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Formaldehyde emission from raw materials for particleboard production at the beginning of processing chain

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Abstract. Meeting new, more strict limits for formaldehyde emission from wood based composites is hardly possible without essential changes in technology and processing. Since modifications of amino resins occurred to be not enough, other approaches must be considered. Thus, the present studies regard analysis of formaldehyde levels in raw materials for particleboard production at the beginning of processing chain: (1) chips from wood yard and (2) wet particles collected after knife ring flaker. The obtained results allowed to determine contribution of formaldehyde emission from wood material to overall emission from particleboard and to define procedures minimizing formaldehyde emission from the products in future.

Keywords: formaldehyde emission, wood particle, chips, particleboards

1. Introduction

Wood-based panels for furniture industry or for construction applications have to fulfill new, more strict requirements defined both by European, American and Japanese standards regarding formaldehyde emissions. Since modifications of amino resins occurred to be not enough, new challenges for manufacturers arose. Meeting the limits allowed for Super E-Zero class imposes wide research on formaldehyde release from wood as well as novel approach for manufacturing. Thus, it seems that analysis of formaldehyde emission from wood at consecutive stages of production is rationale, since not only adhesives and bonding parameters, but wood material storage conditions also contribute to emission from the final product.

Wood as a natural material contains some amount of formaldehyde [1,2] which can be released e.g. during thermal treatment [3]. However, emission levels depend on numerous factors – like species, moisture content, outside temperature or storing time [4,5]. What should be noticed, reports in literature do not cover particleboard technology as a whole [3,6,7]. In order to develop E 0.5-class (4mg/100g) products, it seems essential to recognize emission levels at the consecutive processing steps – including wood in the store-house as well as cut or ground raw materials.

Irle et al. [8] found correlation between moisture content in material and formaldehyde release. It was shown that moisture content change from 0.0% to 4.0% resulted in 6-fold increase in formaldehyde emission, which suggests that release is governed by physical processes rather than chemical ones. Moreover, it was reported that both polysaccharides and lignin, too, were a source of formaldehyde. A path of formaldehyde release includes transformation of polysaccharides to hexoses, oxymethylfurfural and its subsequent disproportionation to furfural and formaldehyde [3]. It was also shown that lignin might undergo reactions releasing formaldehyde – especially in acidic environment [9].

The present studies regard analysis of formaldehyde emission from raw materials for particleboard production: chips from wood yard and wood particles, so that determination of contribution of formaldehyde emission from wood material to overall emission from particleboard was plausible. Since methods for

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determination of formaldehyde emission from wood have not been standardized so far, the experimental procedures were based on EN 717-2 standard [10].

2. Materials and methods

For the tests, pine wood materials were collected at the beginning of processing chain: (1) chips from wood yard and (2) wet particles collected after knife ring flaker (Fig. 1). Formaldehyde emission was determined by gas emission method according to EN 717-2:2005 standard [10]. For easy air flow through the particles layer, they were put in a stainless steel net-box holder (400 x 50 x 50 mm^3) placed within the 0.225 m^3 chamber (Fig. 2). 125 g (dry basis) of particles were subjected to analysis in each batch. The resultant formaldehyde emission values were re-calculated to an equivalent of standard particleboard (moisture content 6%, density 650 kg/m^3, glue load 10%) which make 177 g of wood material.

Moisture content in wood materials was determined gravimetrically.

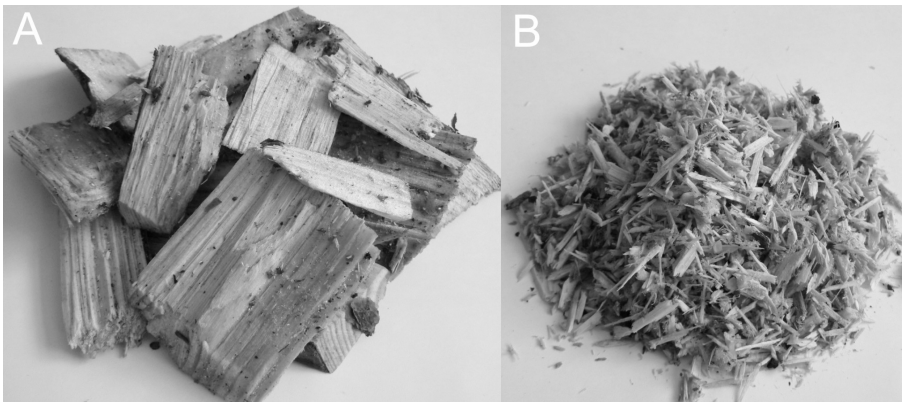

Fig. 1: Wood materials: A – chips, B – particles.

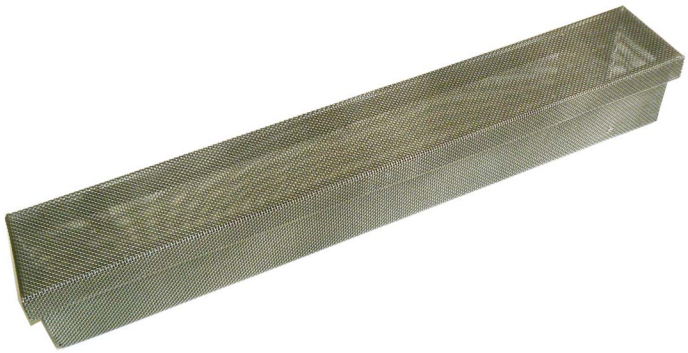

Fig. 2: Stainless steel net-box holder.

For 95% confidence interval, analyses were performed in 5 replications in independent 2 institutions: (1) an accredited Wood Products Laboratory, Research & Development Center For Wood-Based Panels in Czarna Woda and (2) the Faculty of Wood Technology, Warsaw University of Life Sciences – SGGW.

3. Results and discussion

In Table 1 the results of moisture content measurements were presented. Chips and particles exhibited comparable values, while observed small differences (ca. 12%) might come from storage conditions, since natural local migration of moisture within a pile always occurs.

Table 1: Moisture content in chips and particles.

Material	Moisture content [%]
Chips	100.5 ± 5
Particles	112.7 ± 7

As the data in Fig. 3 indicate formaldehyde emission from the particles after cutting was higher by 25% than that from the chips prior to cutting. The phenomenon may come from the developed material surface with regard to mass unit. Strict comparison of the results with the requirements for particleboards is difficult, since emission is expressed in mg/h*m^2. However, it is possible to calculate emission from the particles in the amount contained in a particleboard.

When the amount of absolutely dry particles contained in particleboard of a given density and thickness is known, the obtained results may be re-calculated to surface of particleboard (EN 717-2:2005). Re-calculated release of formaldehyde was shown in Fig. 4.

Thus, it was found that formaldehyde emission from the wood being an equivalent of particleboard made 4.6% of the whole emission permitted by EN 13986:2005 standard for E1-class products (3.5 mg/h*m^2) [11].

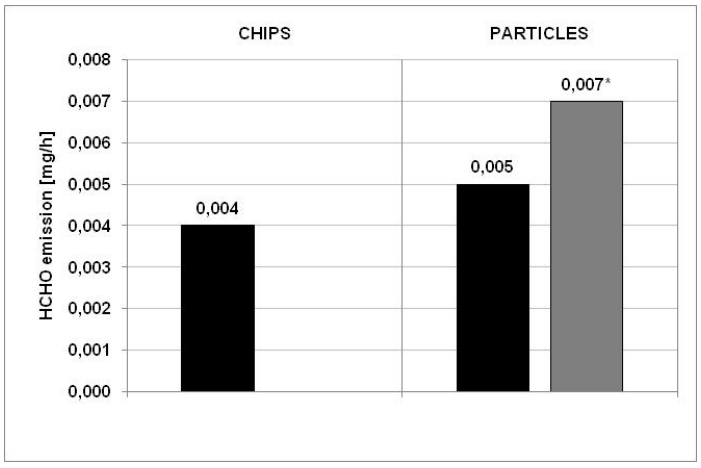

Fig. 3: Formaldehyde emission from wood at the beginning of processing chain – with respect 125 g of absolutely dry material (*re-calculated to particleboard of density 650 kg/m^3 and thickness 16 mm).

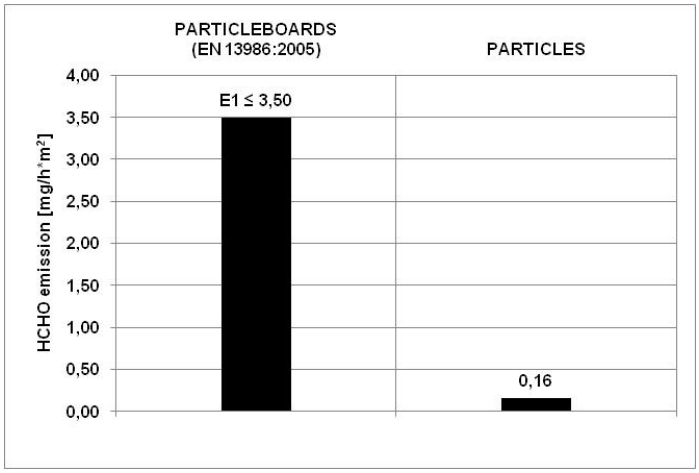

Fig. 4: Formaldehyde emission from E1-class particleboard permitted by EN 13986:2005 standard [11] and from absolutely dry pine particles contained in particleboard of density 650 kg/m^3 and thickness 16 mm.

4. Conclusions

It was shown that process of industrial production of particles influenced on increased formaldehyde emission by 25% when compared to the wood material stored in the wood yard. The emission from pine particles collected just after cutting made 4.6% of the limit permitted by EN 13986:2005 standard for E1-class products.

Subsequent operations of particleboard production may possibly also affect the formaldehyde release, so that the investigations in that matter are currently in progress.

5. Acknowledgements

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