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Analysis of selected factors of the environment in the technological processes of surface treatment of wood with the presence of hazardous substances

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Abstract: *Analysis of selected physical factors of the environment in the technological processes of surface treatment of wood with the presence of hazardous substances.* The paper is an analysis of selected environmental factors in technological processes of surface treatment of wood using paints and products containing hazardous chemicals, as well as forming the dust aerosols that are generated when pretreatment and refinished in different layers of coating systems. Attention is paid to environmental proposal in developing new advanced types of filters bicomponent synthetic fibers blended with high filtration efficiency capture of solid aerosols and dangerous chemicals.

Keywords: hazardous substances, surface treatment, wood, factors of the environment, solid pollutant emisson, new type of filters

INTRODUCTION

Currently, increased attention is given to maintaining and improving the quality of life and working environment in accordance with accepted principles of sustainable development. Effective indicators for assessing the state of the working environment are activities associated with the assessment of the environmental impacts of industrial activities and production processes in the context of the health of the population (RUŽINSKÁ, 2011). For prediction and optimal adjustment of technological processes in the wood processing industry in the production of wood products it is necessary to assess the impact of present physical and chemical factors of the working environment in relation to the required quality of the products.

In the preparation of wood products physical and chemical factors of the working environment are taken into account, in relation to the risks to production workers. The most important physical environmental factors include: noise, vibration, dust, ionizing radiation and others. Chemical environmental factors are judged primarily by the presence of chemical substances (hazardous, respectively dangerous) and compared with legislatively defined concentration limits.

The assessment of air quality in the workplaces of wood finishing is specified by various related legislative documents, for example STN EN 481: Workplace air (Determination of size of fractions for measurement of airborne particles), Act No. 137/2010 on Air, the Act No. 67/2010 on Chemicals, Directive 1907/2006 of the EP and of the Council of EP 2004/42/EC, by decrees of MoE SR No. 549/2007, 360/2010, 410/2012 Coll., Government Regulation No. 47/2011 Coll. with stated $NPEL_c$ (Table 2 - for solid aerosols with irritating and carcinogenic effect of hardwoods with TSH), Government Regulation No. 356/2006 and No. 301/2007 Coll.

The aim of the paper is a comprehensive assessment of physical and chemical environmental factors in technological processes of surface treatment of wood with the specification of particular environmental factors, our attention is paid to the methods

of detection and eco-technical proposals aimed at reducing the risk of hazardous gaseous (aerosols) and solid pollutant emissions (dust particles PM_{10}, $PM_{2,5}$).

SELECTED PHYSICAL FACTORS OF ENVIRONMENT IN FACILITIES FOR THE SURFACE TREATMENTS OF WOOD

One of the most important factors primarily conditioning the health of workers is ***dust level***. The occurrence of dust is indicated during formatting, as well as sanding wood surfaces before application of coatings (based on variable binders), and also during resanding individual layers of coating films in the process of wood finishing.

Toxicologically significant is mainly hardwood dust, at which potential carcinogenic effects on the respiratory system of workers are recorded. An important criterion in eco-design for reduction, respectively substantial elimination of the presence of dust is to achieve the required quality of coating systems without the presence of pollutant particulates (PM), which would be manifested as defects in the coating films in the form of mechanical impurities. Equally important is achieving the required health and ecological quality of the working environment by removing particulate emissions, respectively generated aerosols.

METHODS OF MEASURING CONCENTRATIONS OF DUST IN THE FACILITIES FOR SURFACE TREATMENTS OF WOOD

The methods can be categorized in terms of physical principle used (VEJVODA et al. 2003):

- ***gravimetric method***: is used as a reference method for the purpose of dust meter calibration, but it is not suitable for continuous measurements since it does not provide the information on the concentrations of dust in particular times of measurements, but only the balance values over a period of time; the measuring range by this method is 0,1 to 2 000 $mg.m^{-3}$,
- ***optical methods:*** dust concentration measurements (using the transmissive principle or principle based on light scattering). They are most commonly used methods for transmissive principle. Measurement range is freely adjustable using a method based on light scattering and is 0,1 $\mu g.m^{-3}$ to 200 $mg.m^{-3}$,
- ***method based on the triboelectric phenomenon,*** which is usually only used for control of dust filters; measurement range for this method is 0,1 $mg.m^{-3}$ to 1 $kg.m^{-3}$,
- ***method based on the principle of absorption of beta radiation***: it is a method based on a similar principle as the gravimetric method, the difference is that two β radiations are measured, before sampling and after sampling; a relatively high accuracy is achieved, but it is a costly method.

The advantage of gravimetric method is its simplicity and that it does not demand complicated instruments and especially its mutual comparability and reproducibility of the measurement results regardless of the type of device and filter material, air flow, and the suction speed.

The only disadvantage of this method is that the importance of large dust particles (greater than 10 μm) is overrated and thus the result obtained may not be in line with the actual risk of dust. Although large dust particles can significantly influence the measurement results, but in view of the risk of dust are useless because they are retained in the upper respiratory tract. This drawback of gravimetric methods can be removed by subsequent analysis of the distribution of dust size range or by two-step measurements of dustiness. To separate components of respirable dust cyclones are most commonly used. They earned this name due to the rotation of the air inside their chamber. The cyclone separates the airborne dust particles according to their size. It works on the same principle as a centrifuge, i.e. particles are separated by rapid rotation of the air according to their aerodynamic diameter,

and respirable particulate components are trapped in the filter, while larger particles fall into the collecting container.

ECOTECHNICAL METHODS OF REDUCING POLUTANT PARTICULATES (PM) IN THE FACILITIES FOR SURFACE TREATMENTS OF WOOD

A proposal for an appropriate separation equipment to eliminate polutant particulates depends on the size of dust particles, their distribution and shape, some physical properties, the emission limit values (VEJVODA A KOL. 2003, RUŽINSKÁ A JABLOŃSKI, 2011). According to the principle they are divided into:

- ***mechanical separators:*** dry and wet, using the principle of inertia and gravity,
- ***filters:*** of different material composition, using the principle of diffusion or inertia,
- ***electrostatic precipitators:*** on the principle of electrostatic force and gravity.

Of these, fabric filters have the highest separability, where filters of excellent quality achieve excellent separation rate to 99.99 % and higher, which makes them the most effective mechanical dust separators and separators of generated aerosols of hazardous substances. In fact the development in the area of using new types of synthetic materials allows to achieve a high separation rate in demanding operating conditions, at a lower economic cost compared to e.g. glass, respectively PTFE filters.

PREPARATION OF BICOMPONENT FIBRES FOR NEW TYPE OF DUST FILTERS EXPERIMENTAL PART - METHODS

In order to study the impact of the ratio of ingredients and contents of interfacial agent to prepare a series of fiber-forming polymer mixtures:

a) and / mixtures with different ratio of the components of polypropylene and polyamide 6 Mixtures prepared without interfacial agent was defined PP/PA6 a mixture prepared by mixing polypropylene with polyamide 6, adjusted 4% copolymer PP-MAH, we identified PP/PA6M. Prepare the following mixture:PP/PA6 90/10 and 80/20, PP/PA6M 90/10, 80/20,70/30, 60/40, 50/50, 60/40, 20/80
b) Mixtures containing various interfacial agents at a constant ratio of the components (80/20). The following mixtures were prepared PP/PA6/M: from 1 to 5% wt.

Preparation conditions of fibre-forming polymers

- shear stress (Pa): from τ 1 = 3,997. 10^3 to 3,025. 10^4
- melting time: 5 minutes
- flow conditioning: 1 minute
- temperature: 250, 260, 270 °C.

RESULTS

For evaluating the flow properties of the capillary viscometer were used PP/PA6M polymer blends with the changing content of the dispersed component (polyamide containing 4% by weight. Interfacial agent MAH - maleic anhydride) in the range from 10 to 50 % wt. The results obtained can construct flow curves, respectivelyrecord the results obtained numerically in Table 1.

Tab. 1 Parameters Ostwald de Wael model for pure polymers and mixtures prepared with different contents of modified polyamide component

Samples	250 °C		260 °C		270 °C	
	n*	K**	n*	K**	n*	K**
PP 100/0	0,64	761,4	0,64	540,2	0,73	307,9
PA_{6M}	0,62	1118,3	0,78	424,6	0,82	294,9
PP/PA_{6M} 80/20	0,67	974,9	0,64	745,1	0,69	520,9
PP/PA_{6M} 70/30	0,76	868,9	0,63	877,2	0,67	630,9
PP/PA_{6M} 60/40	0,79	912,4	0,64	1013,8	0,72	565,9
PP/PA_{6M} 50/50	0,87	858,6	0,58	1385,9	0,71	682,2

n* – index of pseudoplasticity, K** – coeficient of consistency

The evaluation of the results in Table 1 raised the following conclusions: the flow of mixed melts the pseudoplastic character like pure PP. Flow properties of mixtures of different organic ingredients can be expressed Ostwald de Wael rheological models. Index values are non-Newton flow of mixtures of pure polypropylene significantly different and did not show a clear dependence on the content of the dispersed component.

The index of non-Newton flow of mixtures of pure polypropylene significantly different and did not show a clear dependence on the content of the dispersed component. However, differences shown in the comparison values for the mixture prepared by mixing the pure components, respectively. using interfacial agent, as illustrated by Table 2. For a more comprehensive assessment of the rheological properties of the experimental part was monitored by apparent viscosity of the mixture depending on the composition and content of the interfacial agent.

Tab. 2 Comparison of parameters Ostwald de Waelovho rheological model for mixtures of PP-PA6 (80/20) with the interfacial agent and without the use of an intermediate

Samples	250 °C		260 °C		270 °C	
	n	K	n	K	n	K
PP/PA_6 80/20	0,52	717,9	0,57	717,9	0,51	929,4
PP/PA_{6M} 80/20	0,67	974,9	0,64	745,1	0,69	520,9

n* – index of pseudoplasticity, K** – coeficient of consistency

The evaluation of the results showed:

- With increasing shear stress decreases the apparent viscosity of mixtures analogy with the entry polymers.
- The viscosity of mixtures increase with increasing content of polyamide components, and their values are significantly higher than the additive value of viscosity, calculated from pure ingredients.
- From the foregoing it can be assumed that it is increasing the tolerance expression system due to the high degree of dispersion of the components, which is consistent with the finding.

CONCLUSION

Bicomponent synthetic fibers are a group of advanced materials that have recently expanded range of conventional fiber-forming polymers, not only in various industrial, but also in construction applications, e.g. as innovative soundproofing, particularly filter materials and they are applicable in the elimination of hazardous substances in air, in industrial technology and also in the wood processing industry - to install separation equipments at the facilities of surface treatment of wood.

REFERENCES

1. FORTELNÝ I.,ROSENBERG R., KOVÁŘ J. 1989: The effect of composition and rheological properties of component on the morphological structure of polymer blends. In: *Polymer Blends. 32nd Microsymposium*, Praha, s. P-98.
2. JORDHAMO G.M., MANSON J.A, SPERLING L.H. 1986: *Polymer Eng. Sci*, 26, s. 517.
3. KULEZNEV V.N. 1980: *Smesi polimerov*. Chimija Moskva, 326 s.
4. LIPATOV J.S. ET AL. 1982: *Vysokomolekul. sojedinenija*, 3, s. 549.
5. MIN K., WHITE J.L., FELLERS J.F 1984: *Polymer Eng. Sci*., 24, p. 1327.
6. PAUL D.R., NEWMANN C. 1978: *Polymer Blends.* New York, 453 p.
7. RUŽINSKÁ E., JABŁOŃSKI M. 2011: Ekotechnické spôsoby redukcie rizikových látok v procesoch povrchových úprav materiálov–II. časť: Návrh odlučovacích zariadení. *Medzinárodný seminár "Nové trendy v technike ochrany ovzdušia" 2011,* Zvolen (CD*),*s. 89-98, ISBN 978-80-228-2003-5. ISBN 978-80-228-2277-0
8. RUŽINSKÁ, E. 2010: Modification of fibre-forming polymers for preparation special composite materials. *Chemické listy*, roč. 2010, číslo 104, 501-510. Sekcia 5:5L-14, (p. 507). ISSN 0009-2770.
9. VEJVODA J., MACHAČ P., BURYAN P. 2003: Technologie ochrany ovzduší a čištění odpadních plynů. *Učebné texty*. Vyd. VŠCHT Praha. 226 s. ISBN 80-7080-517-X.

Streszczenie: *Wpływ wybranych czynników fizycznych środowiska w procesie technologicznym wykańczania powierzchni drewna w obecności substancji szkodliwych*. Praca jest analizą czynników środowiskowych w procesie uszlachetniania drewna materiałami zawierającymi szkodliwe substancje oraz tworzącymi kurz lakierniczy w różnych fazach procesu uszlachetniania. Zwrócono uwagę na propozycję stworzenia nowych typów filtrów opartych na włóknach syntetycznych o zwiększonej efektywności przechwytywania szkodliwych aerozoli oraz niebezpiecznych chemikaliów.

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