition to wood raw material or wood products incurred by the producer. This additional charge is a voluntary tool and producers can utilise it to include the cost related to certification process or wood origin tracing in the product price. Once it is applied, one has to decide whether to include the complete cost or a proportional part of cost in the price. The final decision depends on producers' awareness of consumer preferences and on the availability of information on their willingness to pay a higher price. The certified

entities may also decide not to include cost in the price calculation. In this case the motives for certification include company image, green marketing, and competitive advantage of certified products (in case there is a demand for those products) or there may be no willingness to accept a higher price in the market [Kaputa, 2008]. The survey results show that price premium is not accepted in the market, so there is no stimulus to spend additional amount of money on certification in the supply chain. There is a sensitive perception of price premium in the market. Kozak et al. [2004] states that a majority of surveyed respondents were willing to pay a certain price premium under the condition that products would have an appropriate quality and design. The author also points out that there is a certain end user segment creating demand for certified wood products even if this segment is considered by companies to be very weak. However, some export oriented companies exporting their products to "environmentally sensitive markets" can apply price premium to some extent.

In many aspects the results point out a connection between sustainable forest management and the role of forest and chain of custody certification. The information on certified origin of wood is transferred through different stages of processing to the end users. Finally, the consumers' interest in purchasing certified products should decide the success of certification in the market. Consumers consider sustainable development as a general term linked to the influence of society on the environment. Based on the research carried out among the American consumers of wood products, Teisl et al. [2002] indicated an influence of environmental labelling of wood products on purchasing decisions of respondents. The environmental labelling plays a significant role in paper products, where the strongest connection between the high level of consumption and environmental impacts was identified.

Once the attitudes of respondents towards consumers of certified products are taken into account, factors such as weak domestic demand and willingness to accept a price premium were identified in the research. Kozak et al. [2004], Bigsby and Ozanne [2002], Spetic et al. [2005] point out a willingness of part of consumers to pay a price premium for those kinds of products. Such consumer segment in the market has a potential to grow if it is supported by an appropriate form of communication on the value which certified wood products bear. Forest owners and representatives wood processing companies do not consider the intention to gain a price premium to be a significantly motivating factor, but it is rather considered to be a limiting factor for development of certified wood market. Some foreign studies show similar results. Hrabovsky and Armstrong [2005] indicated that over a half of the questioned export oriented companies were sceptical about acceptation of any price premium by their consumers, which, in connection with low demand, poses problems for chain of custody certification. The main markets in certified wood products are concentrated in the Western Europe (mainly UK, Germany, the Netherlands, and Denmark).

Hubbard and Bowe [2005] show that companies do not link a possible benefit of price premium to the chain of custody. Similarly there are no links between C-o-C certification and productive and managerial improvements, market share increase, and improved market access. On the other hand, results of research carried out in Slovakia show that improved marketing and trade relations as well as market access represent important factors influencing decisions about participation in certification process.

Pajari, Peck and Rametsteiner [1999] state that a majority of companies incorporate ecological aspects of their activities in the long-term strategic objectives. Their research proves that the attitudes of companies to environmental certification is one of the possibilities of gaining competitive advantage, even if environmental awareness of consumers does not significantly influence behaviour of companies in the market. The results also proved that environmental issues affect management and activities of a prevailing part of companies. This is mainly connected with pulp and paper plants where C-o-C certification is often combined with other certifications (EMAS, ISO 14 000 etc.). From the marketing point of view, environmental issues are the main tools used in marketing communication. Once a company invests in the implementation of certification systems, it has an ambition to inform its consumers. Similar research was carried out in the EU countries with significant role of the forest sector in their economies (Finland, Germany, and the UK). In general, no significant differences between the results of surveys carried out in those countries and in the SR were identified.

An analysis of the present needs and implementation of certification schemes in Slovakia proved the importance of chain of custody certification for companies if they want to improve their performance in the domestic market and foreign markets and develop further. The companies are aware of weak demand on the local markets, hence they look for opportunities abroad where certification can play a role of important marketing tool.

Conclusion

A growing number of consumers is seeking evidence of environmentally sound business practices. Public authorities and corporate procurement policies more and more often demand from the paper and wood-processing industries reassurance and proof that the wood they use for their products comes from sustainably managed forests. It is generally agreed that wood-based products have a better overall environmental record than competitive materials, but questions have arisen about the management of forests from which the wood originates. Therefore businesses need a reliable and credible mechanism to prove to their customers where the wood used in their products comes from.

According to the development of recent social and political structures in Europe as well as worldwide the growing significance of forest certification could be expected. With the growing international market in certified wood products and the importance of this market to the Slovak exporters there can be further development of certified area and number of C-o-C certificates issued in Slovakia.

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ANKIETA DOTYCZĄCA POGLĄDÓW NA CERTYFIKACJĘ LASÓW I POCHODZENIA PRODUKTU NA SŁOWACJI

Streszczenie

Głównym celem było pozyskanie informacji na temat poglądów właścicieli lasów oraz firm drzewnych na Słowacji na certyfikację lasów i pochodzenia produktów drzewnych. Ankietyzacji poddano właścicieli lasów reprezentujących wszystkie kategorie własności niezależnie od ich zainteresowania certyfikacją lasów oraz przedstawicieli przedsiębiorstw zajmujących się pierwotną i wtórną obróbką drewna. Analizę zebranych danych przeprowadzono z zastosowaniem opisowych metod statystycznych, w tym analizy częstotliwości. Każdą kategorię respondentów analizowano indywidualnie, a następnie dokonano porównania opinii z obu kategorii. Celem porównania było określenie różnic i podobieństw pomiędzy producentami drewna i jego przetwórcami w zakresie poglądów na certyfikację lasów.

Wyniki badań wskazują, że środowiskowe i ekonomiczne aspekty certyfikacji lasów wpływają na poglądy na certyfikację. „Dostęp do rynku", „popyt zagraniczny" oraz „poprawa relacji marketingowych i biznesowych" to kluczowe czynniki ekonomiczne wpływające na decyzje respondentów w sprawie uczestniczenia w certyfikacji. „Niska lub zerowa premia cenowa" uważana jest za główny ograniczający czynnik ekonomiczny. Poglądy użytkowników końcowych na certyfikację, niski popyt krajowy na certyfikowane produkty oraz brak akceptacji premii cenowej postrzegane są jako czynniki utrudniające rozwój certyfikacji lasów. „Rola certyfikacji w zrównoważonej gospodarce leśnej" uważana jest za najważniejszy czynnik środowiskowy wpływający na decyzje respondentów odnośnie do uzyskania certyfikatu. Wyniki ankiety porównano z wynikami podobnych badań przeprowadzonych przez zagranicznych autorów. Nie znaleziono istotnych różnic pomiędzy poglądami respondentów zagranicznych i respondentów słowackich. Przedsiębiorstwa, których celem jest preferowanie wartości środowiskowych są dobrze przygotowane do włączenia aspektów środowiskowych do marketingu, aby zyskać przewagę konkurencyjną na rynku. Istnieją perspektywy dla przyszłego rozwoju certyfikacji lasów i pochodzenia produktu. Jednakże tempo rozwoju zależy od ogólnego zainteresowania społeczeństwa oraz popytu na produkty certyfikowane w ramach łańcucha las – użytkownik końcowy.

Słowa kluczowe: certyfikacja lasów, łańcuch kontroli, ankieta, rynek drewna certyfikowanego

DREWNO – WOOD 2009, vol. 52, nr 182

Jarmila ŠALGOVIČOVÁ, Jana URDZIKOVÁ

A SATISFIED CUSTOMER – IN THE LIGHT OF ISO STANDARDS

This paper focuses upon the significance and position of customer as a driver of success of organisations not only from the wood industry. At the same time, it emphasises the position of business entity in relation to the customer and stresses the variety of customer purchasing habits. It focuses upon the importance of a comprehensive and systematic approach to resolving complaints and claims within organisations. The article was written within the framework of Institutional project No. 1/0290/09 "Integrated Communication of the Quality-Oriented Organisation" and the institutional project entitled "Distance Education in the Quality of production, customer protection and market surveillance".

Keywords: customer, organisations, satisfaction, dissatisfaction, complaint, claims

Introduction

The significance of the wood industry in the Slovak economy results from its specific mission and role in the entire national economy. In the basic structure of industrial production the wood industry represents a significant source of economic income in the national economy; this sector depends entirely on processing of renewable, domestic, primary raw materials. In 1989, after the initial recession, the wood industry in Slovakia started to develop promisingly. However, the current complicated economic situation, showing all signs of crisis, has affected this area significantly as well. Nevertheless, there is hope for improvement since at present wood is returning to furniture, building, architecture and design industries, despite the overwhelming exports in the past, and this could alter the complicated situation as well as strengthen the competitiveness of the wood industry. One of the ways to improve this situation is striving for satisfaction of consumers of wood products.

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Relationship: business entity/organisation and the customer

Any business entity that wishes to achieve a desired level of success must flexibly and effectively react to changes in the market. The customer is the only one to determine which products are of good quality and thus which business entity is competitive.

Through their behaviour, the customer is a driver of effective production without losses and without holding excessive stock. Therefore, the main aim of a successful organisation is to satisfy customer demands. ISO 10001:2007 defines the customer as an "organisation or person who receives a product, e.g. consumer, client, final user, retailer, beneficiary – the receiver who benefits from the product, purchaser [ISO 10001:2007]". In relation to organisation customer may be internal or external. The term 'customer' also includes potential customers. In simple language, a customer is anyone to whom we pass on the results of our activities.

The relationship between an organisation or business entity and the customer plays a significant role in the competitive environment. Organisations ensure the quality of their products and customers expect and consume quality products. To unify a preview of the issueof the mentioned relationship the author drew the scheme (fig. 1) showing the connection between both interested parties leading to customer satisfaction. Everything starts and ends with the customer, and therefore, from a strategic viewpoint, it is important for organisations to focus on customers, to know and understand them, and especially, to accept customer needs, requirements and desires in business operation.

From creation of a need to product evaluation by customer, they go through individual phases [Urdzikova 2005; Cook 2008]:

a) Seeking – initial stage of decision-making process – in this phase a need is created. The need can arise from an internal stimulus of a person or be induced by external stimuli (stimuli from the surroundings). The phase of seeking gradually moves on to the decision-making phase.
b) Deciding – this phase is strongly influenced by many factors. On the basis of information, feelings, product appearance, etc., various alternatives appear that are assessed by the customer who gradually selects the right supplier (organisation).
c) Implementing – purchase decision – depends upon the results of the previous phase. Nevertheless other company tools of customer care may still influence the customer.
d) Evaluating – after purchase the customer recognises the actual value of the obtained item: whether the original expectations were too high, how the supplier (i.e. organisation) reacted to changes in expectations etc. This phase again is linked to the first phase.

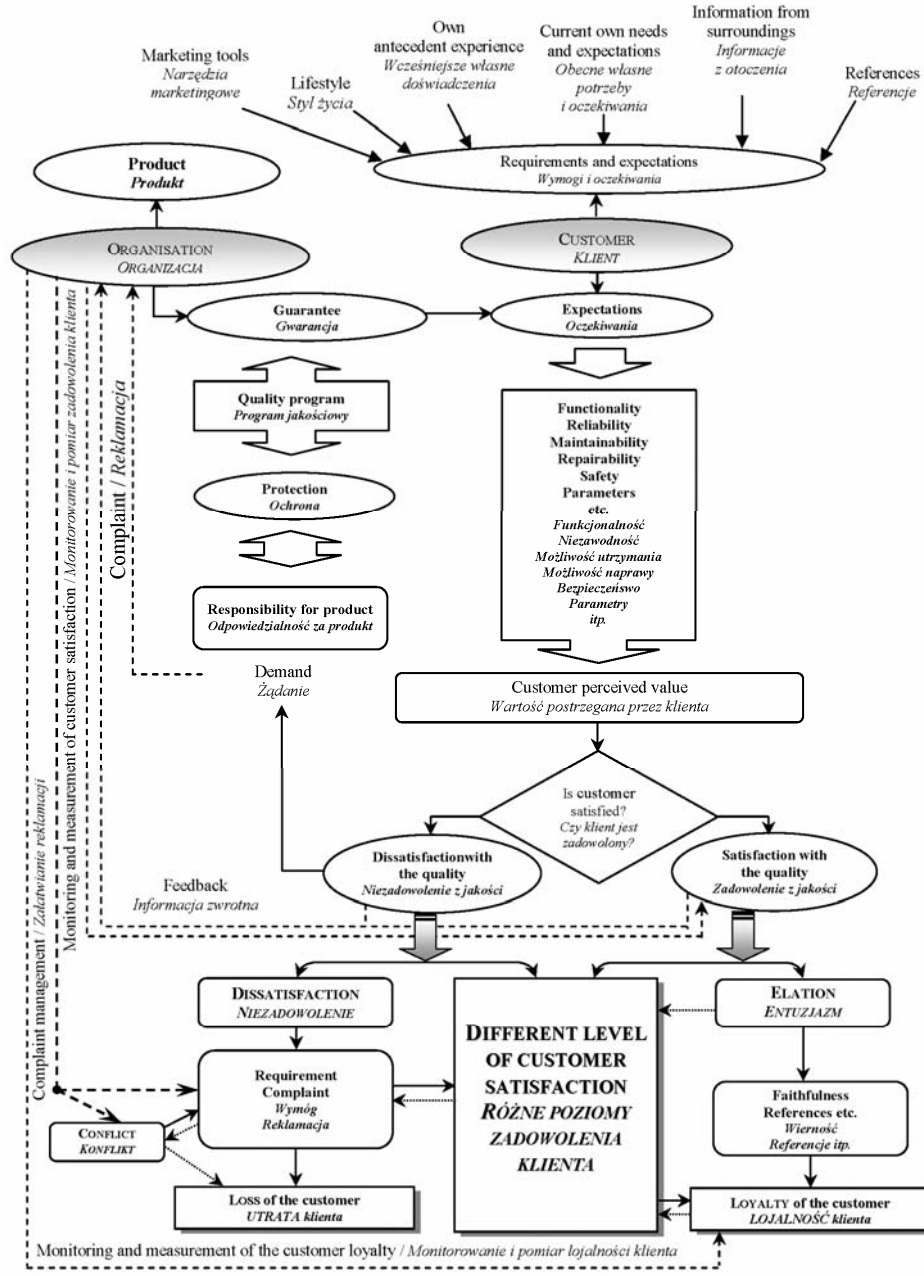

Fig. 1. The connection between an organisation or business entity and customer leading to customer satisfaction

Rys. 1. Powiązanie pomiędzy organizacją lub podmiotem gospodarczym a klientem prowadzące do zadowolenia klienta

In the evaluation phase the customer observes the actual value of the product, compares it with their requirements, internal preconceptions, expectations and wishes on the basis of which the sensation of satisfaction or dissatisfaction with the given product appears. Therefore, customer satisfaction can be understood as customer's positive feelings about fulfilment of their needs by a particular product within a given time. On the other hand, customer dissatisfaction can be understood as customer's negative feelings about fulfilment of their needs by a particular product within a given time. It follows from the above that if the expected result is achieved or exceeded the customer is satisfied, but if the expected result does not meet expectations the customer is disappointed and dissatisfied. Therefore, buying a product the customer purchases its value without side effects and risk if possible.

A dissatisfied customer as a reason for improvement in organisations

A lot has been written about customer satisfaction and loyalty. Therefore we will focus upon the other and less pleasant aspect. i.e. customer dissatisfaction. If it is underestimated and unresolved its consequences are more far-reaching.

We have already mentioned that customer dissatisfaction can be understood as a negative feeling about the fulfilment of needs in a given time and with a particular product, i.e. if the actual result does not meet expectations. We connect customer dissatisfaction with feelings of disappointment, even anger, which arise from results of the comparison of expected and actual product performance. The greater the difference between expected and actual product performance is, the greater customer dissatisfaction is.

Therefore, it is necessary to monitor factors, either objective or subjective, that result in an increase in customer dissatisfaction. Objective factors influencing an increase in dissatisfaction include such things as variability of choice, impossibility to try a product or impossibility to return a product. Apart from little information about a product, the set of subjective factors influencing an increase in dissatisfaction includes mainly those that arise from the customer’s personal profile. A significant role is played by customer indecisiveness and low self-confidence which leads to increased monitoring of other alternatives, even in the post-purchase phase, and is a reason why on purchasing a product such customers seek reassurance from people in their surroundings.

Dissatisfaction with a product can lead to such negative consequences as change of brand, biased non-acceptance which means that the customer not only refrains from buying a given product from organisation, but also refrains from buying different categories of products from that organisation, giving preference to competitors and spreading a negative message in their surroundings regarding the product, brand and the business entity. The organisation not only loses the customer, but this can also lead to serious consequences, including negative

advertising which means that the customer expresses their dissatisfaction through negative personal communication with people in their surroundings regarding the product, organisation and brand. It is important to bear in mind that customers express negative experiences considerably more often than any positive experience.

It follows from the above that in extreme cases customer dissatisfaction with a product may result in destructive consequences for organisation that may even wind up. Therefore, it is necessary to carry out regular monitoring in this area.

The most common expressions of customer dissatisfaction are complaints and claims. ISO 10002:2004 and ISO 10001:2007 define a complaint as an "expression of dissatisfaction with an organisation related to its products or the process for dealing with a complaint itself, where a reply leading to a solution is explicitly or implicitly expected [ISO 10001:2007; ISO 10002:2004]".

The number of registered complaints and claims in an organisation is an objective indicator of customer dissatisfaction. However, it is necessary to stress that for various reasons zero claims and complaints in an organisation cannot serve as a measure of quality since they it is not a guarantee that the organisation has only satisfied and loyal customers. Therefore, monitoring claims and complaints can only be considered as a partial or additional indicator of customer satisfaction.

A proof of the significance of monitoring and effectively resolving claims and complaints from customers within organisations and of the seriousness of resolving those issues is the fact that even the International Organisation for Standardisation deals with those issues, which work results in a systematic approach to resolving claims and complaints that is described in the following standards:

- ISO 10001:2007 – Quality Management – Customer Satisfaction – Guidelines for codes of behaviour for organisations,
- ISO 10002:2004 – Quality Management – Customer Satisfaction – Guidelines for resolving complaints in organisations,
- ISO 10003:2007 – Quality Management – Customer Satisfaction – Guidelines for resolving disputes outside the organisation.

Standards making the abovementioned triumvirate are conceptually connected and together they represent a comprehensive approach to all phases of addressing complaints and claims from customers. The purpose of this approach is to provide a comparative base to assist organisations and their customers to carry out business in markets whose borders are being removed. Fig. 2 shows how those standards are interconnected. For organisations they represent guidelines for successful resolution of the majority of complaints within an organisation without the necessity of using other time consuming and unpleasant methods.

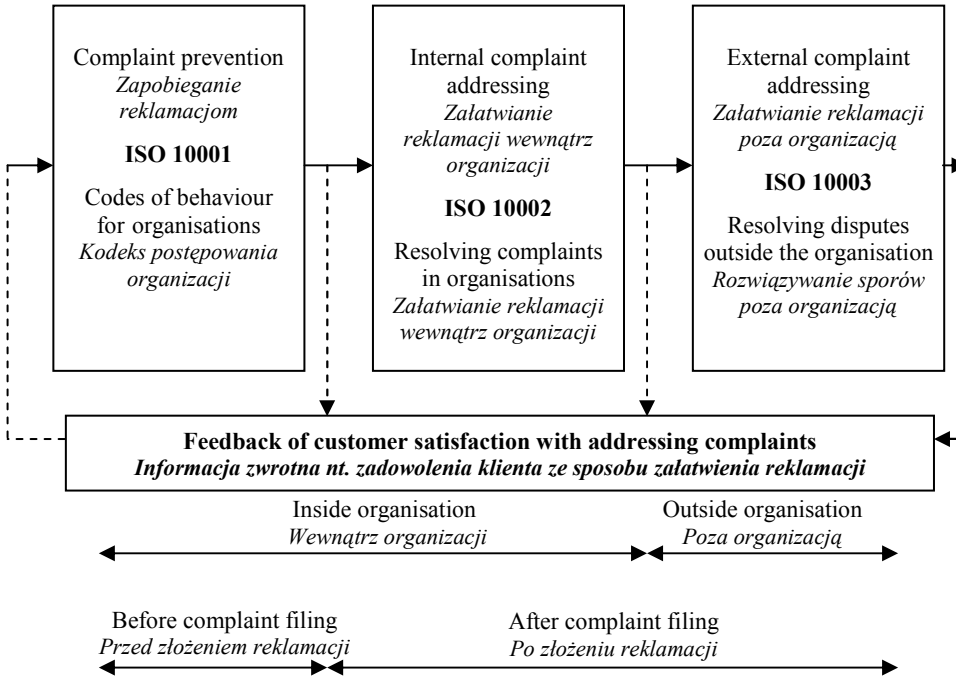

Fig. 2. Comprehensive approach to all phases of addressing complaints and claims from customers [Dee et al. 2004]
Rys. 2. Wszechstronne podejście do wszystkich faz załatwiania reklamacji i roszczeń klientów [Dee i in. 2004]

Complaints and claims that are properly and quickly resolved by an organisation will probably maintain or even improve customer satisfaction. Apart from this, information regarding complaints and claims may assist an organisation in improving the quality of products and activities.

External dispute resolution processes are designed for resolving complaints and claims that cannot be addressed using internal processes. Similarly to resolving claims and complaints a properly resolved dispute can maintain or increase customer satisfaction and provide important feedback for quality improvement.

The mentioned standards are compliant with Quality Management System standards ISO 9000:2005, ISO 9001:2008, and ISO 9004:2000, and support targets through effective application of the process for resolving complaints, claims, and disputes. They can also be applied independently or be interconnected. However, if they are applied together, they can become part of a wider and integrated scope for greater customer satisfaction through a code of behaviour, addressing complaints, and resolving disputes.

Standards are voluntary, non-binding, and recommended guidelines for behaviour and activities which organisations will accept and apply in their operation or ignore.

Discussion

It is necessary that the issue of resolving complaints, claims or disputes becomes common knowledge not only for the professionals but also for the lay public, using a different approach to individual groups of the public. The very title of this paper indicates that the customer is a key 'element' in the market environment. We commonly approach the relationship of 'organisation – customer' (fig. 1). We either represent the interests of an organisation and its position and promote its interests or sometimes we are customers with needs and wishes, who publicly or privately convey their positive or negative feelings which express satisfaction, praise and appreciation or, on the other hand, dissatisfaction, complaints, and claims. It is important to identify and monitor various manifestations of post-purchase behaviour of customers and to bear in mind that customers often recall the negative experience much more often than positive.

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ZADOWOLONY KLIENT W ŚWIETLE NORM ISO

Streszczenie

Przedstawiono znaczenie i pozycję klienta, jako siły napędowej sukcesu, nie tylko w przemyśle drzewnym, oraz podkreślono pozycję podmiotu gospodarczego w relacji z klientem. Skoncentrowano się na znaczeniu wszechstronnego podejścia do załatwiania w zgłaszanych reklamacji i roszczeń.

Słowa kluczowe: klient, organizacje, zadowolenie, niezadowolenie, reklamacja, roszczenia

DREWNO – WOOD 2009, vol. 52, nr 182

Miloš HITKA, Marek POTKÁNY, Mária SIROTIAKOVÁ

PROPOSAL OF ASSESSMENT OF WOOD PROCESSING COMPANY EMPLOYEES

The paper focuses on a new way of assessment in a wood processing company with reference to assessment criteria relevance. The description of the main criteria and sub-criteria provides an opportunity for supervisors to evaluate their subordinates objectively and thus motivate them to achieve higher performance. The suggested system of assessment enables an organisation to systematically work on human resources.

Keywords: employee assessment, criteria of assessment, human resources management

Introduction

Human resources management is the part of a company management that focuses on issues connected with human factor in working process and the importance of the workforce for the company as well as on recruitment and formation, operation, utilisation, and organisation of human resources, and finally on combination various activities. It is aimed at the results of work of employees, their working skills and behaviour, relation towards work done, company and colleagues, and last but not least at their personal satisfaction resulting from their performance and personal and social development. Assessment of employee performance is inseparable part of company management. The role employee assessment is to find out what is the human potential at the company's disposal. If the assessment is carried out properly it is beneficial to employees, their supervisors, and organisation as well. Every employer needs to know their employees, their working habits, how they support the company operation and its

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reputation. On the other hand, every employee also is entitled to know if the employer is satisfied with their performance. Employees look for feedback concerning their performance which motivates and leads them in their future activities.

Goal and object of the article

Issues concerning employee assessment were identified in a wood processing company in the central part of middle Slovakia. The company deals with primary wood processing and has no complex system of employee assessment. Until now such system was substituted with a motivational system which was determined for employee remuneration based on coefficients of assessment. Work performance assessment was carried out only for employees fulfilling technical and economic functions. Their assessors were their direct supervisors. It was suggested to conduct the assessment once a year.

The organisational structure of the company is a functional one and is based on labour division and specialisation of individual divisions. It is hierarchically structured from the highest to the lowest level. It concentrates on performance and fulfilment of the company's goals.

On 31st December 2008 the company had 798 registered employees and in comparison to 2007 the number of employees decreased by 146 people. The employee structure was as follows: 12 top executive managers (out of it 3 women), 54 administrative employees – middle management (out of it 17 women) and 732 workers (out of it 149 women). Currently there are 25 employees with tertiary education, 243 employees with secondary education, 435 with apprentice school education, and 95 with primary education.

Methodology

Assessment is considered a natural need of every employee which is in a specific way connected with a higher social human need – a need of social affiliation (response). When employees are assessed they also get a feedback concerning their performance and working behaviour which leads to strengthening or modification of their actual activities. Employees based on information they get from managers, colleagues and on their own reflexion (self-assessment) adjust their actual and future activities and goals. From the point of view of managers provision of assessment or feedback is one of basic tasks involved in their working post.

There are two ways to organise assessment in organisations, i.e. formal and informal, and they both serve as a tool of employee development. Even if from social and psychological viewpoint the above-mentioned processes are almost the same some differences should be mentioned due to their utilisation.

Formal assessment is periodical, planned, and systematic. Documents concerning assessment are included into personal files. Results of assessment are mostly used in the process of remuneration, allocation (promotion, case shift, and labour contract termination), and education, and also as a tool of motivation to improve employee performance.

Informal assessment (feedback) is a wider term. It is natural part of human communication. It is mostly provided in an informal way and is not based on standard procedures [Repková 1989]. Informal assessment results from every day contact of the manager with the employees [Vetráková 1996].

The assessed period is a time interval during which employee assessment is carried out. Recommended frequency of a regular assessment is 1 assessment per 1 to 3 years. Executive managers and important employees should be assessed at least once per two years and also when they are promoted.

An appropriate method connected with selection of particular criteria provides the best and most objective assessment of employees and brings information on the differences between evaluated employees resulting from assuming particular criteria [Pichňa 1994]. There are a lot of methods for employee assessment. In general, they can be divided into two groups, i.e. ex post methods and ex ante methods.

If the assessment is to become a real tool of employees' development and company's growth it should be:

- Objective – the assessment should take into account characteristics of a particular working post. Employees should know its standards and how to achieve them,
- Universal – the assessment should be applicable to all employees performing the same job defined by the same indicators of evaluation,
- Comparable – the results of many evaluators should be almost the same. This proves objectivity from the point of view of the situation and applied methods of evaluation,
- Oriented at present – it is not possible to connect current performance with past successes or failures, but based on current performance it is correct to define potential performance goals and motivation tools,
- Oriented at performance – although the level of work performance is closely connected with personality of employees, their family background, social activities etc. only precisely determined and standardised criteria of work performance and other aforementioned indicators should become the object of assessment to the extent to which they concern employees and influence their standards,
- Focused on positive aspects – it follows from psychological research that people tend to strengthen and repeat these formulas of behaviour they are positively awarded for. It also concerns working behaviour,

– Actual –in formal and informal assessment the interval between evaluated periods should be particularly determined, i.e. it should not be too long, because in this case employees cannot see the direct relation between the assessed performance and character of their assessment and adopted measures. It concerns especially the assessment of unusual situations such as exceptional successes or failures, where the topicality of assessment and adoption of a corresponding measure are the most important factors of its efficiency [Repková 1989].

Results

The topic of employee assessment was identified based on the needs of the wood processing company in which a system of employee assessment does not exist. There is a system of motivation developed by the human resources department, but it is only a replacement of a system defined for employee remuneration based on coefficient of evaluation. Each effective system of assessment should be objective and fair. General frame of its creation consists of the following steps:

1) determination and clarification of roles or duties of employees (enables subordinates to participate in goals establishment and performance assessment),
2) determination of preliminary and partial goals reflecting company's mission and vision,
3) regular meetings and monitoring of the process of achievement of set goals,
4) assessment at the end of the agreed period.

Regardless of the method of working performance assessment the company is required to pay attention to who will assess and evaluate working performance and who will provide the feedback concerning the employee performance.

Proposal of the assessment procedure and criteria

The system of assessment suggests conducting an assessment once a year and use a special assessment form and carry out an evaluation interview.

Assessment by means of assessment form – the evaluator conducts this assessment without the presence of people being assessed. The evaluator uses a five-point scale and allocates points to individual criteria. Then all point values are added up and the evaluator obtains the total number of points for individual employees.

The point method is an analytical method of assessment based on comparison of work and verbal description which get corresponding number of points. Its advantage is that evaluators must consider more factors; hence they can avoid simplified judgements. The judgements can be simplified if non-analytical summary methods are used.

Employee assessment by means of evaluation interview – the form used by the evaluator is an evaluation interview. The assessment is successful only if the evaluator discusses its results with individuals. Usually the direct supervisor interviews the employee with the aim of finding out the ways to improve the employee's performance or behaviour and considers suggested all measures. Both partners in the interview must clearly understand the sense of the assessment. That is why the interview must be prepared thoroughly.

The term criterion means an indicator which helps judge the ability to perform a particular working activity or function. The character of criteria is different and depends on the type of work posts. In the paper two main areas of evaluation criteria are suggested:

A – special readiness and predispositions to a job

B – working behaviour.

Each scope of criteria is internally divided into several sub-criteria. The agreed five-point scale is used in the following scope:

Exceptional – permanent performance considerably exceeds standard expectations as to total work.

Above standard/expectations – often exceeds expectations as to standard performance in key working tasks.

Standard/in line with expectations – meets working standards in line with the defined norm and may exceed requirements in some working tasks.

Needs improvement – total performance is acceptable but improvement is required in one or more working aspects.

Insufficient – performance is insufficient in several working areas. A considerable change is a must.

All assessment results need to be based on notes and total assessment of the types like *Exceptional* or *Above standard* should include examples which support particular level of assessment. If the assessment results are *Needs improvement* or *Insufficient* it is recommended to add a written plan of performance improvement to the report. In the following part the characteristic of the assessment criteria and sub-criteria is provided.

A – Main criteria: Special readiness and predispositions to a job:

Special readiness and suppositions for a job are one of the most critical criteria when a supervisor is assessed. Basis for assessment should be deep knowledge concerning the managed area, correctness of decision-making, ability to educate subordinates, creation of a team etc. Apart from formal authority delegated by the organisation and resulting from the post each supervisor should also have natural authority based on the quality of his knowledge and abilities. The above-mentioned criteria are divided into the following partial criteria:

A1 – knowledge in the field,

A2 – ability to make decisions (managerial and organisational skills),

A3 – authority and prestige,
A4 – ability to lead a unit,
A5 – training of subordinates and team creation,
A6 – interest in further special development.

Sub-criteria A1 Knowledge in the field:
Knowledge in the field means competence and ability to understand specific problems concerning particular field in which an employee works.

5	The employee's knowledge in the field is excellent, including abilities which they fully uses in execution of their function
4	The employee's knowledge and abilities in the field are good and are utilised sufficiently in execution of their function
3	The employee's knowledge, abilities and experience in the field and management are average, sufficient only to carry out ordinary tasks resulting from their post
2	The employee's knowledge, abilities and experience in the field are marginal, some of them require to be renew and rebuild
1	The employee's field knowledge is poor or insufficient

Sub-criteria A2 Ability to make decisions (managerial and organisational skills):
Ability to make decisions and manage is a personality trait. It can be partially influenced by education and environment. Correctness of a decision is seen only after some time, but based on experience, intuition, and specific knowledge it is possible to limit the number of incorrect decisions to a minimum. For a supervisor their managerial and organisational skills are a way to their self-realisation.

5	Organises work in a correct way, motivates a team properly, their authority is strong but informal
4	Has predispositions to manage work effectively, organise it correctly, and motivate the team adequately
3	Has a good formal authority, is able to motivate the team properly
2	When solving operational tasks prefers doing it themselves but in critical situations is able to motivate the team properly
1	Managing a team brings them problems, has no authority

Sub-criteria A3 Authority and prestige:
Authority of a supervisor is the extent to which their orders, recommendations and views are respected by the subordinates. Prestige of a supervisor is an extent to which their priorities, abilities, skills, knowledge, results etc. are respected by their subordinates or colleagues.

5	Has high authority and prestige, all subordinates respect them strongly and try hard to improve their performance
4	Subordinates respect orders and tasks, all orders and tasks are executed in time
3	Most subordinates respect the supervisor's orders
2	Sometimes the supervisor's orders are not respected
1	Subordinates do not respect their supervisor and do not meet their requirements and their tasks

Sub-criteria A4 Ability to lead a unit:
A supervisor has to know how to manage a unit and build positive working atmosphere, allocate tasks to their subordinates, and check the work done.

5	Manages their unit in an excellent way, is able to create fine working atmosphere, properly allocates duties to their subordinates, takes into consideration their specialisation and personal characteristics, is able to inspire colleagues to fulfil tasks exceeding their scope of duties, does not miss checking activities
4	Manages a unit without any problems, allocates work in a responsible way, respects wishes of a team, has good relations with their supervisors and subordinates
3	Has no big problems in unit management, checks work activities regularly
2	Makes considerable mistakes in duties allocation, does not often respect colleagues' specialisation, there is atmosphere of dissatisfaction and stress in a team, neglects inspection
1	Makes big mistakes in team management and the team does not respect them, is not able to allocate work and to check it

Sub-criteria A5 Training of subordinates and team creation:
Each supervisor is supposed to have the correct attitude towards their subordinates and educate and lead them properly. The supervisor's ability to establish a working group (a team) and correctly estimate abilities and skills of the subordinates is closely connected with it.

5	Excellently educates their subordinates and tries to make key employees in the managed team better, is totally committed to the company
4	Properly and successfully leads colleagues, is a good organiser, is able to allocate tasks successfully, adequately estimates skills and abilities of their employees
3	Is able to synchronise their subordinates, sometimes problems arise with team synchronisation
2	Knows what should be done to improve activities of a team, but has a problem to choose the right people
1	Is not able to recognize what is in people, what they should know and manage, is not able to judge the need of their qualification, prefers doing a lot of things themselves, their estimation concerning subordinates is often false

Sub-criteria A6 Interest in further special development:
Each supervisor should make an effort to develop themselves as well. It can be done through self-education as well as by means of special training and courses.

5	Exceeds requirements concerning specific readiness, is interested in their own professional development, spends their free time on professional improvement and development
4	Is interested in training within the scope of business activities, regularly participates in courses and training
3	Occasionally participates in training, their interest in courses in low
2	Is not interested in their professional development, sometimes tries to work on their own growth
1	Is not interested in professional development, does not seek or refuses activities including this content

B – Main criteria – Working behaviour:
The group of criteria under the common name 'working behaviour' is closely connected with the character of a person and often influenced by motivation factors. A supervisor should be composed carrying out working tasks, their performance and work quality should be sufficient. The above-mentioned criteria are divided into the following partial sub-criteria:
B1 – fulfilment of work obligations,
B2 – work performance and quality,
B3 – ability to finish a begun task,
B4 – supervisors' orders fulfilment,
B5 – working initiative.

Sub-criteria B1 Fulfilment of work obligations:
Fulfilment of work obligations should be automatic for every supervisor. A supervisor should be a role model for their subordinates in the area of working initiative and composure.

5	The employee executes managerial function intensively, even after working hours, is more than composed, their effort to meet all the obligations exceeds the scope of their duties and obligations
4	The employee fulfils managerial duties evenly and precisely
3	The employee´s concentration and energy use is average
2	The employee in the process of task execution often slacks off and is not fully committed to work
1	The employee's work commitment is minimum and they is not able to work intensively and permanently

Sub-criteria B2 Work performance and quality:
The group of criteria under the common name 'work performance and quality' is closely connected with criteria relating to the company. An employee loyal to the company they works for tries to increase the quality of their work. Within their abilities their performance will be better as well.

5	The employee's performance is evenly high
4	The employee's performance is good, there are no changes in the work quality
3	The employee's performance is average and the work quality is acceptable
2	The employee's performance is sometimes insufficient, also the quality of work fluctuates
1	The employee's performance is not sufficient, work quality does not meet requirements

Sub-criteria B3 Abilities to finish a begun task:
Ability to finish a begun task is a feature which should be common to all supervisors. It is not enough just to be inspired by a task but it is important to work on it. And it is critical to finish the begun task.

5	The employee always finishes the assigned task within the shortest period and with the highest quality
4	The employee almost always finishes the assigned tasks in time and with sufficient quality
3	The employee is almost always able to finish the assigned tasks but sometimes not in time
2	The employee always finishes the assigned tasks with the support of other persons and based on a notice
1	The employee is not able to finish the assigned task

Sub-criteria B4 Supervisors' orders fulfilment:
Supervisors' orders fulfilment is very important in terms of finishing the given tasks. If case of any doubts a supervisor should consult their opinions with their own supervisor.

5	The employee shows initiative and full independence in execution of their tasks and meets the supervisor's orders
4	The employee meets the supervisor's orders in execution of tasks
3	The employee mostly follows the supervisor's orders
2	The employee often does not follow the supervisor's orders in execution of tasks
1	The employee mostly contradicts the orders and viewpoints of his supervisor which results in conflict situations

Sub-criteria B5 Working initiative
In human working life very frequently there are problems which must be solved very quickly. The ability to take decisions quickly and correctly is a very important task of a supervisor.

5	Initiatively brings new and original ideas
4	Independently and successfully solves unexpected situations and has a lot of new ideas
3	Is able to predict instructions of others but needs orders
2	Not reliable enough, needs permanent control
1	Does not show any initiative, is not interested in introduction of new ideas

The process of assessment

Zero assessment – creates bases of the assessment system in a company in case when such system is introduced for the first time or when the existing assessment system is being improved.
Zero (initial/starting) assessment means establishment of a positive view of evaluators and people who are evaluated or assessed. The result is that both parties get a precise concept of the assessment. Zero assessment shows assessed employees what their supervisors will require of them in the future. During zero assessment initial goals are defined as well and their fulfilment becomes the object of assessment during the first normal assessment.

Analysis of zero assessment process – brings an answer to the question to what extent the experts who executed the assessment used the assessment methodology, how they defined goals for employees, and how they formulated the assessment conclusion. The experts also get information from the assessed employees concerning their opinion on the executed assessment, i.e. what is benefit from it, how they perceived the assessment interview, what they consider the most important in the process of assessment etc. This information provides the evaluators with feedback. The analysis of the assessment execution shows if the initial/starting assessment caused any problems or if there were any minuses of it.

Conclusions

The results of a well prepared assessment system will be especially reflected in better motivation of employees towards quality of their work, higher performance, willingness to develop themselves, and also in a positive change of attitudes towards the company, its management whose informal authority and trustworthiness will be strengthened. Consequently the quality of management may improve, especially when it is focused on future development of the com-

pany in accordance with the company's strategy and critical company values. Also the work with people is much better. In the area of personnel work especially the quality of education planning and career development of the assessed employees (including building of managerial reserves) and their allocation increased considerably. Also the level of recruitment of new employees improves. The equity and effectiveness of remuneration and satisfaction of employees in the company is higher as well. The total result is better acceptation of the common company values and norms of behaviour by the assessed employees, i.e. an increase of impact of the company culture on the employees' behaviour. If the system of assessment does not bring the expected result it is necessary to go back to the second step and work out a new one. If the system of assessment meets expectations it is implemented and used regularly once per year.

A correct employee assessment shows who is able to take up a higher post and also who should be reallocated to a post requiring lower scope of responsibility. In this way the company can modernise its organisational structure so that every employee holds an adequate position in line with their knowledge, abilities, predispositions and qualifications. If the company provides extra rewards for the high quality of the work done the employees are motivated to performance better and achieve better results, and customers of the company are more satisfied, thus the company not only gain more profit but also its reputation gets higher. When all rules concerning the correct employee assessment are obeyed, benefits are visible in all areas of human resources management.

For the employees of the analysed company the introduction of a new system of employee assessment means:

- acquaintance with a new system of assessment and its criteria,
- acquaintance with the way and form of assessment,
- acquaintance with set goals for the future from the point of view of organisation and individuals,
- acquaintance with the system of remuneration.

In the area of human resources management the dominant position at all levels belongs to employee assessment. Together with motivation and remuneration it has a critical impact on human potential development in the company. Employee assessment presents a rational and systematic comparison between the requirements of individual working activities and employees' abilities to perform allocated tasks properly.

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PROPOZYCJA OCENY PRACOWNIKÓW FIRMY DRZEWNEJ

Streszczenie

Omówiono nowy sposób przeprowadzania oceny pracowników w przedsiębiorstwie drzewnym. Opis kryteriów głównych i drugorzędnych ułatwia obiektywną ocenę podwładnych. Zaproponowany system oceny umożliwia racjonalne zarządzanie zasobami ludzkimi.

Słowa kluczowe: ocena pracowników, kryteria oceny, zarządzania zasobami ludzkimi

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THE POLISH FURNITURE INDUSTRY – A VISION OF THE FUTURE

The article contains information and results of research concerning the Polish furniture industry. The author's vision of operation of furniture companies in the future is presented in comparison to general characteristic of this industry, changes in production, export, and innovation activities[1].

Keywords: furniture industry, innovation, structure of organisation, Poland

General characteristic of the furniture industry in Poland

Since the beginning of 1990s the furniture industry has been considered one of major drivers of the Polish economy and export. This industry represents a considerable percentage of GDP (0.8%), overall production value (1.2%), and total employment in industry (5.9%). For a dozen or so of years the furniture industry has been demonstrating high production dynamics. In the period 2005–2008 furniture production increased from PLN 20.0 billion to PLN 25.5 billion, i.e. by 27%. As a rule a relatively good situation of the furniture industry is an effect of big export volumes and the exchange rate of zloty to euro and dollar that is periodically favourable for exporters. For many years furniture exports in relation to production has been amounting to 79–88% (73% in 2008).

In the period 2005–2008 the value of Polish furniture exports rose from USD 5.3 billion to USD 7.9 billion. Germany is the biggest consumer of furniture from Poland. In 2008 Germany purchased 33% of Polish furniture, France 9%,

[1] The article contains part of results of an analysis entitled "Technological and product innovation in the Polish furniture industry" prepared within the framework of a project entitled "Foresight in the wood science and industry – research development scenarios in Poland till 2020" (POIG 01.01.01-30-022/08). The project is co-financed by the European Regional Development Fund (ERDF) within the framework of Operational Programme Innovative Economy 2007–2013 and carried out in the Wood Technology Institute in Poznan.
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Great Britain 6%, the Czech Republic 6%, Sweden 5%, the Netherlands 5%, Belgium 4%, and the United States 3%.

Poland is an eminent furniture producer with its established sixth place amongst European countries (after Italy, Germany, Great Britain, Spain, and France). The furniture industry employs a considerable and ever growing number of people. In 2005 employment in this industry amounted to over 155 thou. people, and in 2008 to over 168 thou. people, i.e. it was by 8% more.

The Polish furniture industry is much dispersed. There is a large number of small and very small enterprises. In 2006 the number of registered business entities in the furniture industry was around 24.5 thou., of which companies of employment of up to 9 people amounted to 22.3 thou., i.e. 91%. At the same time, there is a high level of production concentration in big companies in Poland.

Approximately 65% of furniture production comes from over 500 big companies (employing more than 50 people). There are 99 enterprises employing over 250 people, and ten biggest producers manufacture around 30% of total production. The industry is characterised by considerable presence of foreign investors, amongst whom German investors dominate.

Investments and innovation in the Polish furniture industry

It stems from statistical data that expenditure on investments in the furniture industry[2] has been increasing in recent years. In the period 2005–2007 the recorded growth of investments in this industry was over 20% to the level of PLN 1.8 billion.

The competitiveness of the Polish furniture industry to a great extent depends on the level of technical equipment of plants, applied technologies, and production innovativeness. The innovativeness of the furniture industry, despite the improvement observed in recent years, is unsatisfactory. The expenditure on innovation of furniture companies amounts to 2.0% of the value of sold production of furniture. In 2007 in the furniture industry the outlay per one company that carried on the innovation activity was PLN 3.0 M.

The innovation activity of the wood industry companies in the field of new knowledge generation is very low. The outlay on R&D (3.5%) and on personnel training connected with the innovation activity (0.1%) is only a small percentage in the structure of expenditures on innovation (table 1). In general, the furniture industry makes use of offered achievements of foreign and, to a less extent, domestic technical thought.

[2] Together with other production activity – section 36. of The Polish Classification of Activities (PKD).

Table 1. Structure of expenditures on the innovation activity in the furniture industry[1] in 2007
Tabela 1. Struktura nakładów na działalność innowacyjną w przemyśle meblarskim[1] w 2007 roku

Detailed list *Wyszczególnienie*	Share of the investment outlay [%] *Udział nakładów na inwestycje [%]*
Technical machines and devices *Maszyny i urządzenia techniczne*	49.2
Investments in buildings and structures *Inwestycje w budynki i budowle*	44.0
Research and development activity *Działalność badawczo-rozwojowa*	3.5
Purchase of a ready technology in the form of documentation and rights *Zakup gotowej technologii w postaci dokumentacji i praw*	0.04
Personnel training connected with the innovation activity *Szkolenie personelu związane z działalnością innowacyjna*	0.1
Marketing of new and modernised products *Marketing dotyczący nowych i zmodernizowanych wyrobów*	1.4
Other *Pozostałe*	1.8
Total *Razem*	100.0

[1] Together with other production activity – section 36. of The Polish Classification of Activities (PKD).
[1] Łącznie z pozostałą działalnością produkcyjną – dział 36. PKD.

Source: Calculations based on: [Statistical Yearbook 2008]. Central Statistical Office (GUS), Warsaw 2008, p. 423.
Źródło: Obliczenia na podstawie: [Rocznik Statystyczny 2008]. GUS, Warszawa 2008, s. 423.

As it stems from the research of Kapuściński and Listwoń [2007], in the last 3 years a little over 84% of companies surveyed by them have taken up activities that have influence on the company's competitiveness (fig. 1). In this group 74% of companies launched new or significantly improved product/service, 44% invested in new or significantly improved production processes or solutions (taking into account processes concerning supply and sales), 1/3 of the respondents made significant changes in operation organisation or introduced a new way of it, and 22% introduced new or significantly improved marketing concept. Approximately 47% of total number of enterprises introduced changes concerning more than one of the aforementioned innovativeness aspects.

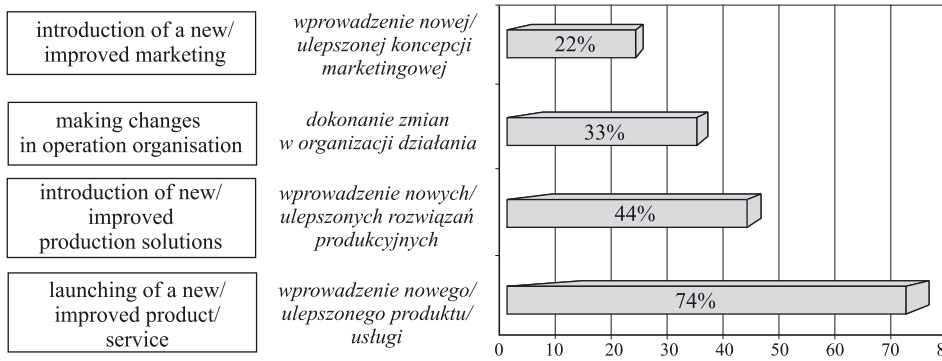

Fig. 1. Innovation types in furniture companies that carry on the innovation activity
Rys. 1. Rodzaje innowacji w przedsiębiorstwach meblarskich prowadzących działalność innowacyjną
Source: [Kapuściński, Listwoń 2007]
Źródło: [Kapuściński, Listwoń 2007]

Customer directions constitute the most common and most important source of suggestions of innovative solutions. In addition, introduction of new products into companies' offer usually is preceded with search after information during industry fair (47%) and specialist conferences (43.5%). A source of innovativeness in furniture companies consists of ideas of their own employees as well. The research of Kapuściński and Listwoń [2007], indicates that information from specialist press, own R&D activities, peering at products of other companies in the industry, and information from suppliers, often are the factors as well. However, those factors are graded differently as regards their importance. In that group of factors directions from suppliers are rated the highest, then follow own R&D activities, information from specialist press, and peering at products of other companies from the industry. The attention is drawn to the fact that in none of the surveyed companies application of innovative solutions was the result of co-operation (contacts) with scientific and R&D organisations.

As it stems from research, in 2005 a bit over 34% of companies did not engage in any type of the innovation activity. The other producers, who bet on innovativeness in their business, were concentrated mainly on purchase of machines and devices (56%), design development (28%), and personnel training (25%). Few companies also took up R&D activities carried out in their own works and marketing actions connected with technical innovation (around 6.25%).

The Polish furniture industry must be competitive. In the nearest future its ability to participate in the global trade will decide the industry's competitiveness in the first place. The companies have to base their competitive positions on sustainable competitive edges that enable them to gain and keep new markets at

a local, regional and international scale. Such position may be gained thanks to innovation. Therefore, the entrepreneurs have to keep on looking for and implementing results of R&D activities, inventions, new business concepts, and organisational ideas. Thus, for the entrepreneur innovation means refinement and development of the existing technologies of production, exploitation, and those connected with services, as well as introduction of new solutions to organisation and management, improvement and development of infrastructure, especially the infrastructure responsible for collection and processing of information and making it available.

In the nearest 5–10 years' perspective previous sources of economic growth, such as low labour costs and cheap raw materials, will be running low. It will be more difficult to benefit from favourable geographic location or accession to the European Union. Therefore, the furniture companies should search after new sources of competitive advantage. The growth trends of high-developed countries indicate that only competitive advantage built on knowledge and innovation may assure sustainable development at present and in the nearest future. Poland must join in building of the global knowledge-based economy. The innovation activity in the Polish furniture industry should be more active and further gone in relation to its present, embryonic stage of development. The fast growth of production potential of Asian countries, especially China, India and Malaysia, is a factor forcing more dynamic development.

A very active policy (especially of China) in the field of implementation of Computer Integrated Manufacturing (CIM) systems for furniture production should be specially emphasised. Such systems combine management systems (e.g. ERP or MRP) with Computer Aided Manufacture (CAM) systems, as well as integrate Computer Aided Design (CAD) systems, thus creating an extensive integrated system of open control of various processes [Li 2000; Zhou, Chuah 2002]. The Chinese market analysts [Robb, Xie 2003] draw attention to the fact that Chinese companies consistently execute the innovation development policy laying great stress on low business costs, low prices of their own products, and at the same time doing their best to improve the quality of materials, processing, and furniture. The search in this field is concentrated not only on enhancement of the innovativeness of products (pattern-design and quality) and processes (technologies and materials), but also of business systems, including systems of employment, management, culture, clients, competition, sale, and the art of arranging exhibitions [Navarro et al. 2008]. The increase in industrial production in Asian and South American countries is a result of spurring the industrial initiative based on economic laws.

In the case of the European (including Polish) furniture industry a crucial question arises: will home furniture companies survive in the conditions of fierce international competition or are they doomed to vanish? In this regard there are three important scenarios for the furniture industry [Navarro 2008].

The first scenario entitled "Elegant solutions – the dream house and innovation" assumed such events as:

- revitalisation of economies of individual member states of the European Union and economic acceleration (including the USA) until 2010, full employment and extension of retirement age, and control of job immigration as mass phenomenon,
- an increase in the share of sustainable development policy in the field of urban and rural areas, urban polycentrism, fast development of information and communication technologies, and waiting for intelligent residential construction systems,
- an increase in investments in "intelligent" residential construction, an increase in apartment (house) values as a manifestation of such values as safety, stabilisation, respect for the environment etc., and a better condition of the furniture market, including an increase in its absorptive power.

While the second scenario named "A true brand – global suppliers and supply chain values" assumed trends like:

- economic slowdown in the period 2008-2010 and expansive cycle after this period,
- a global increase in economic discipline,
- huge consolidation of sale networks, enhancement of traditional sale of furniture by end users, strengthening the awareness that the brand of purchased furniture corresponds to the brand of the seller.

On the other hand, the third scenario under the name "Consumption reduction – budget and basics" assumed the following events:

- a serious recession in the EU as well as in the USA and slow development after this period,
- higher economic instability, employment stagnation and immigration pressure, a decrease in anticipated incomes,
- concentration on keeping of possessed residential space and prolongation of furniture use cycle, maintenance of the dominant role of function and price of furniture that have influence on decisions concerning furniture purchase and in consequence – reduction of absorptive power of the market,
- search after best combinations in furniture price optimisation, a serious crisis in mature furniture companies, all this will result in anti-dumping conflicts.

Structural and organisational changes in the Polish furniture industry

Until the end of 1970s trends towards establishing big production plants were dominant in the furniture industry. Big factories were set up and production processes were long, many a time starting from roundwood processing and ending with distribution of products to salesrooms. In this way companies tried to

eliminate difficulties resulting from co-operation. However, benefits proved to have been apparent for the degree of use of some pieces of production equipment and machine tools was at a critically low level. The furniture was produced mainly to have been stored in warehouses and large series of identical products were preferred. On the other hand, central management during the long period of centrally planned economy contributed to serious inhibition of organisational development of furniture factories. Big and often badly run enterprises became organism unable to survive in the face of dynamic economic changes that occurred in 1990s. Previous magnates lost their position of monopolists due to emerging competition that could successfully tried to fulfil individual needs of customers. Thanks to their production flexibility and skill at selling new products the newly established plants, small in the beginning and employing dozen or so people, in a short time evolved into medium-sized and big companies with efficient organisation and "lean" production. The high production effectiveness and ability to easily adjust production to continuously changing needs dictated by variety of manufactured furniture products, were achieved thanks to application of innovative production techniques. Apart from modern machinery, machine tools and numerically controlled processing centres, companies started to use management supporting computer systems. In the beginning those systems covered warehouse management, raw material supply planning, furniture design support, as well as organisation of sales and purchase. When computer integrated management systems of module structure appeared, it was possible to create systems taking into consideration individual requirements and needs of those companies. In many factories quality management systems compliant with the standards of ISO-9000 group were introduced as well.

Thus, groups of better developed companies formed. Those companies were characterised by reorganised organisational structures, modern equipment of production rooms, efficient computer support of some processes (e.g. design and construction, control of stock, fulfilment of purchase orders, sales orders, and production orders) or implemented computer system managing the whole company. Until this day continuous dynamic development, improvement of product quality, production manners and services may be observed in those companies.

In the last fifteen years many new furniture plants were established and production organisation in these units was built based on advanced production technique and supported by computer management systems. The possibilities offered by technical development in the form of flexible production lines (that can be refurnished thanks to computer programmes), automated warehouses of tools, materials and finished products, as well as state-of-the-art control and test devices, will soon make it possible to fully integrate production processes in furniture companies.

Furniture companies in the future – a vision

A furniture company of the future will be an unmanned enterprise in which perfectly integrated computer management system will make it possible to manufacture products with a minimum direct labour consumption. People will be responsible for proper management of the production process supporting system, which task will be performed only using computers installed in individual machines and devices. Today, taking into account computerisation development dynamics and common use of the Internet, it is difficult to depict future form of the 21st century furniture plant. The plant may be totally remote-managed by an administrator who will use information and telecommunications techniques that will ensure transfer of impulses from the person's brain to devices controlling all processes in the company. Those and similar plans should be aided by the strong trend of developed countries towards globalisation and development of actions promoting knowledge implementation.

The global economy based on knowledge, and information or telecommunications technologies, forces new skills in all vocations: traditional ones like furniture making or wood processing, and also new and those that will be only created. In the contemporary world producers of every kind of products, who meet the knowledge society needs, are aware of the great significance of the capital of mind. Drucker [1999] thinks that, "the basic economic resource – the means of production – is no longer capital, or natural resources, or labour, but is and will be knowledge". Knowledge has become thing of paramount importance as a source of innovation and social cognition. It has become a safe-conduct, pass and key to the world of success and power. Contemporary producers and service providers, who continuously look for novel methods for attracting new customers and keeping those already gained, first of all focus on innovative techniques and methods of knowledge organisation. At present, the drive for new resources of knowledge, recognition and possession of it is a specific expression of the enterprising person's desire for power over material world [Borowska 2006].

The inclination to hegemony over material world leads to the situation when information and knowledge constitute the fundamental production factor [Sokołowska 2005]. In time, there will be gradual move away from typical and time-consuming vocations towards professions that use information and telecommunications techniques more intuitively and to a greater extent. Therefore, there will be created intellectual entrepreneurship in global organisations directed at creation of material wealth using non-materialistic knowledge. Drucker [1999] calls coming new days and new civilisation "knowledge society".

A changeable composition of global organisation will enable it to quick and easy react to permanent changes by dynamically setting resources aside or releasing them and selecting only those that will be the cheapest and available in the shortest time. Although business entities will be dispersed and away from

each other, they will still remain mutually dependent, not because of hierarchy, but reciprocity of services provided to one another. Maybe a new modular business organisation will be established that will resemble orderly legions heading together in the same direction [Warnecke 1999].

With reference to knowledge-based or information-based organisations of the future, their structures will become unquestionably more level. Most of managerial positions, predestined to give orders, will be eliminated. The scope of duties will be changing dynamically depending on the task, and the term "position", too static in relation to coming vigorous changes, will be substituted by the term "assignment" [Drucker 1999]. The organisation centre will look after this kind of organisational unit structure and gather crucial and priority entitlement. Undoubtedly, another processes common amongst global organisations, such as organisation virtualisation, will overlap the established organisational network.

The phenomenon of virtualisation is connected with operation of a company through outside resources and knowledge, and also through its own resources. A virtual company will consist of a few real enterprises which will be its partners. Services provided amongst partners will not be provided based on market rules and will not be one-time actions. The main trump of the virtual company will be its ability to dynamically change quantity and type of consumed resources, as well as finished production volume. This way a temperamental company will be created that quickly reacts to changing environment and continuously improves quality of its products and services in the conditions of constant benchmarking. [Warnecke 1999].

Virtual networks of companies may have their own minimum infrastructure and be characterised by changeable leadership [Mrówka 2001]. The value of a network of virtual enterprises consists in such things as their ability to built alliances to effectively compete for contracts, which they could not win on their own. Those enterprises create a special type of relations and may enter into many different economic sectors. However, it is a crucial issue that visions and strategies of individual junctions of the network are consistent, and the whole network should have a common vision.

A cobweb structure of global organisation will entail the necessity of decentralising every action, including decentralisation of leadership. In accordance with the subsidiarity principle, all decisions should be made at the lowest hierarchy level possible, as close to the client as possible [Handy 1996]. It means, that even in those global organisations, in which it is possible to easily distinguish hierarchical relations between units, more and more strategic competence, once reserved for the top management of the organisation, is delegated to lower levels. Therefore, an important function in such organisation will be the role of a leader-coordinator who can reconcile apparently conflicting interests of individual units of the organisation – fractals [Warnecke 1999]. The role of the

aforementioned leader of a local division, i.e. a fractal, will be equally important as well. In the conditions of internal market economy no fractal can be sure of its existence and it will require very efficient management and development and implementation of the right vision and strategy. A fractal will be an independent company unit whose goals and productivity can be unambiguously described. Its features are self-similarity and self-organisation [Morgan 1999; Warnecke 1999]. The system of fractals' goals should be consistent and it must serve achievement of the company's goals. An efficient communication and information system will link fractals into a network. As a matter of fact, a fractal organisation will be on the brink of order and chaos [Mrówka 2001].

Already today the relations of the Polish furniture industry with the global economy are impressive and deserve to be distinguished. Many big companies, with solely Polish capital, may take the liberty not to enter into co-operation with any of the global firms or networks. However, globalisation imposes on Polish managers new and previously unknown tasks stemming from the necessity of building multiethnic vocational relations within the framework of one organisation. Those tasks result from the fact that furniture plants in Poland are purchased by German, Scandinavian or British investors, and also from the fact that Polish plants are moved east due to increasing labour costs. An additional difficulty that is faced by Polish businessmen is the still low and unsatisfactory percent of well educated graduates of higher technical education institutions. In a society in which 2/10 of higher education institution graduates hold the engineer title it is extremely difficult to implement a vision of better use of specialists' knowledge. And soon this knowledge will evidently decide the future of an organisation and country. In the days when globalisation phenomena are getting popularised, it should be expected that organisational changes will affect small and medium-sized companies in the furniture industry as well. Those firms, thanks to their relations with strategic partners, will be able to build new, limitless, global or local virtual networks.

Conclusions

The Polish furniture industry is an industry that for many years has been one of the major drivers of the Polish economy. It is an industry that practically since the beginning of 1990s has been characterised by very high production dynamics and high active balance of foreign trade, and created numerous jobs. The fierce competition over a place in national market and foreign markets caused changes in structure, organisation, and marketing strategies of the Polish furniture industry. The operation of established new furniture plants to a great extent is based on advanced production technique based on computer management systems. The market offer of furniture producers has changed distinctly – the assortment of manufactured furniture has been broadened and the quality bettered. In the days

of dynamic development of computerisation and more common use of the Internet, further advantageous changes in the Polish furniture industry may be expected. It may be that a furniture company in the future will be an enterprise in which a perfectly integrated computer management system will make it possible to manufacture products with a minimum interference of human.

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POLSKI PRZEMYSŁ MEBLARSKI – WIZJA PRZYSZŁOŚCI

Streszczenie

W artykule przedstawiono informacje dotyczące znaczenia przemysłu meblarskiego w polskiej gospodarce, wielkości jego produkcji, eksportu, zatrudnienia, liczby działających podmiotów gospodarczych w latach 2005–2008. Wskazano na fakt małej aktywności innowacyjnej w przemyśle meblarskim w zakresie generowania nowej wiedzy. W strukturze nakładów na innowacje udział nakładów na działalność badawczo-rozwojową stanowi 3,5%. Zwrócono uwagę na konieczność podnoszenia innowacyjności i konkurencyjności w polskim meblarstwie, zwłaszcza wobec dynamicznego rozwoju potencjału produkcyjnego krajów azjatyckich, a w szczególności Chin, Indii oraz Malezji. Przedsiębiorstwa polskie powinny opierać swoją pozycję konkurencyjną na trwałych przewagach, pozwalających zdobywać i utrzymać nowe rynki w skali lokalnej, regionalnej i międzynarodowej. Jak pokazują trendy krajów wysoko rozwiniętych, trwały rozwój może zagwarantować aktualnie i w najbliższej przyszłości przede wszystkim budowanie przewagi konkurencyjnej opartej na wiedzy i innowacjach. Przedstawiono także wizję funkcjonowania przedsiębiorstw meblarskich. Fabryka mebli w przyszłości może być przedsiębiorstwem bezzałogowym, w którym doskonale zintegrowany informatyczny system zarządzania umożliwi wytwarzanie wyrobów z minimalnym bezpośrednim udziałem pracy człowieka. Będzie on odpowiedzialny za prawidłowe zarządzanie systemem wspomagającym procesy produkcyjne przy wykorzystaniu komputerów zainstalowanych na poszczególnych maszynach i urządzeniach.

Słowa kluczowe: przemysł meblarski, innowacyjność, struktura organizacyjna, Polska

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DONIESIENIA – REPORTS

Jadwiga ZABIELSKA-MATEJUK, Juliusz PERNAK

MYCOLOGICAL STUDY OF AMMONIUM IONIC LIQUIDS

The paper presents results of investigations of the effectiveness action of innovative structures of ionic liquids – quaternary ammonium derivatives – against three species of fungi decaying softwood and a species causing blue stain of softwood[1]*. The experiments were carried out using the culture medium method and inhibition of mycelium colony growth on agar-maltose substrate made toxic with ionic liquids was determined.*

Keywords: ionic liquids, fungi, biocidal activity

Introduction

Enhancement of durability of wood and wood-based materials in the aspect of environmental protection requirements and counteracting the environment degradation requires verification of technology of protection with agents harmful to living organisms. The requirement of obligatory tests of biocidal products, including wood preservatives, in terms of their emission to the environment contained in Directive 98/8/EC eliminated from the market compounds of chromium, fluorine, arsenic, pentachlorophenol, tin organic compounds (TBTO) and other biologically active substances of similar toxicity that accumulate in the environment. Together with dynamic development of building industry there was an increase in demand for impregnated building wood, especially impregnated in pressure preserving works, as well as for particleboards and plywood of

[1] The research was conducted within the framework of the project no. POIG.01.03.01-30-074/08 co-financed by the European Regional Development Fund (ERDF) under Operational Programme Innovative Economy 2007–2013.

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higher resistance to microorganism action. It is anticipated that in the nearest future in Poland the demand for impregnated wood will be approximately 1.2-1.5 M m^3/year, which implicates an increase in demand for new, safe preservatives. The ecology aspect of management of impregnated wood and its post-consumer waste is one of the ideas of sustainable development, which is the overriding goal of economic and social activity. An innovative look at the issue of safe preservation of lignocellulosic materials and the importance of subject matter connected with development of new biologically active substances drew the researchers' attention to novel organic compounds, i.e. ionic liquids which are often called "green" solvents. Multifunctionality of ionic liquids, compounds made of organic cation and inorganic or organic anion, stems from huge number of possible combinations of the cation-anion structure. The state of the art knowledge in the field of organic technology makes it possible to design structures and synthesis of ionic liquids of strong biocidal activity, as well as structures of non-volatile ionic liquids of affinity for cellulose.

The innovative concept of application of ionic liquids to cellulose dissolution (with the use of enzymes) may contribute to development of new biotechnological processes for obtaining cellulose from renewable wood raw materials, and in the next stage, obtaining many chemical substances (that are important from pharmacologic, antiseptic, and cosmetic point of view) as well as additions to biofuels. The search after structures of ionic liquids which intensively dissolve natural and the most popular on Earth polymer, i.e. cellulose, as well as selection of enzymes facilitating this process constitute a research issue faced by the researchers of the 21st century. The latest research indicates that 1-butyl-3-methylimidazolium chloride and 1-allil-3-methylimidazolium chloride [Remsing et al. 2006; Moulthrop et al. 2005; Stolte et al. 2008] are good cellulose solvents, and the process may be accelerated by heating with microwaves. The research of Binder et al. [2009] and Pu et al. [2007] describes a possibility of depolymerisation of model lignin compounds in ionic liquids, which in the future may contribute to obtainment of a series of aromatic chemical structures from biomass rich in lignocellulosic complex. Apart from numerous applications of task specific ionic liquids (TSILs) in catalysis, organic synthesis, extraction processes [Lee 2005], nanomaterial technology (nano-sized materials; metal nanoparticles, silica nanostructure modification), and electrochemistry (as solutions of electrolytes in lithium batteries), the third generation ionic liquids of therapeutic properties were developed, e.g. lidocaine [Hough et al. 2007]. The multifaceted action of ionic liquids, when at the same time they are susceptible to bioelimination in the environment, are the features that make the application of these novel organic compounds at the industrial scale preferred in the conditions of sharpened environmental protection requirements.

A result of cooperation between the Wood Technology Institute in Poznan and the Institute of Chemical Technology and Engineering of the Poznan

University of Technology was development of ionic liquids, quaternary ammonium derivatives, characterised by high fungitoxicity against wood-decaying fungi, microbes, and pathogenic fungi, as well as demonstrating good tissue preserving properties [Pernak et al. 2006]. Those substances demonstrated strong penetration properties in contact with wood and their hydrophobicity ensured limitation (or lack) of emission from impregnated wood to the environment. Those positive effects of research on ionic liquids in the aspect of lignocellulosic material protection persuaded the authors to take up research on design and development of novel structures with function natural anion and cation obtained from vegetable or animal fats or other market products as well. The Wood Technology Institute in Poznan took out financial support for carrying out of that research in the form of a three-year development project entitled "Ionic liquids in innovative technologies connected with processing of lignocellulosic raw materials" executed within the framework of Operational Programme Innovative Economy. The executor of the project, in cooperation with the Institute of Chemical Technology and Engineering of the Poznan University of Technology and the Institute of Papermaking and Printing of the Technical University of Lodz, is working to achieve two partial goals, i.e. enhancement of durability of wood, particleboards and plywood using novel and biologically active ionic liquids, and development of structural modification of ionic liquids of affinity for cellulose with the view of using them in the processes of cellulose technology.

In this publication the first effects of investigations of the fungicidal activity of designed, novel structures of ionic liquids obtained as a result of developed methods for syntheses and product isolation, purification, and identification. In the first phase of the project syntheses of thirty ionic liquids of biologically active properties were developed and carried out. The structures of the ionic liquids were confirmed by analysis of proton and carbon spectra of magnetic nuclear resonance (Varian 300 VT type spectroscope) or by the method of CHN elementary analysis. As a result of determination of the syntheses parameters, ionic liquids with nitrate(V) anion, with environmentally friendly vegetable and animal cation, and with modified function anion were obtained from market products. Other obtained compounds were the so-called ciechowskie ionic liquids and ionic liquids from market products by PCC Rokita S.A. Company. The applied methods of isolation and purification of products of the reactions of quarternation and ionic exchange made it possible to obtain ionic liquids of active substance content > 95%.

Mycological tests

The identification of fungistatic and fungitoxic properties of designed structures of ionic liquids was carried out using the culture medium method and brown rot fungi *Coniophora puteana* (Schum: Fr.) Karst. strain BAM 15, white rot fungi *Trametes versicolor* (L.: Fr.) Pilát- strain CTB 863 A, soft rot fungi *Chaetomium globosum* Kunze strain ATCC 6275, and *Sclerophoma pithyophila* (Corda) van Höhn fungi, strain S 231, causing blue stain. The examined compounds were dissolved in the culture medium so as to obtain the following concentrations: 10, 25, 50, 100, 250, 500, 750, 1000, 2500, and 5000 ppm. The colony diameter was measured and standard deviation from the average from six measurements was calculated. The inhibitions of the growth of test fungus colonies on culture media containing ionic liquids were determined. In addition, toxic values ED_{50} and ED_{100}, i.e. concentrations effectively inhibiting mycelium growth in 50 and 100% in relation to fungus on the culture medium without fungicide, as well as LD value, i.e. minimum concentration causing mycelium death, were determined. All experiments were performed in three replications.

Toxic values of developed ionic liquids were compared with the results obtained for commercial didecyldimethylammonium chloride.

Test results

Fig. 1 presents the growth of a colony of *Coniophora puteana* mycelium on culture media made toxic using five ionic liquids obtained from market products by Ciech S.A. Company ([Ciech][1], [Ciech][2], and [Ciech][3]) and PCC Rokita S.A. Company ([Rok][1] and [Rok][2]). That growth confirms very effective fungistatic action of all the above-mentioned ionic liquids. The inhibition of the growth of *C. puteana* colony when the concentration in the culture medium was 50 ppm (compared to the colony growth on non-toxic culture medium which was 87 mm on average) was the greatest in the case of compounds with the symbols [Ciech][1] and [Ciech][3]. The ionic liquid obtained from products by PCC Rokita Company with the symbol [Rok][1] containing in its structure strongly bioactive ammonium cation demonstrated strong fungistatic properties as well. The most effective fungicidal action was demonstrated by a compound with the symbol [Ciech][3]. That action was confirmed by threshold values ED_{100} and LD that were 1000 ppm for *C. puteana*. Those values are comparable to commercial didecyldimethylammonium chloride (ED_{100}, LD = 1000 ppm) and five times lower than the values for benzalkonium chloride. The ionic liquids with the symbol [Ciech][2] demonstrated the weakest fungicidal action against the test brown rot fungus. The threshold values ED_{100} and LD were more than 5000 ppm.

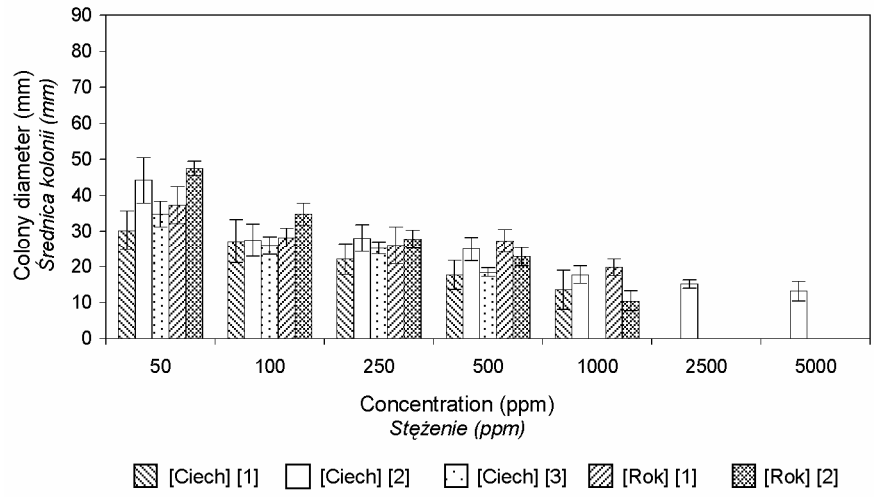

Fig. 1. The growth of *Coniophora puteana* fungus colony on culture medium containing ionic liquids after 11 days of incubation

Ryc. 1. Wzrost kolonii grzyba Coniophora puteana na pożywce zawierającej ciecze jonowe po 11 dniach inkubacji

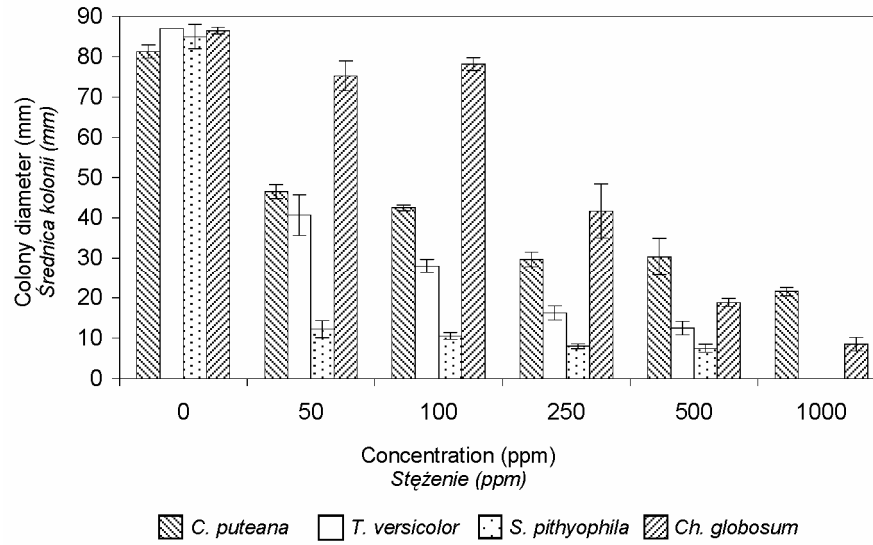

Fig. 2. The growth of test fungus colony on culture medium containing ionic liquid – a coconut oil derivative after 11 days of incubation (*T. versicolor*, *Ch. globosum* after 7 days of incubation)

Ryc. 2. Wzrost kolonii grzyba testowego na pożywce zawierającej ciecz jonową – pochodną oleju kokosowego – po 11 dniach inkubacji (T. versicolor, Ch. globosum po 7 dniach inkubacji)

Fig. 2 shows the results of biocidal activity tests of nitrate(V) containing an environmentally friendly natural cation obtained from coconut oil (symbol [Eth C/12][NO_3]) against four species of test fungi. The developed ionic liquid demonstrated the highest activity against *S. pithyophila* fungus causing blue stain of wood: ED_{50} was 25 ppm, ED_{100} and LD was 1000 ppm. The soft rot fungus *Ch. globosum* was the most resistant to the action of that compound: ED_{50} was 250 ppm, ED_{100} – 2500 ppm, LD > 5000 ppm. The activity of that compound against white and brown rot fungi was higher than the activity of commercial didecyldimethylammonium chloride.

Conclusions

The developed structural modifications of ionic liquids, obtained from market products by Ciech S.A. Company and PCC Rokita S.A. Company and natural vegetable products, are characterised by strong fungistatic and fungitoxic properties against wood-decaying species. The threshold toxic values of the synthesised ionic liquids are comparable to, and in some cases lower than, the values of commercial didecyldimethylammonium chloride.

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BADANIA MIKOLOGICZNE AMONIOWYCH CIECZY JONOWYCH

Streszczenie

Opracowano nowe struktury amoniowych cieczy jonowych o właściwościach bioczynnych z anionem azotanowym (V), z kationem pochodzenia naturalnego, uzyskanym z tłuszczów roślinnych i zwierzęcych, jak również z innych produktów rynkowych i funkcyjnym anionem. Określono ich aktywność biobójczą w stosunku do grzybów niszczących drewno: *Coniophora puteana*, *Trametes vesicolor, Chaetomium globosum i Sclerophoma pithiophila*. Nowe modyfikacje cieczy jonowych są silnymi grzybostatykami, a ich progowe wartości toksyczne są porównywalne z komercyjnym chlorkiem didecylodimetyloamoniowych.

Słowa kluczowe: ciecze jonowe, grzyby, aktywność biobójcza

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Aleksandra SZOSTAK, Ewa RATAJCZAK

RESULTS OF THE INNOVATION ACTIVITY OF THE WOOD SECTOR

The article contains part of the results of research on the innovativeness of the wood sector in Poland and focuses on the effects of the innovation activity. The research was carried out within the framework of the project entitled "Foresight in the wood science and industry - research development scenarios in Poland till 2020"[1].

Keywords: innovativeness, measures, innovation activity effects, wood sector

Introduction

Companies whose innovation activity is effective constitute an innovativeness generator. In few recent years the percentage of companies which outlayed on the innovation activity was decreasing in the wood sector, while the lowest activity in this matter was characteristic of wood industry producers, and the highest of furniture producers[2]. It should be added that the downward trend and distinct decrease, in the share of wood sector companies investing in innovation which occurred in 2007, is a situation similar to the situation in the whole Polish industry. In general, relatively low susceptibility of the wood sector to innovation stems from the specificity of processing processes in particular industries. This concerns mainly industries based on solid wood, a natural raw material that

[1] Project "Foresight in the wood science and industry – research development scenarios in Poland till 2020" (POIG 01.01.01-30-022/08) has been carried out since June 2009 in the Wood Technology Institute in Poznan within the framework of the Operational Programme Innovative Economy 2007–2013. The Programme is co-financed by the European Regional Development Fund (ERDF).

[2] A comprehensive and up to date analysis of the issue of innovation in the wood sector is presented in the monograph [Innowacyjność … 2009].

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does not require significant modifications, and thus involvement of very modern techniques and technologies.

The subject matter of the innovation activity encompasses many issues. One of them is devoted to the effects of the innovation activity. In research on that issue a set of the following measures was used: production improvement index, inventive activity index, and extent of equipment with production process automation means.

Characteristics of the measures of innovation activity effects

The main measure of innovation activity effects, i.e. in principle of its commercialisation, is production improvement index that presents the share of value of sold production of new and upgraded products launched in the last three years[3] to total value of sold production of goods in the investigated year. The important feature of that approach is a possibility of identification of the structure of sold production of innovative products according to their degree of novelty, i.e. sold production is divided into sold production of new products and sold production of products that were only upgraded (modernised). At the mesoeconomic level the production improvement index indirectly indicates these industries that are the most modern and active in the sphere of innovation. However, that measure refers only to technical innovation, and especially to products. Hitherto the international and Polish methodology of research on innovativeness lacks a similar measure of effects of process innovation (introduction of new and improved processes) and organisational innovation. This is because such effects of those types of innovations as reduction of production costs, reduction in labour consumption and material intensity are unusually difficult to quantify in unambiguous way [Ratajczak, Szostak, Bidzińska 2005].

An indirect measure of innovation activity effects in the scale of an industry branch or particular industry consists of indices concerning the inventive activity: number of inventions, number of patents granted in an industry, and number of licences sold abroad. The number of inventions encompasses both inventions applying for patent in the country and inventions applying for legal protection abroad[4]. Similarly, the number of patents comprises all patents obtained in the country and abroad. Especially the latter type of patents proves the activity of an

[3] Until the beginning of 1990s in accordance with the Polish methodology of research on innovation, this index meant the share of value of sold production of new and modernised products launched in a given year to total value of sold production of goods in the same year. In Poland, research based on the presented international Oslo methodology was carried out for the first time in 1996. [Działalność innowacyjna… 2002].

[4] An invention may apply for protection in many countries. However, the official statistics in Poland are based on applications filed in the country. [Nauka i technika 2009].

industry in creating novelties at the world scale, while degree of invention diffusion, as a relation of patent applications abroad in a given year to their number in the previous year, determines the rate of an industry's invention dissemination in the world.

In the mesoeconomic depiction a measure of innovation activity effects is also the extent of equipment with production process automation means (automatic production lines, computer-controlled production lines, processing centres etc.). This measure is a numerical reflection of the investigated phenomenon.

Innovation activity effects – research results

In the wood sector companies the production improvement index achieved in the period 2004–2007 did not show a stable upward trend and was different in particular industries (table 1).

It should be emphasised that product innovations are conducive to market extension, production diversification, and sector development. They can also influence the development of new methods for marketing, distribution or production.

Compared to production processing with the production improvement index of 16.3% in 2007, the best situation was observed in furniture production (19.9%), and a similar one in production of pulp, paper and paper products, whereas the worst situation characterised production of wood products (8.0%).

In the field of inventiveness, the activity of the wood sector companies does not differ from the average in processing industries (10%). In the period 2004–2006 wood product manufacturing companies that were active in the inventiveness area amounted to around 8% of the total number of firms in this industry. In the case of companies producing pulp, paper and paper products that ratio was approximately 11%, and in the case of furniture producers over 10%. The wood sector companies, like firms from other branches of industrial processing, concentrated their actions concerning protection of intellectual property first of all on trademark registration (manufacturers of wood products – around 6% of the total number of companies, producers of pulp, paper and paper products – approximately 8%, and furniture producers – 6%). Companies that filed applications for patents for inventions amounted to, respectively, 0.7%, 0.8%, and 1.8% of the total number of enterprises.

An important measure of innovation activity effects (and at the same time a condition for it) is equipment with production process automation means, especially high-tech means, including devices automatically controlling and regulating the course of technological processes. In the period 2004–2007 in the wood sector companies, like in the whole industrial processing, automatic and computer controlled production lines were dominant (table 2).

Table 1. Sold production of new and modernised products in the wood sector companies in the period 2004–2007
Tabela 1. Produkcja sprzedana wyrobów nowych i zmodernizowanych w przedsiębiorstwach sektora drzewnego w latach 2004–2007

in business entities with employment higher than 49 people, current prices
w podmiotach gospodarczych o zatrudnieniu powyżej 49 osób, ceny bieżące

Type of activity (The Polish Classification of Activities, PKD) *Rodzaj działalności (PKD)*		2004	2005	2006	2007
		products whose production was launched in the period: *wyroby, których produkcję uruchomiono w latach:*			
		2002–2004	2003–2005	2004–2006	2005–2007
		in % of sold production of goods *w % produkcji sprzedanej wyrobów*			
Industrial processing *Przetwórstwo przemysłowe*	D	23.8	25.1	20.2	16.3
Production of wood and wood products *Produkcja drewna i wyrobów z drewna*	20	9.2	5.9	8.0	8.0
Production of pulp, paper and paper products *Produkcja masy włóknistej, papieru oraz wyrobów z papieru*	21	14.5	22.4	17.8	16.9
Furniture production[a] *Produkcja mebli*[a]	36	21.6	15.8	16.1	19.9

[a] And production activity that is not classified elsewhere.
[a] *I działalność produkcyjna, gdzie indziej niesklasyfikowana.*

Source: An own study based on: [Nauka i technika 2009].
Źródło: Opracowanie własne na podstawie: [Nauka i technika 2009].

Table 2. Means of automation of production processes in the wood sector companies in the period 2004–2007
Tabela 2. Środki automatyzacji procesów produkcyjnych w przedsiębiorstwach sektora drzewnego w latach 2004–2007

in business entities with employment higher than 49 people
w podmiotach gospodarczych o zatrudnieniu powyżej 49 osób

Type of activity *Rodzaj działalności*		Years *Lata*	Production lines *Linie produkcyjne*		Processing centres *Centra obróbcze*	Robots and industrial manipulators *Roboty i manipulatory przemysłowe*		Computers [a] *Komputery* [a]
			automatic *automatyczne*	computer controlled *sterowane komputerem*		total *razem*	of which: robots *w tym: roboty*	
Industrial processing *Przetwórstwo przemysłowe*	D	2004	9333	7104	3859	4082	2369	19051
		2005	10064	7447	4712	4297	2540	20420
		2006	11378	8854	5974	5357	3000	22871
		2007	11737	9874	6872	5803	3514	24496
Production of wood and wood products *Produkcja drewna i wyrobów z drewna*	20	2004	300	214	157	12	9	452
		2005	321	234	197	16	7	541
		2006	359	283	201	36	16	577
		2007	412	300	251	45	21	641
Production of pulp, paper and paper products *Produkcja masy włóknistej, papieru oraz wyrobów z papieru*	21	2004	308	259	16	15	15	497
		2005	323	281	18	20	17	567
		2006	399	370	18	15	15	614
		2007	443	386	31	18	18	638
Furniture production [b] *Produkcja mebli* [b]	36	2004	272	265	466	213	130	599
		2005	357	349	826	190	141	623
		2006	389	391	652	210	150	808
		2007	363	463	634	183	124	734

[a] Big computers, minicomputers and microcomputers for control and regulation of technological processes.
[b] And production activity that is not classified elsewhere.
[a] *Komputery duże, minikomputery i mikrokomputery do sterowania i regulacji procesami technologicznymi.*
[b] *I działalność produkcyjna, gdzie indziej niesklasyfikowana.*
Source: [Działalność innowacyjna… 2008; Nauka i technika 2009].
Źródło: [Działalność innowacyjna... 2008; Nauka i technika 2009].

The attention should be given to the fact that in few recent years the number of production process automation means in the wood sector companies has been ever growing. In the case of production lines their number rose by 46%, the number of processing centres increased by 43%, of computers controlling and regulating technological processes by 30%, and of robots and industrial manipulators by 2%. The biggest changes in equipment of production processes were made in the case of manufacturers of wood products who increased the number of automation means by 45%. In the case of producers of pulp, paper and paper products the increase was 38%, and in the case of furniture producers 31%. Furniture producers made the greatest changes in equipment with production lines (their number increased by 53%), producers of pulp, paper and paper products in equipment with processing centres (an increase by 93%, when the significance of this type of devices in this industry is relatively less) and production lines (a growth by 46%), and manufacturers of wood products made considerable changes in their equipment with processing centres (a rise by 60%) and various types of computers (an increase by 41%).

Conclusions

Creating innovativeness and taking care of the innovation potential is the basic condition for competitiveness on domestic as well as international markets. In few recent years in the wood sector the percentage of companies outlaying on the innovation activity demonstrated downward trends and it was a situation similar to the situation in the whole Polish economy.

In the wood sector (but also compared to other processing industries) the most modern and active in the area of innovation are furniture companies. Producers of pulp, paper and paper products achieve a level of innovation similar to the average level characteristic of processing industries. The lowest production improvement index, and thus the least innovation activity, is demonstrated by manufacturers of wood products.

In the field of inventiveness the wood sector companies do not differ from the average level achieved by all processing industries.

Positive changes in the wood industry are observed as regards equipment with technological process automation means, especially high-tech means. Their number has been ever increasing in recent years. The greatest changes were made by manufacturers of wood products (mainly producers of agglomerated wood-based panels).

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EFEKTY DZIAŁALNOŚCI INNOWACYJNEJ SEKTORA DRZEWNEGO

Streszczenie

Istotnym elementem badań innowacyjności sektora drzewnego w Polsce, prowadzonych w projekcie *„Foresight* w drzewnictwie – scenariusze rozwoju badań naukowych w Polsce do 2020 roku", była analiza efektów działalności innowacyjnej. Posłużono się w niej zbiorem takich mierników, jak: wskaźnik odnowienia produkcji, wskaźnik działalności wynalazczej oraz skala wyposażenia w środki automatyzacji procesów produkcyjnych. Badania wykazały, że w sektorze drzewnym najbardziej innowacyjne, także na tle innych przemysłów przetwórczych, są przedsiębiorstwa wytwarzające meble. Wskaźniki zbliżone do średnich w kraju uzyskują producenci masy włóknistej, papieru oraz wyrobów z papieru. Natomiast najniższy stopień odnowienia produkcji, a tym samym najmniejsze efekty w sferze innowacyjności, wykazują producenci wyrobów drzewnych. Przedsiębiorstwa sektora drzewnego nie odbiegają od średniego poziomu osiąganego przez wszystkie przemysły przetwórcze w dziedzinie wynalazczości. Korzystne zmiany w tym sektorze następują pod względem wyposażenia w środki automatyzacji procesów, zwłaszcza wysoko zaawansowanych technologicznie. Największe zmiany miały miejsce wśród producentów wyrobów z drewna (głównie producentów płyt drewnopochodnych aglomerowanych).

Słowa kluczowe: innowacyjność, mierniki, efekty działalności innowacyjnej, sektor drzewny

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Peter TREBUŇA, Jozef MIHOK

EXPERIMENTAL SOLUTIONS OF CORPORATE CRISIS

Current developments suggest that crises are unknown, unstructured, unplanned and unexpected which requires application of systems approach to management to fathom their complexity and ambiguity. Companies are trying to adapt to internal and external changes when the speed, size and frequency of different types of changes is increasing. This article describes functions of management in crisis.

Keywords: process of restructuring, crisis, management.

Introduction

Companies are trying to adapt to internal and external changes when the speed, size and frequency of different types of changes is increasing. Generally, the causes of crisis in enterprises may be divided into two basic groups:

- external causes,
- internal causes.

Most businesses still operate a combination of all possible internal and external causes and it corresponds to their current status. Enterprises do not give sufficient attention to primary symptoms of a crisis such as decrease in profitability, productivity and other problems and so the crisis gradually deepens [Magul'áková 2004].

The role of crisis management

The tasks of crisis management differ in nature, scope and importance at various levels of management. The tasks of crisis management can be divided by periods in which they are performed [Mihok, Vidová 2006]:

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1. Tasks of crisis management before a crisis occurs:
   - processing and adoption of a comprehensive crisis management strategy in terms of business development,
   - creation of a crisis management system and its ongoing adjustment in accordance with changing external and internal conditions,
   - pre-selection of potential crises and their anticipated negative effects,
   - preparation for the crisis, development of processing methodology and plans of action,
   - reduction of risks in response to the evaluation of possible emergency events,
   - implementation of effective control activities in the subordinate parts of crisis management,
   - continuous monitoring of risk events, assessment of their level and taking action (elimination of negative factors).
2. Tasks of crisis management in crisis:
   - activation of crisis management actions based on the initial information on the crisis,
   - collection of additional information on the crisis,
   - adjustment of measures and performance to tackle the crisis on getting detailed information,
   - suspension of all activities which do not help solve the situation and perform only works rescuing organisation, localisation and connected with liquidation,
   - prevention of the spread of panic providing regular and sufficient information,
   - taking preventive measures against escalation of the crisis,
   - declaration of the state of emergency and introducing special arrangements in the company depending on the extent and nature of the crisis,
   - regular reporting of information on crisis management within the enterprise,
   - restoration of normal mode after completion of work connected with tackling the crisis.
3. Tasks of crisis management after crisis:
   - analyse of the course of crisis tackling process, assessment of achieved results and proposal of further relief actions to return to the pre-crisis situation,
   - assessment of prepared documentation compliance with the actual way the crisis was tackled and suggestions of possible changes and adjustments,
   - assurance of broader and more detailed monitoring of risk factors,
   - restoration of routine activities.

Those tasks are performed at various stages of crisis by managers, whose work is specific and full of particularities. All those tasks require different skills from corporate managers.

Detection of corporate crisis

Opinions about the difference between a well functioning business and enterprises having problems differ. The main reason is that the entities that carry out the assessment attach different weight to criteria that are used in the evaluation.

A healthy business is a business where there are doubts about its future. It is able to finance its activities, to meet its commitments and generate sufficient profit which is used to invest in the company and ultimately provide sufficient remuneration for the shareholders' investments.

A company which is unable to meet the criteria should take appropriate measures to restore its vitality. Problems that a company may indicate are termination of operation or at least the threat of extinction. All other factors affecting business performance cause only periodic fluctuations in the company's performance.

It is not easy to recognise when a company deals only with a periodic variation of results and when it actually falls into a crisis [Regester, Larkin 2002]. There are several areas of company activity in which symptoms of the crisis occur sooner and its effects are the most sensible and, at the same time, undesirable. Those areas are finance, information, communication, marketing, and logistics.

Financial crisis

Causes of financial difficulties in companies may vary in terms of scale and intensity. According to their severity they are divided into three groups:

- lack of profitability which arises when the rate of return of capital tied in the company falls below the standard in the respective field of business,
- relative illiquidity or insolvency which means that the company is unable to pay its obligations on time,
- absolute illiquidity, insolvency which occur when the company's obligations are higher than the fair value of its assets. In practice, this means that the firm spent the entire equity and therefore owes more than it owns.

Information in crisis

In crisis it is necessary to provide full information to all interested individuals and groups about what is happening in the business. It is necessary to adopt a common approach in dealing with the press and public, rather than confrontational attitudes.

Most businesses are now able to gather information and to process it, but few companies are able to efficiently sort and filter information so that everybody receives fast, regular, timely and necessary information.
It can be compulsory to collect and provide information. Such type of information includes:
- information necessary for compiling the accounts,
- statistical information required by law,
- registration information of different nature, whose absence may jeopardise the legal status of business or jeopardise the enterprise in another way.

Information availability improves the position of the company in the market and increases its competitiveness. This category includes:
- information on the evolution of demand,
- information on competitive activities,
- information forming a database of customers,
- information on sales and financial performance of individual products,
- information on the range of breakdown and turnaround of stocks,
- information on claims and payments,
- information providing a detailed analysis of variable costs by product,
- information providing a detailed analysis of fixed costs.

Those categories of information may be considered essential and a priority for successful business management. Other details are mostly minor in nature, nevertheless may be interesting and beneficial for the company.

Communication in crisis

Communication is important part of business management. Without it managers could not influence individuals and groups to achieve performance targets. Studies suggest that oral communication takes up to 80% of the manager's time. [Mihok, Trebuňa 2006].
To achieve a long-term success in communication managers have to:
- communicate openly and participate in public relations,
- keep competent communication advisers,
- integrate strategic communications and public relations in policy-making,
- maintain two-way communication with internal and external audiences,
- co-ordinate what they do and what they say,
- clearly define goals and objectives.

The most common communication problems and causes of inefficient communication in crisis management are:

- different views, attitudes, knowledge and experience as a result of misunderstanding or incorrect understanding of the content information,
- underestimation of the information needs of subordinates and underestimation of their ability to participate in solving problems of emergency planning,
- selective perception, focus on another source of information, substantially undervalued information,
- inability of leaders to listen to the views of subordinates,
- errors in the evaluation report,
- filtering messages for a folder or a senior media,
- lack of preparation time and correct response to information.

The aforementioned communication problems may be as well:

- disruption of the communication system, deformation of interactions within the entity and with external environment,
- lack of satisfaction of information needs, distrust of management, disruption of social relationships, disturbance in motivation, negative emotions, aggression, but also feeling of helplessness, insecurity, fear, and panic.

In a crisis situation it is important that the manager performs his communications role actively implementing various communications functions to prevent communication of negative effects such as:

- emergence of communication barriers,
- emergence of communication holes, which may be wholly or partially extinguished by information and incentive function of communication, which is important in managing crisis situations.

When a crisis emerges first of all formal and informal internal communication flows have to be separated and during the crisis control has to be not only comprehensive but also appropriately informative. When the first signals of a crisis appear informal communication flows, which give priority to employees, have to be deactivated in the enterprise in the first place. Even in normal conditions employees tend to mix reality with rumour. If this happens in crisis then the crisis is escalating even more. When these signals are ignored, they can become risky for the management. The quantity of information that is uncontrolled, misrepresented and motivated by emotions and speculations, may give rise to panic or mob psychosis and become an obstacle to rational management of crisis situations.

In crisis situations many phenomena of the communication process are involved. In a crisis application of specific rules based on flexibility and speed of response in daily contact with customers and the media become a crucial factor

of success. An enterprise that fails to quickly and effectively communicate in a crisis, end up in a situation where there is a talk about it without it. This may deepen the crisis.

Marketing

Integration of marketing activities and organisations within the enterprise, but also the thinking of workers, is a key to achieve a responsible company and provide lasting business ahead of competition. A corporate strategy has to embrace not only marketing strategy, but also innovation and technology strategies, which result in products that fulfil customer needs, and financial strategy, which provides advance funding. Future product development requires close interaction of marketing, development, production and financial management. Change in product parameters is a very effective tool of marketing strategy. Its deployment would require a major advance.

Logistics

A result of errors in management and decline in sales may be a situation where the inventory of raw material, semi-finished or finished products is too high compared to turnover. Often the key issue does not consist in very large stocks but in the fact that some items are not available and other are available in surplus.

In normal conditions it is possible to achieve a reduction in stocks of up to 20% by improving leadership [Jaksee 2007], change shopping process, and control stores, planning and production.

Conclusions

If there are symptoms of impending crisis or the company is even in the state of crisis, then the crisis management measures may be formulated as follows:

- seeking rescue for the company,
- liquidation of the company.

The intensity of interventions and actions taken by the company to resolve the crisis must correspond to the seriousness of the company's problems. In principle those interventions and actions can be divided into two groups:

- informal measures taken by the enterprise itself, usually in co-operation with creditors or with the assistance of advisory organisations,
- measures implemented under the supervision of the court and in accordance with applicable legal regulations.

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EKSPERYMENTALNE ROZWIĄZANIA W PRZYPADKU KRYZYSU W PRZEDSIĘBIORSTWIE

Streszczenie

Obecne wydarzenia wskazują, że kryzysy są nieznane, nieustrukturyzowane, niezaplanowane i nieoczekiwane, co wymaga zastosowania systemowego podejścia do zarządzania, aby ogarnąć ich złożoność i niejasność. Przedsiębiorstwa próbują przystosować się do wewnętrznych i zewnętrznych zmian w sytuacji, kiedy wzrasta tempo, rozmiar oraz ich częstość. Niniejszy artykuł opisuje funkcje zarządzania w warunkach kryzysu.

Słowa kluczowe: proces restrukturyzacji, kryzys, zarządzanie

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KOMUNIKATY – ANNOUNCEMENTS

Mark IRLE, Grzegorz KOWALUK

COST E49: PROCESSES AND PERFORMANCE OF WOOD-BASED PANELS – THE ACTION SUMMARY AND FINAL CONFERENCE

The final conference of COST Action E49 "Processes and Performance of Wood-Based Panels" was held on 14th–15th September 2009 in Nantes, France. The whole 4-year's activity of the Action was summarized.

Keywords: wood-based panels, scientific and technical co-operation

The final conference of COST Action E49 was held on 14th and 15th September 2009 in Nantes, France. The Action title was "Processes and Performance of Wood-Based Panels". The Chairman of the Action was Mark Irle, PhD, from the Ecole Supérieure du Bois in Nantes. The conference provided a summary of four years of activity in the field of wood-based panels, including raw materials, production, application and properties. The Action, apart from academia partners, had also industry partners, e.g. Chimar, Binderholz Group, Dynea, UPM-Kymmene Wood and Latvijas Finieris and other. The Polish delegates to the Action's Management Committee were Jarosław Banecki, PhD (Wood Technology Institute, Poznań) and Professor Danuta Nicewicz (University of Life Sciences, Warsaw).

The Action had three Working Groups:

1. Process optimisation and process innovation,
2. Fundamentals and modelling,
3. Performance in use and new products.

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The Conference programme was divided into 3 parts, according to the field of interest of Action Working Groups. In the first part, dedicated to optimisation and innovation of processes, Professor Bunichiro Tomita, President of the Wood Technological Association in Japan, as a keynote speaker presented general terms of ecological survey of wood adhesives and brief history of formaldehyde emission concerns in Japan. He also presented two topics about advancement of technologies for reduction of formaldehyde release from wood based materials. Martin Ohlmeyer, PhD, from the Institute for Wood Biology and Wood Technology in Hamburg presented research showing that VOC and formaldehyde emission from plywood are affected by process parameters. In the same section Dorota Fuczek, MSc, from the Wood Technology Institute in Poznan, Poland, presented the possibilities offered by application of near infrared spectroscopy to characterisation of raw materials used for wood-based panel production. The main advantages of this method such as speed, simplicity and non-destructive testing, were confirmed by investigation carried out during a COST-supported Short Term Scientific Mission (STSM) in IVALSA, San Michele all'Adige, Italy. Sergej Medved, PhD, from the University of Ljubljana, Slovenia, presented the possibility of urea-formaldehyde resin substitution by liquefied wood during particleboard production; whereas Marek Grześkiewicz, PhD, from the Warsaw University of Life Sciences, Poland, discussed the advantages and disadvantages of thermally modified veneers as raw material for laminate bending, panel finishing and plywood manufacture.

The activities of Working Group Two, devoted to Fundamentals and Modelling, were described by its leader, Heiko Thoemen, PhD, from the University of Hamburg, Germany. Lech Muszyński, PhD, a keynote speaker from the Oregon State University, USA, asked the following question: "Is what you see all you can get"? His presentation concerned bridging experimentation and modelling with advanced imaging techniques and the aim was to present a brief review of promising material characterisation techniques based on advanced imaging technologies and inverse problem methodology, which techniques seemed particularly suitable for complex heterogeneous composites study.

After the presentation of achievements of Working Group Three given by its leader Mizi Fan, PhD, from the Brunel University, the United Kingdom, the next keynote speaker, Robert Massen, PhD, from Baumer Inspection GmbH, Konstanz, Germany, gave a comprehensive presentation on the use of camera-based automatic visual inspection systems for flat panel-type materials. The core of this system is a multi-sensorial technology combining different camera and illumination modules to check both local and global physical and aesthetic defects. This was followed by a presentation from Ulrich Hilbers, University of Hamburg, Germany, on the use of ultrasonic velocity measurements to determine panel properties. Anti Rohumaa, Helsinki University, Finland, then gave a presentation on the use of a technique for following adhesive sure during hot press-

ing. José Gomes-Bueso, Dynea, Norway, made a presentation on how research is transferred from the laboratory to industrial application.

The last presentation was devoted to the Strategic Research Agenda for the Polish Forest-Based Sector. The speaker, Anna Woś, MSc, from the Wood Technology Institute in Poznan, Poland, emphasized that the above-mentioned strategy was prepared in connection with the Strategic Research Agenda (SRA) for the European Forest-Based Sector Technology Platform (FTP), and the research areas presented in the Polish Agenda result from previous experiences, Polish sectoral needs, existing international cooperation and traditions.

The conference was attended by 56 delegates from 21 countries.

During the closing ceremony, several remarks were made on the usefulness of COST Action E49 and the need to continue in some way and perhaps in the form of a follow-on Action. This initiative was undertaken by the team of scientist from the Wood Technology Institute in Poznan, Poland, who applied for the creation of an Action entitled "From fundamental research to applied science. Advanced and innovative wood-based panels produced by competitive industry". The proposed Action acronym is WoodPan.

COST E49: ROZWÓJ I OSIĄGNIĘCIA W PŁYTACH DREWNOPOCHODNYCH – PODSUMOWANIE AKCJI I KONFERENCJA FINAŁOWA

Streszczenie

Finałowa konferencja Akcji COST E49 „Rozwój i osiągnięcia w płytach drewnopochodnych" odbyła się w dniach 14–15 września 2009 roku w Nantes, Francja. Na konferencji podsumowano czteroletnią działalność Akcji.

Słowa kluczowe: płyty drewnopochodne, współpraca naukowo-techniczna

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Ewa RATAJCZAK

FORESIGHT W DRZEWNICTWIE – SCENARIUSZE ROZWOJU BADAŃ NAUKOWYCH W POLSCE DO 2020 ROKU

W warunkach globalizacji i stale rosnącej konkurencyjności międzynarodowej, w każdej dziedzinie działalności niezbędne jest szybkie i efektywne wdrażanie wiedzy do praktyki gospodarczej. W większym niż przeciętnie stopniu dotyczy to drzewnictwa, które z racji wykorzystywania surowca naturalnego napotyka istotne ograniczenia w procesie stałego doskonalenia produktów i technologii oraz ich radykalnych zmian. Jednocześnie, jako dziedzina wytwórczości silnie determinowana przyrodniczo przez możliwości produkcyjne lasów oraz oferująca ekologiczne produkty, ma ona szczególne znaczenie dla zrównoważonego rozwoju polskiej gospodarki. W tym kontekście istotne jest uzyskanie wiedzy na temat społecznie oczekiwanych i pożądanych kierunków długofalowego rozwoju drzewnictwa jako dziedziny nauki i gospodarki. Jest to możliwe dzięki rozpoczętemu właśnie projektowi badawczemu, realizowanemu za pomocą metody foresightu technologicznego.

Słowa kluczowe: drzewnictwo, *foresight* technologiczny, projekt badawczy

We współczesnych społeczeństwach nowe jest postrzeganie roli nauki i badań w procesach rozwoju i nowe uznanie potrzeby uwzględniania czynników (opinii) społecznych w procesie „kształtowania" przyszłości. Takie podejście jest szczególnie zasadne w przypadku drzewnictwa, w którym wykorzystuje się produkt lasów traktowanych jako dobro narodowe.

Okazją do spojrzenia w przyszłość drzewnictwa i do jej kreowania jest projekt „*Foresight* w drzewnictwie – scenariusze rozwoju badań naukowych w Polsce do 2020 roku", realizowany w Instytucie Technologii Drewna od czerwca 2009 roku do stycznia 2011 roku, a współfinansowany – ze środków Europejskiego Funduszu Rozwoju Regionalnego w ramach Programu Operacyjnego Innowacyjna Gospodarka 2007–2013. Projekt ma charakter badawczy i wykorzystuje metodę *foresight* dla wsparcia badań naukowych w celu budowy gospodarki opartej na wiedzy poprzez rozwój nowoczesnych technologii. Dla

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polskiego drzewnictwa prowadzony jest *foresight* technologiczny o charakterze branżowym i odnoszony do całego kraju.

Strategicznym celem Projektu jest identyfikacja kierunków badań naukowych priorytetowych dla wzrostu innowacyjności i rozwoju polskiego sektora drzewnego do 2020 roku. Celami dodatkowymi są:

- upowszechnienie wiedzy o szczególnej roli drzewnictwa w gospodarce narodowej, będącego dziedziną wytwórczości opartą na ekologicznym, odnawialnym surowcu naturalnym,
- aktywizacja środowiska naukowców i przedstawicieli praktyki gospodarczej do współuczestnictwa w kreowaniu wizji pożądanego rozwoju drzewnictwa,
- uświadomienie wszystkim uczestnikom rynku drzewnego, a ostatecznie całemu społeczeństwu, konieczności współpracy sfery nauki i przemysłu w dążeniu do innowacyjnego rozwoju i wzrostu konkurencyjności polskiej gospodarki.

Projekt zawiera kilka zadań badawczych, polegających na: diagnozie innowacyjności polskiego sektora drzewnego, ocenie kondycji nauki w drzewnictwie, określeniu stanu wiedzy o badaniach naukowych w drzewnictwie, wskazaniu kluczowych przesłanek światowego postępu naukowego w drzewnictwie, identyfikacji priorytetowych kierunków badań naukowych w drzewnictwie i opracowaniu scenariuszy ich rozwoju w Polsce do 2020 roku, dokonaniu oceny wpływu przewidywanego rozwoju nauki w drzewnictwie na innowacyjny rozwój sektora drzewnego.

Wymiernym efektem pierwszego etapu Projektu jest raport o charakterze monografii, dotyczący problematyki innowacyjności sektora drzewnego w Polsce (dostępny na stronie internetowej: www.itd.poznan.pl/foresight). Rozpoczęto również uświadamianie środowisku naukowemu i praktyki gospodarczej znaczenia uczestnictwa w procesie wytyczania pożądanych kierunków badań dla wzrostu innowacyjności oraz potrzeby integrowania środowisk zainteresowanych przyszłością polskiego drzewnictwa jako dziedziny naukowej i sektora gospodarki. Służyło temu między innymi zorganizowane w czerwcu bieżącego roku w Instytucie Technologii Drewna seminarium naukowe „Drzewnictwo – nowe nurty w technice i technologii", podczas którego – poza prezentacją założeń i zasad projektu dotyczącego *foresight*'u w drzewnictwie – naukowej dyskusji poddano kwestie stanu innowacyjności drzewnictwa oraz najnowszych kierunków badań w obszarach kompozytów drzewnych, mechanicznej obróbki drewna i tworzyw drzewnych oraz ochrony drewna. Projekt i realizowane zadania zostały również przedstawione uczestnikom spotkania Polskiej Platformy Technologicznej Sektora Leśno-Drzewnego w referacie „*Foresight* – pomostem między nauką a sektorem leśno-drzewnym". Wszystkim działaniom towarzyszyła szeroko zakrojona akcja informacyjna i promocyjna w mediach.

FORESIGHT IN THE WOOD SCIENCE AND INDUSTRY – RESEARCH DEVELOPMENT SCENARIOS IN POLAND TILL 2020

Summary

In the conditions of globalisation and ever growing international competition fast and effective implementation of knowledge into economic practice is necessary. Wood industry is more, than it usually is the case, concerned by that issue due to the fact that it uses natural raw material; hence there are constraints of the process of steady improvement of products and technologies and introducing radical changes to them. At the same time, this industry is of special importance for sustainable development of the Polish economy, for it is a production sector strongly determined by nature (production capability of forests) and offering ecological products. In that context it is important to know which lines of long-term development of wood science and industry are expected and desired by society. It is possible to gain that knowledge thanks to the research project entitled "Foresight in the wood science and industry – research development scenarios in Poland till 2020" carried out in the Wood Technology Institute in Poznan. The product of the first phase of the project is a monographic report on the innovativeness of the wood sector in Poland (available on: www.itd.poznan.pl/foresight).

Keywords: wood science and industry, technology foresight, research project

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Władysław STRYKOWSKI

"FORESTS AS A RENEWABLE SOURCE OF VITAL VALUES FOR CHANGING WORLD" – SPOTKANIE PLENARNE I KONFERENCJA MIĘDZYNARODOWEJ AKADEMII NAUKI O DREWNIE

Tematyka plenarnego spotkania i konferencji obejmowała wiele zagadnień, głównie dotyczących struktury drewna i jego właściwości, współczesnych technik i technologii przerobu drewna, innowacyjnych produktów drzewnych, zrównoważonego pozyskania surowca drzewnego, zasobów leśnych, ich utylizacji, rynku drewna.

Słowa kluczowe: drewno, nauka o drewnie, zasoby leśne

Międzynarodowa Akademia Nauki o Drewnie (*International Academy of Wood Science – IAWS*) jest organizacją naukową typu *non-profit*, powstałą w 1966 roku. Aktualnie liczy 325 członków i 27 członków wspierających, reprezentujących 36 państw.

Celem działalności Akademii jest:

- skupianie wybitnych naukowców z dziedziny nauki o drewnie,
- upowszechnianie osiągnięć z zakresu nauki o drewnie,
- promowanie wysokich standardów badań naukowych i publikacji (w tym w *„Journal of Wood Science and Technology"*),
- certyfikacja programów badań i uczelni.

IAWS aktualnie jest zarządzana przez sześcioosobowy Komitet Wykonawczy, którego przewodniczącym jest profesor Frank C. Beall (*University of California, Department: Environmental Science, Policy & Management, Division: Ecosystem Sciences*) oraz dwunastoosobową międzynarodową Radę Naukową.

Tegoroczne plenarne spotkanie i konferencja pt.: *„Forests as a Renewable Source of Vital Values for Changing World"* odbyły się w dniach 15–21 czerwca

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2009 roku w Sankt-Petersburgu i w Moskwie. W plenarnym spotkaniu uczestniczyło ponad 100 pracowników naukowych z 20 państw.

Na konferencji, w 142 referatach i posterach, przedstawione zostały takie problemy, jak: struktura drewna w nano-, mikro-, mezo- i makroskali, właściwości drewna jako materiału przemysłowego, współczesne techniki i technologie przerobu drewna, przemysłowe sterowanie produkcją drewna i produktów drzewnych, innowacje i inteligentne produkty drzewne, zrównoważone zużycie zasobów leśnych, zwielokrotniona wartość lasów i jej szacowanie, lasy i zmieniający się świat, międzynarodowe aspekty utylizacji zasobów leśnych, zasoby leśne, globalny rynek drewna i handel, tworzenie drewna, fizjologia i dendrologia. Poszczególne referaty i postery zostały zebrane i przedstawione w sposób syntetyczny w materiałach konferencyjnych[1].

Warto dodać, że wybór miejsca spotkania miał wymiar symboliczny, gdyż w Rosji znajdują się największe rezerwy surowca drzewnego.

Konferencji towarzyszyły dwa ciekawe wyjazdy terenowe. Pierwszy do nowoczesnej fabryki mebli w Sankt-Petersburgu, a drugi do Instytutu Fizyki Ciała Stałego w Moskwie. Należy zauważyć, że z Instytutem Fizyki Ciała Stałego w zakresie badań nowoczesnych produktów opartych na drewnie od wielu lat współpracuje Moskiewski Państwowy Uniwersytet Leśny.

"FORESTS AS A RENEWABLE SOURCE OF VITAL VALUES FOR CHANGING WORLD" – A PLENARY MEETING AND CONFERENCE OF THE INTERNATIONAL ACADEMY OF WOOD SCIENCE (IAWS)

Summary

The subject matter of the plenary meeting and conference entitled "Forest as a renewable source of vital values for changing world", which were held from 15th till 21st June 2009 in Russia, concerned mainly wood structure and properties, modern wood processing techniques and technologies, innovative wood products, sustainable harvesting of wood raw material, forest resources and their utilisation, and the wood market.

Keywords: wood, wood science, forest resources

[1] *Forests as a Renewable Source of Vital Values for Changing World, 2009 IAWS Plenary Meeting and Conference. 15–21 June 2009 Saint Petersburg-Moscow, Russia.* Materiały są dostępne w Instytucie Technologii Drewna w Poznaniu.

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Miriam PEKARČÍKOVÁ

PRODUCT DESIGN FOR DISASSEMBLY

Product design solutions is a complex decision about design and development that are directed at production of product which would be the best combination of options that will lead to manufacture of product that is technologically sound, environmentally friendly, economically rational, and socially acceptable. This material was prepared within project KEGA 3/5208/07 "Virtual laboratory for designing the disassembly systems of eliminated products" carried out in Slovakia.

Keywords: design, disassembly, environment, product

Introduction

The product design represents a complex which should be considered in a broader context. Issues to be pondered deal not only with product design in terms of product's appearance, but with the whole concept of product making consisting of:

- concept of product solutions taking into account environmental requirements,
- choice of materials,
- geometry of the product,
- dimensions and placement of product components,
- product technology in terms of assembly/disassembly.

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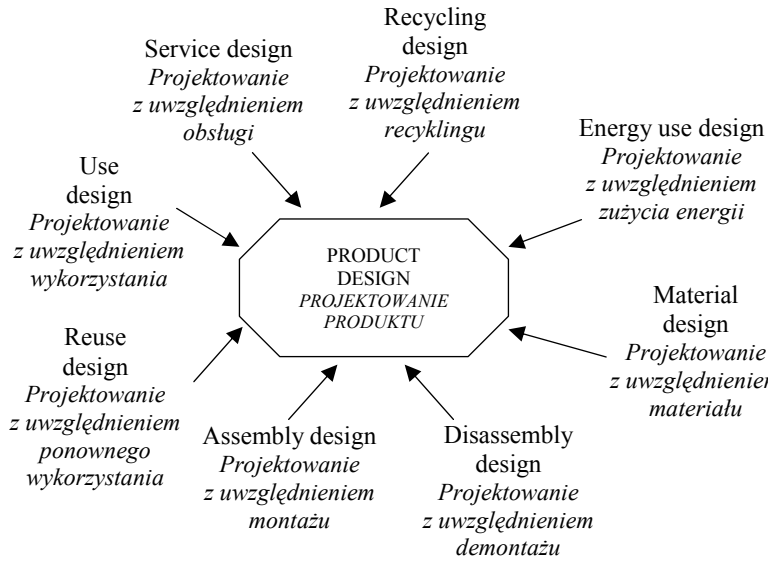

Fig. 1. Product design as a complex
Rys. 1. Projektowanie producktu jako kompleks

The concept of product solutions taking into account environmental requirements

Within this characteristic is necessary to answer the question: How to translate customer requirements and needs into the product and at the same time keep to principles of low consumption of energy and resources, and production of minimum of waste?

At this stage it is important to think of product survival, i.e. consider the efficiency of recovery of various parts of the product when its life cycle ends, i.e. whether it is better to turn post-consumer materials into secondary raw materials or reuse undamaged components and parts in new products or as spare parts.

On the one hand, product design in the context of energy design should ensure low power consumption and, on the other hand, long life of the product.

The choice of materials from the recycling perspective

- Already in product design it is necessary to think about product recovery at the end of the life cycle, i.e. to consider the following:
- reduce the number and variability of materials used in the product, for example use the same plastic polymers,

- use of materials depending on the material stock to achieve sustainable use of natural resources and ensure a healthy environment,
- carefully select materials to exclude materials that are not environmentally friendly, and focus on production of parts that are easy to recycle,
- indicate materials used in individual parts that makes the classification for subsequent recycling easier, and also facilitates the use of recycled materials in any case as well as compliance with quality criteria,
- indicate the part of the product which must be cleaned, specially maintained to extend the life of the product etc.

Dimensions and placement of product components

Dimensions of individual components constituting the product influence the quality and speed dismantling process. The aim is to reduce the amount of labour and number of tools engaged in dismantling to the minimum.

This can be achieved for example by using the same type and size of screws in the entire product, placing parts that are likely to wear out at the same time, near each other, so they can be easily replaced at the same time, or using a bind to simplify disassembly of individual components for servicing and recycling (screw, bind, click bind, soldering and welding bind etc.).

Product technology in terms of assembly/disassembly

Optimal disassembly process is the one that ensures removal of the product (or obtainment of required components) at the lowest cost possible, as quickly as possible, using the least amount of labour, the smallest number of operations, and the smallest number of tools and devices.

Basic criteria for selection of optimal dismantling procedures are the following:

- productivity – the amount of dismantled products per unit of time or labour,
- quantity of processed waste,
- number of operations,
- layout of workplaces – depending on the type and quantity of products,
- degree of automation – depending on the type and quantity of products,
- equipment of workplaces with modern technologies,
- equipment of workstations with tools and devices,
- ergonomics,
- energy intensity,
- economic criteria - the efficiency of recycling (energy and material consumption), the effectiveness of repairs (the price of a new product versus the price of spare parts and labour costs associated with servicing).

Looking for the optimal process of product dismantling it is necessary to fulfil the aforementioned parameters.

Conclusions

The efforts of producers should focus on creation of product that is the best combination of options that will lead to manufacture of product which is technologically sound, environmentally friendly, economically rational, and socially acceptable.

The product solutions may incorporate requirements connected with inclusion of environmental parameters of products, product design allowing for dismantling necessary for servicing and disassembly necessary for recycling.

PROJEKTOWANIE PRODUKTU Z PUNKTU WIDZENIA DEMONTAŻU

Streszczenie

Niniejsze opracowanie pokrótce informuje o rozwiązaniach w sferze projektowania, rozumianego jako skomplikowana decyzja ukierunkowana na wybór optymalnego wariantu. Prowadzi to do wytworzenia produktu solidnego z punktu widzenia technologii, ekologicznego, ekonomicznie racjonalnego i akceptowanego społecznie.

Słowa kluczowe: projektowanie, demontaż, środowisko, produkt

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Ewa TOMASZEWSKA

SKOMPUTERYZOWANE CENTRA INFORMACJI W SZWAJCARII

We wrześniu bieżącego roku odbyło się seminarium szkoleniowe dla pracowników informacji i bibliotekarzy, którego celem było zapoznanie uczestników z organizacją i funkcjonowaniem centrów informacyjnych i multimedialnych oraz strukturami bibliotek w Szwajcarii.

Słowa kluczowe: informacja naukowa, biblioteka, zbiory biblioteczne, komputeryzacja, centra multimedialne, współpraca międzynarodowa, Szwajcaria

W dniach 19–26 września 2009 roku odbyło się w Genewie, Lozannie i Bernie seminarium szkoleniowe zorganizowane przez Unię Europejskich Federalistów – Polska pt.: „Skomputeryzowane biblioteki, centra informacyjne i multimedialne Szwajcarii."

W seminarium uczestniczyły 44 osoby. Wśród uczestników byli pracownicy informacji naukowej i bibliotekarze wyższych uczelni (np.: Uniwersytetu Jagiellońskiego, Uniwersytetu Wrocławskiego, Uniwersytetu Warszawskiego), Biblioteki Narodowej w Warszawie i Paryżu oraz ośrodków badawczo-rozwojowych. Instytut Technologii Drewna w Poznaniu reprezentowała Ewa Tomaszewska, kustosz Zakładu Informacji i Promocji.

W ciągu czterech dni uczestnicy szkolenia zapoznali się z organizacją pracy narodowego systemu bibliotek w Szwajcarii, z działaniem centrów informacyjnych i multimedialnych oraz różnego typu bibliotek. Seminarium obejmowało wykłady i wizyty w bibliotekach takich jak Biblioteka Genewskia (*Bibliothèque de Genève*), Biblioteka Kantonalna i Uniwersytecka w Lozannie (*Bibliothèque cantonale et universitaire*), Biblioteka Narodowa w Bernie (*Bibliothèque nationale suisse*), czy Wyższa Szkoła Zarządzania – Centrum Informacji i Dokumentacji (*Haute école de gestion – Information et documentation*). Podczas seminarium przedstawiono nowoczesne technologie informacyjne i związane z nimi

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usługi stwarzające wiele udogodnień w zakresie gromadzenia, przetwarzania oraz wymiany informacji naukowej. W Bibliotece Genewskiej omówiono wykonane prace w zakresie digitalizacji zbiorów oraz prawną stronę gromadzenia egzemplarza obowiązkowego i konsekwencje jego braku. Biblioteka Kantonalna i Uniwersytecka w Lozannie przedstawiła możliwości publikacji elektronicznych zamieszczonych na specjalnych portalach – repozytoriach oraz wolny dostęp do nich – *open acces*.

Sposoby wyszukiwania informacji zgodnych z potrzebami użytkownika zostały omówione w Wyższej Szkole Zarządzania – Centrum Informacji i Dokumentacji.

Zaprezentowano wyszukiwanie informacji tematycznej między innymi dotyczącej ekonomiki drzewnictwa i technologii drewna.

Seminarium stało się okazją do wielostronnej dyskusji nad perspektywą rozwoju komputeryzacji bibliotek, informacji naukowej oraz tworzenia serwisów przydatnych specjalistom, w tym dotyczących zagadnień drzewnictwa. Cenną korzyścią szkolenia jest nawiązanie kontaktów pomiędzy bibliotekarzami polskimi i szwajcarskimi, które mogą zaowocować większą bazą informacyjną dla polskich naukowców. Podkreślić należy zaangażowanie i profesjonalne podejście strony szwajcarskiej w przygotowaniu seminarium, ogromną życzliwość i serdeczność w stosunku do uczestników.

COMPUTERISED INFORMATION CENTRES IN SWITZERLAND

Summary

From 19th till 26th of September 2009 a training seminar for employees working in information centres and librarians was organised in Geneva, Lausanne and Berne, Switzerland. The goal of the seminar was to acquaint the participants with organisation and operation of information and multimedia centres as well as with the structures of libraries in Switzerland.

Keywords: scientific information, library, library collection, computerisation, multimedia centres, international cooperation, Switzerland

ERRATA

Do artykułu pt. „Metoda wyceny surowca drzewnego w przerobie przemysłowym" z numeru 181, vol. 52, str. 99 – 104, wkradł się błąd, za który w imieniu Autora przepraszamy. Powinno być:

Formuła rozwinięta rachunku wartości drewna okrągłego według klas jakości.

Dla drewna okrągłego I klasy jakości jego wartość można określić następująco:

$$W_I = \frac{a_I}{Q}\left[\frac{\prod_{j=1}^{0}\left(1-r_j\right)P}{f\left(1+m\right)} - k_t - k_s - k_P - 0{,}5\sum_{j=1}^{0} r_j\left(k_s + k_p\right)\right] + f\left(1-a_I\right)\left(c_o - k_o\right)$$

odpowiednio dla II klasy wartość drewna wyniesie:

$$W_{II} = \frac{a_{II}}{Q}\left\{\frac{\prod_{j=1}^{0}\left(1-r_j\right)P}{f\left(1+m\right)} - \frac{a_I}{a_{II}}\left[k_t + k_s + k_P + 0{,}5\sum_{j=1}^{0} r_j\left(k_s + k_p\right)\right]\right\} + f\left(1-a_{II}\right)\left(c_o - k_o\right)$$

oraz dla III klasy wyniesie ona:

$$W_{III} = \frac{a_{III}}{Q}\left\{\frac{\prod_{j=1}^{0}\left(1-r_j\right)P}{f\left(1+m\right)} - \frac{a_I}{a_{III}}\left[k_t + k_s + k_P + 0{,}5\sum_{j=1}^{0} r_j\left(k_s + k_p\right)\right]\right\} + f\left(1-a_{III}\right)\left(c_o - k_o\right)$$

gdzie:

W_i – wartość drewna i-tej klasy w przerobie przemysłowym (tu I, II, i III) [zł/m^3],

a_i – wskaźnik wydajności w przerobie surowca i-tej klasy (tu a_I, a_{II} i a_{III}),

$i \in \langle I;III \rangle$ – numer klasy jakości surowca,

Q – miesięczne zapotrzebowanie na surowiec do przerobu wszystkich klas [m^3/m-c],

P – wartość przychodów ogółem netto (bez VAT) ze sprzedaży wyrobów w badanym okresie czasu (tu miesięczna) [zł/m-c],

r_j – stopa dyskontowa dla dnia o numerze j, (r_j = var),

$j \in \langle 1,o \rangle$ – numer dnia cyklu odzyskania należności za produkcję,

f – współczynnik udziału przedsiębiorstwa w zysku brutto umożliwiający potrącenie podatku dochodowego,

m – założony poziom rentowności operacyjnej brutto,

k_t – miesięczne koszty transportu surowca ze składnicy leśnej do zakładu [zł/m-c],

k_s – miesięczne koszty suszenia tarcicy [zł/m-c],

k_p – miesięczne koszty przerobu surowca [zł/m-c],

c_o – średnia ważona cena odpadów z przerobu surowca [zł/m^3],

k_o – średni koszt przygotowania odpadów do sprzedaży [zł/m-c].

Uogólniając formułę odnoszącą się do wszystkich klas drewna okrągłego, wartość drewna można wyrazić następująco:

$$W_i = \frac{a_i}{Q}\left\{\frac{\prod_{j=1}^{0}(1-r_j)P}{f(1+m)} - \frac{a_I}{a_i}\left[k_t + k_S + k_P + 0{,}5\sum_{j=1}^{0} r_j\left(k_S + k_p\right)\right]\right\} + f(1-a_i)(c_o - k_o)$$