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MATERIAL EMISSIONS OF BUILDINGS INTERIOR

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ABSTRACT

Indoor environment especially concerning to interior architecture affect us not only by their mass, surfaces, color and shapes. Indoor surfaces mostly emit the compounds which have great impact on human beings. Growing attention is being paid to indoor air quality as one of the main health and well-being factors, also in Slovakia. The Building and Environmental Engineering Institute is concerned to indoor sciences research work within indoor environmental engineering orientation of the structural architecture. Today, the buildings are divided into: very low-polluting, low polluting and not low polluting. The classification of buildings is affected by the approach in selecting low emitting materials and restricting activities that emit pollutants into the environment of buildings. Therefore, the interior material surfaces selection is important from volatile organic compounds (VOCs) occurrence point of view. The main subject of the last period interest is and the materials emissions. Several office interior surfaces emissions are compared in this study. Comparing performed by chemical analysis and sensory tests using the test chamber. Methodology of material comparison is based on the volume of total volatile organic compounds (TVOCs) in the air. It has become evident that building materials are the major source of indoor volatile organic compounds. The indoor air acceptability and indoor air quality concerning to several types of interior materials are presented in this case study. The impact of individual materials and their interaction effects to the indoor air quality will be discussed within the paper.

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Key words: Indoor Quality, Interior Design, Materials, TVOCs.

Introduction

The traditional way of material selection for building design has been primarily based on cost, aesthetic values, availability and durability. Many of the materials used in buildings, either as structural materials or as furnishings, are the main sources of indoor air pollution. The research activities of Building and Environmental Engineering Institute is continuously focused to indoor architecture, indoor environment, perceived air quality within of green building projects. Interior surfaces are generally accepted as source of VOCs emissions. Even the result perceived air quality can be affected by their interactions and sorption effects. The surface sorption of materials emissions can reduce the concentration and improve the perceived air quality. The aim of the running research projects is to design the environmental friendly buildings in respect to sustainable building materials in order to guarantee acceptable perceived and healthy indoor air quality [1,2].

Methods

The wooden parquet, PVC flooring, Polyamide (PA) carpet, High Density Fiberboard laminated flooring – HDF and Oriented strand boards – OSB were investigated within the study (Table 1). The gypsum boards finished with water based painting were considered as sorption material. The chemical measurements and sensory assessments were done under the standardized and stabilized conditions (23°C, 50%).

Table 1 : Selected individual material surfaces

Interior	A	B	C	D	E
Flooring	Polyamide carpet	Wooden parquet	PVC	OSB board	HDF Laminate Flooring
Wall covering	Painted gypsum boards	Painted gypsum boards	Painted gypsum boards	Painted gypsum boards	Painted gypsum boards
Ceiling	Painted gypsum boards	Painted gypsum boards	Painted gypsum boards	Painted gypsum boards	Painted gypsum boards

The samples of investigated materials were placed in test chamber. The chamber was cleaned and the background sensory assessment was established before the experiment. The air of the empty chamber was perceived as neutral and without odors (means: mean odor intensity 0.2, mean acceptability +0.05). The surface of the test specimen was exposed to the chamber air which was maintained at a temperature, humidity and velocity similar to that which can be expected in the indoor environment. In addition to these conditions the chamber VOCs concentration depends on the supply airflow rate in the chamber and the area of the test specimen. The tests were performed with an area specific airflow rate similar to that which can be expected during the normal use of the material. Emission from different indoor surface materials was investigated in a test chamber under the standardized condition - 23°C , 50%, v = 0.1 – 0.2 m/s and air change rate n = 0.5 1/h. The chemical analysis was based on detection of selected volatile organic compounds. The active sampling of VOCs was performed by using a pump (Aircheck 2000) with air flow rate of 400 ml/min on charcoal tubes ORBO 32S (Supelco) during 24 hours. The absorbed VOCs were analyzed by gas chromatography (GC Varian 3 300) after extraction into CS2. The sum of VOCs was calculated based on individual VOCs concentrations including unidentified peak areas converted to decane equivalents (equivalent to toluene). The exhaust air from each test chamber was led through a diffuser for sensory assessments. An untrained sensory panel of 20 subjects assessed perceived air quality. Before the first assessment the panels were instructed how to use the scale and the exposure equipment. The responsible person of the experiment assessed each subject's attitude and motivation concerning to experiment and subject's personal hygiene. There was no restriction on distribution of gender or smoking habits. The age ranged from 24 to 54 years with mean a 30 years, and 35 % of the subjects were smokers. The panel was placed in the good ventilated room without odors before the assessments. Then the subjects indicated their immediate evaluation on continuous scale regarding acceptability of the air (from -1 clearly unacceptable to +1 clearly acceptable) from which the percentage of dissatisfied was estimated. In order to estimate the percentage of dissatisfied the relationship between percentage dissatisfied (PD) and mean acceptability from Gunnarsen and Fanger was used (Fig. 1). During the measurements, the test chambers were covered with aluminum sheets to hide the building products from the view of the sensory panels [3,4].

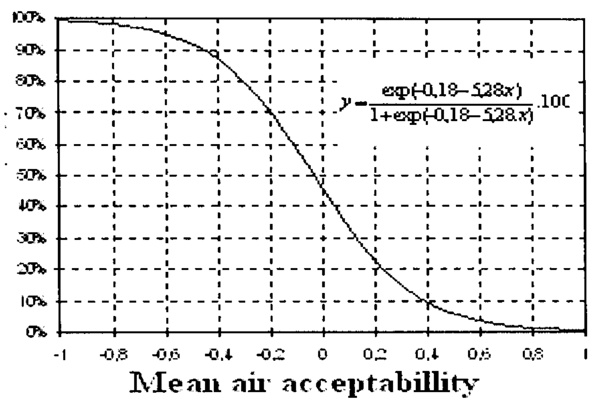

Figure 1 : Percentage of dissatisfied and mean air acceptability

Sensory Assessments

Perceived air quality of material surfaces combination (A) is represented by 60 % percentage of dissatisfied. Odor acceptability -0,12 and odor intensity 1,62 were evaluated in the case of this interior materials combination, therefore this combination did not meet the criteria of perceived indoor air quality. Odor acceptability -0,25 and odor intensity 1,06 was achieved by polyamide carpet flooring covering. Painted gypsum boards for wall and ceiling covering were presented by 0,1 odor acceptability and 2 odor intensity. Emissions of material surfaces combination (A) constitute an unacceptable perceived indoor air quality conditions.

Table 2 : Combination A – Odor characteristic

Constructions	Material	Odor acceptability (-1/+1)	Odor intensity (0-5)
Flooring	Polyamide carpet	-0,25	1,06
Wall covering	Painted gypsum boards	0,1	2
Ceiling	Painted gypsum boards	0,1	2
Combination		-0,12	1,62

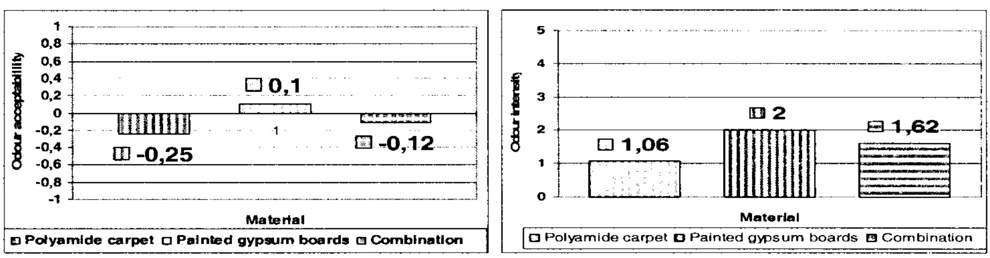

Figure 2 : Combination A – Odor acceptability and odor intensity

Material surfaces combination (B) perceived air quality is represented by 25 % percentage of dissatisfied. Odor acceptability 0.07 and odor intensity 1.42 was achieved by wooden parquet flooring covering. Odor acceptability 0.18 and odor intensity 1.3 were evaluated in the case of this interior materials combination. All materials and material surfaces combination meet the perceived indoor air quality criteria of odor acceptability and odor intensity.

Table 3 : Combination B – Odor characteristic

Constructions	Material	Odor acceptability (-1/+1)	Odor intensity (0-5)
Flooring	Wooden parquet	0,07	1,42
Wall covering	Painted gypsum boards	0,1	2
Ceiling	Painted gypsum boards	0,1	2
Combination		-0,18	1,3

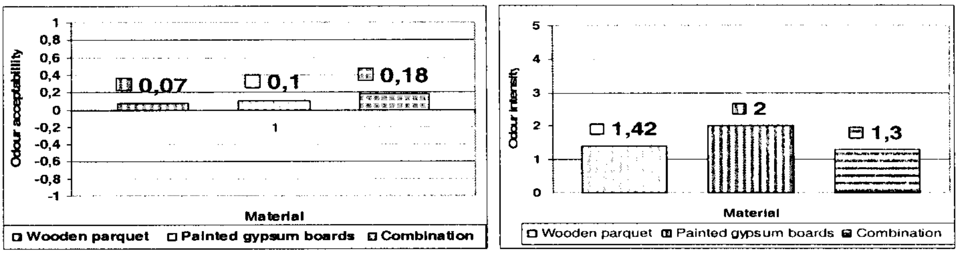

Figure 3 : Combination B – Odor acceptability and odor intensity

Perceived air quality of material surfaces combination (C) is represented by 48 % percentage of dissatisfied. Odor acceptability -0.07 and odor intensity 1.73 were evaluated in the case of this materials surfaces combination, therefore this combination did not meet perceived indoor air quality criteria of odor acceptability. Odor acceptability 0.08 and odor intensity 1.13 was achieved by PVC flooring covering. Emissions of material surfaces combination (C) constitute an unacceptable perceived indoor air quality conditions.

Table 4 : Combination C – Odor characteristic

Constructions	Material	Odor acceptability (-1/+1)	Odor intensity (0-5)
Flooring	PVC	0,08	1,13
Wall covering	Painted gypsum boards	0,1	2
Ceiling	Painted gypsum boards	0,1	2
Combination		-0,07	1,73

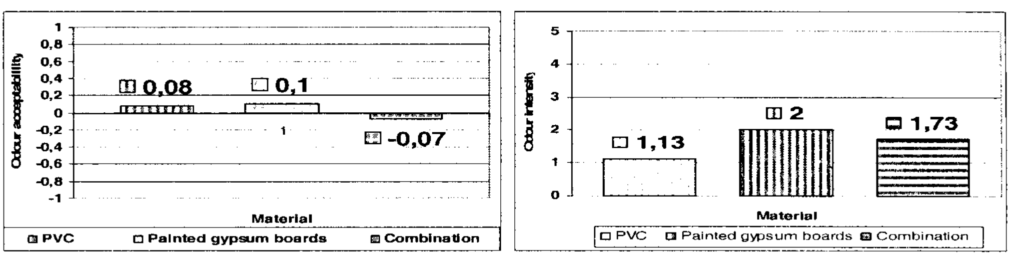

Figure 4 : Combination C – Odor acceptability and odor intensity

Perceived air quality of material surfaces combination (D) is represented by 95 % percentage of dissatisfied. OSB boards flooring covering was presented by -0.67 odor acceptability and 3.2 odor intensity. Odor acceptability -0.62 and odor intensity 2.7 were evaluated in the case of this interior materials combination. All materials and material surfaces combination except painted gypsum boards did not meet the perceived indoor air quality criteria of odor acceptability and odor intensity.

Table 5 : Combination D – Odor characteristic

Constructions	Material	Odor acceptability (-1/+1)	Odor intensity (0-5)
Flooring	OSB board	-0,67	3,2
Wall covering	Painted gypsum boards	0,1	2
Ceiling	Painted gypsum boards	0,1	2
Combination		-0,62	2,7

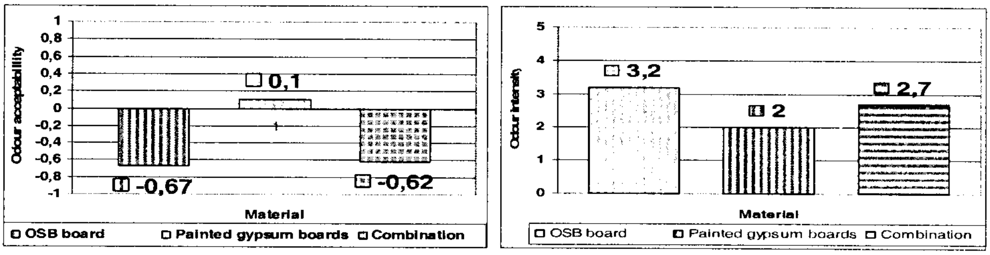

Figure 5 : Combination D – Odor acceptability and odor intensity

Material surfaces combination (E) perceived air quality is represented by the percentage of dissatisfied by 75 %. HDF laminate flooring covering was presented by -0.38 odor acceptability and 2.1 odor intensity. Odor acceptability -0.24 and odor intensity 1.6 were evaluated in the case of this interior materials combination, therefore this combination did not meet perceived indoor air quality criteria of odor acceptability. Painted gypsum boards for wall and ceiling covering were presented by 0.1 odor acceptability and 2 odor intensity.

Table 6 : Combination E – Odor characteristic

Constructions	Material	Odor acceptability (-1/+1)	Odor intensity (0-5)
Flooring	HDF Laminate Flooring	-0,38	2,1
Wall covering	Painted gypsum boards	0,1	2
Ceiling	Painted gypsum boards	0,1	2
Combination		-0,24	1,6

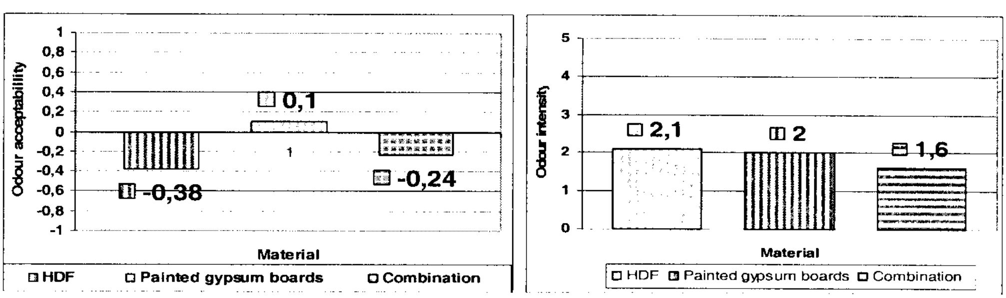

Figure 6 : Combination E – Odor acceptability and odor intensity

Sensory Assessments

Measured TVOCs emissions concentration of material surfaces combination (A) represent value 11.1 μg/m3, therefore this combination met the indoor air quality criteria. The material emissions concentration was below estimated limit 200 μg/m3. The highest emissions concentration 18.1 μg/m3 of painted gypsum boards was measured and the emissions 9.7 μg/m3 of polyamide carpet flooring covering was obtained.

Table 7 : Combination A – TVOCs emissions

Constructions	Material	TVOCs (μg/m^3)
Flooring	Polyamide carpet	9,7
Wall covering	Painted gypsum boards	18,1
Ceiling	Painted gypsum boards	18,1
Combination		11,1

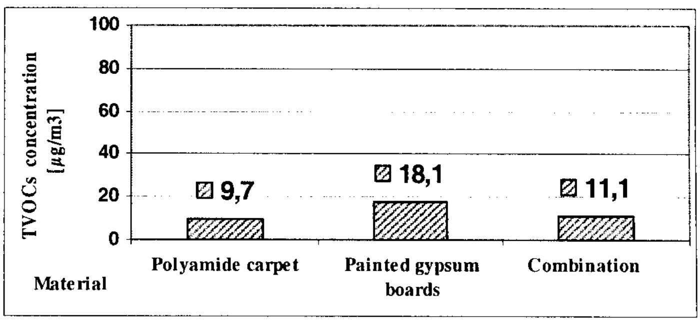

Figure 7 : Combination A – TVOCs emissions

Material emissions of interior surfaces combination (B) met the limit value 200 μg/m3. Measured TVOCs emissions of material combination represent value 9.7 μg/m3. The TVOCs emissions concentrations 7.5 μg/m3 of wooden parquet was obtained. The highest TVOCs emissions concentration 18.1 μg/m3 of painted gypsum boards was measured.

Table 8 : Combination B – TVOCs emissions

Constructions	Material	TVOCs (μg/m^3)
Flooring	Wooden parquet	7,5
Wall covering	Painted gypsum boards	18,1
Ceiling	Painted gypsum boards	18,1
Combination		9,7

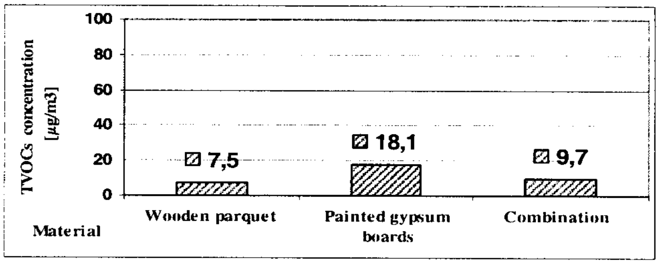

Figure 8 : Combination B – TVOCs emissions

Material emissions of interior surfaces combination (C) met the limit value 200 µg/m3. Measured TVOCs emissions of material surfaces combination represent value 22.5 µg/m3. The highest TVOCs emissions concentrations 40.3 µg/m3 of PVC was obtained. The TVOCs emissions concentrations 18.1 µg/m3 of painted gypsum boards was obtained.

Table 9 : Combination C – TVOCs emissions

Constructions	Material	TVOCs ($\mu g/m^3$)
Flooring	PVC	40,3
Wall covering	Painted gypsum boards	18,1
Ceiling	Painted gypsum boards	18,1
Combination		22,5

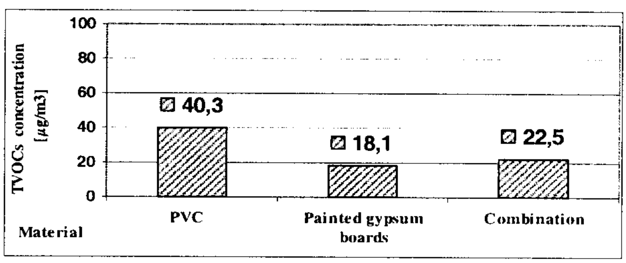

Figure 9 : Combination C – TVOCs emissions

Material emissions of interior surfaces combination (D) met the limit value 200 µg/m3. Measured TVOCs emissions of material combination represent value 52.3 µg/m3. The TVOCs emissions concentrations 44.8 µg/m3 of OSB was obtained.

Table 10 : Combination D – TVOCs emissions

Constructions	Material	TVOCs ($\mu g/m^3$)
Flooring	OSB board	44,8
Wall covering	Painted gypsum boards	18,1
Ceiling	Painted gypsum boards	18,1
Combination		52,3

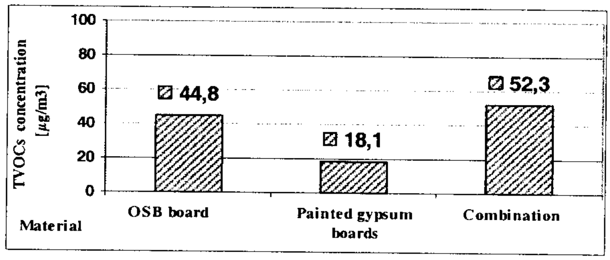

Figure 10 : Combination D – TVOCs emissions

Material emissions of interior surfaces combination (E) met the limit value 200 μg/m3. Measured TVOCs emissions of material combination represent value 28.7 μg/m3. The TVOCs emissions concentrations 21.5 μg/m3 of HDF was obtained.

Table 11 : Combination E – TVOCs emissions

Constructions	Material	TVOCs ($\mu g/m^3$)
Flooring	HDF Laminate flooring	21,5
Wall covering	Painted gypsum boards	18,1
Ceiling	Painted gypsum boards	18,1
Combination		28,7

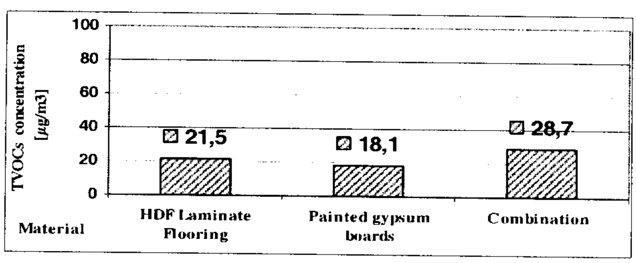

Figure 11 : Combination E – TVOCs emissions

Conclusion

The presented results are still not sufficiently described. The sorption processes are indicated especially by combination of surface interior materials. The impact of indoor materials on perceived air quality and odor intensity is discussed within the paper. The higher TVOCs values and higher odor intensity were observed for flooring materials. In the case of OSB flooring covering individually and its combination with painted gypsum board the measured values were the most unacceptable. Only the case of PVC and gypsum board combination showed better measured values than the individual materials themselves. The results demonstrate the various sorption abilities of various indoor materials as well as various sorption ability of the same indoor material in various combinations. The challenges of various indoor chemical interactions are to be studied constantly.

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