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Investigation of VOC emissions from pine plywood

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Abstract: *Investigation of VOC emissions from pine plywood.* The level of emission of volatile organic compounds from pine plywood was determined. The tests were performed according to the chamber and TD GC-MS methods based on the requirements of ISO 16000 standards. Within the whole test period the pine veneer and plywood emitted several times higher amounts of volatile organic compounds. In both cases the composition of the analysed air was dominated by terpenes after 4 days and carbonyl compounds after 180 days .

Keywords: pine, plywood, emission ,VOC, veneer

INTRODUCTION

In last years more attention has been given to tests of air quality. The interest of many scientific institutions in this issue stems from the fact that indoor air contains a broad spectra of various pollutions, which strongly influence physical comfort and health of room users, and according to the information from specialist literature people spend more than 90% of time inside buildings, in which they are isolated from the outside environment (Mølhave 1990, 1991, Mølhave et al. 1997). One of the causes of indoor air pollution is emission of volatile organic compounds (VOC) from wood elements and wood products such as plywood, particleboard, OSB, MDF of indoor equipment. In the Wood Technology Institute research on VOC emission from wood-based panels and solid wood has been conducted for many years. The article presents research on VOC emissions from pine veneer and pine plywood.

MATHERIALS AND METHODS

Veneer. In the study pine veneer veneers (*Pinus sylvestris* L.) were used. The veneers were used with different storage times 4 and 180 days, defined as the time between manufacture veneer , started for peeling the hydrothermally plasticized log at veneer, formatting, and then drying to a moisture content of 6 ± 1%, and its use in research. For the preparation of 3-layer plywood, veneers with dimensions 300x300x1, 8 ± 0.1 mm, and MC = 6 ± 1% were used.
Glue mixtures. To approximately one third of the MUF resin was added a certain amount of filler, (wheat flour type 650 and kaolin powder KOG-OS, and active silica Aerosil-120 part. by wt.), then the mass was stirred for 10 min with a mechanical stirrer, and then introduced the remainder part of the resin was carried out by stirring for a further 20 min. In the final stage of preparation of the adhesive, the hardener 3.2% NH_4NO_3 was added.
The parameters pressing process. Veneer was applied on one side with the adhesive roller in an amount of 180 g/m^2. Then three layer sets was formed. After 30 min assembly time sets pressing at 125° C for 5 min at a pressure of 1.2 MPa .
Emissions of volatile organic compounds. Determination of VOC was performed by TD-GC/MS section consisting of the compounds adsorbed by gas chromatography using a thermal desorption and detection by mass spectrometry according to the procedures contained in the ISO 16 000-6 .
In a climate chamber with capacity. 0,025 m^3 placed the test material (plywood, veneer). Used following terms and conditions of the chamber :

- temperature of 23 ± 2 ° C
- relative humidity of 45 ± 5 %
- air change rate 1.0 ± 0.1 / h
- loading factor 3.7 m^2/m^3

The chamber was placed in an air-conditioned room. Chamber air was sampled after 3 days. Glass sorbent tubes were used to collect emissions. The tubes were packed with one layer of Tenax TA.

TD-GC/MS VOC analysis was performed using a thermal desorption " Omnisfera 'and a gas chromatograph " Thermo -Quest / Finnigan " (capillary column DB -624 MS with a diameter of 0.25 mm , film thickness of 1.4 microns and a length of 30 m) with MS detector " Trace 2000 " under the following conditions :

- injector temperature and adsorption trap 280 ° C
- analysis of the temperature profile

35 ° C (4 min) 5 ° C / min → 140 ° C → 12 ° C / min → 240 ° C (3 min)

- type of carrier gas helium
- flow rate 1cm^3/min
- temperature of the emission source 220°C
- 70 eV electron ionization
- range of 35-550 amu mass analyzed

The content of volatile organic compounds was expressed as TVOC sum determined in toluene equivalents based on the calibration. The target compounds were identified using the NITS MS library and the in-house database of the GC retention times for the compounds.

RESEARCH RESULTS AND DISCUSSION

The concentration of VOC emitted in a climate chamber for a pine three-layer plywood, pine veneer as a function of seasoning time was shown in Table 1.

Table 1. The emission of volatile organic compounds belonging to particular groups of chemical compounds from pine veneer and pine plywood (numerator = veneer, denominator = plywood)

Seasoning time [1)] [day]	**Terpenes**	**Aliphatic compounds**	**Aromatic compounds**	**Carbonyl compounds**	**Alcohols and esters**	**TVOC**
	[µg/m³]					
4	5708 / 5227	1 / 42	4 / 350	-- / 64	-- / 20	5713 / 5733
180	7 / 2	2 / 1	10 / 5	31 / 13	1 / 1	51 / 22

1) time between the formation of veneer and VOC measurement

There was a strong influence of the seasoning of veneer or plywood on the volume of emitted VOCs. Both for veneer and plywood after 4 days of storage were a similar level emission, a very high TVOC respectively 5713 and 5733 µg/m3 with dominant monoterpenes 99.9 and 91.7% of volatile organic compounds. These results fully correspond to research of VOC emission of pine particle (Marutzky and Dix 2004), pine chipboard (Baumann et al. 1999,2000), OSB (Makowski et al. 2005).

Twelve different terpene compounds were identified, with the highest concentrations were observed for α-pinene and Δ^3-carene, which reflects the composition of turpentine derived from pine (Prosinski 2004).

It was observed that, during storage of pine veneers and plywood was followed a sudden decrease of the content of monoterpenes with the formation of carbonyl compounds.

Regardless after 180 days aging veneer and plywood pine, found only trace amounts of α-pinene, Δ^3-carene and β-myrcene. Among the ten identified organic compounds with carbonyl group the highest concentration was found for hexanal. It was also observed that the emission of carbonyl compounds depended on the storage time of veneer and plywood. Thus, veneer stored for 4 days, in contrast to plywood not emit carbonyl compounds. With increasing storage time veneers and plywood emission of carbonyl compounds increased.

CONCLUSIONS

The extent of VOC emission depended on the seasoning time of pine veneer and pine plywood. The main compounds emitted from pine plywood included monoterpenes and carbonyl compounds. The highest emissions among terpenes were shown by α-pinene and Δ^3- carene, while among carboonyl compounds, it was done by hexanal.

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Streszczenie: *Badania emisji VOC ze sklejki sosnowej.* Przedstawiono wyniki badań emisji lotnych związków organicznych z forniru i doświadczalnej sklejki sosnowej w funkcji czasu sezonowania. Na podstawie przeprowadzonych badań m.in. stwierdzono że na wielkość emisji VOC ze sklejki ma wpływ czas składowania forniru i sezonowania sklejki. Głównymi związkami VOC emitowanymi zarówno ze sklejki sosnowej jak i forniru były monoterpeny oraz związki karbonylowe. Najwyższą emisją wśród monoterpenów charakteryzował się α-pinen i Δ^3- karen, a w grupie związków karbonylowych heksanal.

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