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INFLUENCE OF CLASSIC FINISHED SURFACES OF MASSIVE WOOD ON INDOOR ENVIRONMENT

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Abstract

In this paper there is discussed the influence of classic finished surfaces of wooden massive materials, such as oak, cherry and oak on indoor environment. The article investigates the problematic of quantitative and qualitative compositions of VOC emissions emitted by classic finished surfaces of massive wood such as oak, cherry and oak with finished surfaces by classic coatings materials shellac varnish, wax coating materials dissolved in solvent turpentine, oil-based coating materials. The volatile organic compounds evaporated by tested finished surfaces were measured and analysed by GC-MS chromatography with the thermal desorption. The results of the observing odor intensity in the dependent on the amount of odorants emitted volatile compounds contains the article too.

Key words*: GC-MS chromatography; shellac varnish; odor intensity; wax emissions.*

INTRODUCTION

Clean air, healthy environment has the significant influence of the quality of human life. The industry production belongs among main sources, which reduce well-being and decrease the quality of air and environment. One of the most important branches of the industry production to have the influence of the air quality is the finishing or coating surfaces of the products by liquid coating materials.

So the investigation of quality of air is aimed on the measurement of the quantitative and qualitative composition of VOC (volatile organic compounds emissions) emitted during the finishing wooden based furniture surfaces. The investigation of the influence of coated materials and their solvents on the amount and on the composition of evaporated VOC emissions during the conversion the liquid paints and lacquers into solid finished surfaces has been aimed on the coated materials but the influence of the classic coated materials during their conversion on the solid finished surface on the quality of indoor air in the workshop hasn’t been measured yet.

This article is interested in VOC emissions emitted by classic coating materials such as classic wax dissolved by turpentine, shellac varnish during their conversions in solid finished surfaces.

One of the most using classic solvent for solving especially wax materials is used the nature solvent turpentine. Turpentine is a fluid obtained by the distillation of resin obtained from live trees, mainly pines. Turpentine is composed of terpenes, mainly the monoterphenes, alpha-pinene and beta-pinene with lesser amounts of carene, camphene, dipentene, and terpinolene.[2].

The emissions emitted by the different kinds of finished surfaces have the odor intensity in dependent on the amount of odorants emitted by the coated materials during their changing into finished surfaces. The exposure of quantity of TVOC to human olfactory system and the influence of the different olfactory stimuli on the human body, expressed as the intensity of sensation and hedonic tone.

In the scientific literature there is no information about the hedonic impact of emitted VOC emissions by the classic coated materials.

OBJECTIVES

This work brings new information in: the influence of the emissions VOC, which are emitted by classic coating materials during the curing and drying of the finished surfaces, on quality indoor air in working environment, the identification the volatile organic compounds emitted by classic coating materials during their changes from the liquid phase into the solid phase of the finished surfaces, the identification the main components and their contributing to odors activity of VOC emissions emitted by classic finished surfaces, the comparison the amount of TVOC emitted by the classic finished

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surfaces and the modern water borne finished surfaces, this work solves the odor impact of the individual chemical compound in the correlation with the concentration of measured VOC emissions
Tested materials: the following materials were used during the tests:
Classic finished surfaces: shellac lacquers, lacquers wax solved by turpentine
Modern contemporary finished surfaces: water borne lacquers, oils lacquers,
The coating materials were coated non the inert bases, glass, dimensions 200mm x 200mm x 4mm
The amount of coated materials on the sample of glass were 100g.m-2

METHOD, MATERIALS AND EQUIPMENT

The following standards were applied for measuring the VOC emissions: ISO 16000 (2004) Indoor air, ISO 16000-1 (2004) General aspects of sampling strategy, ISO 16000-5 (2005) Measurement strategy for (VOC) volatile organic compounds, ISO 16000-11 (2004) Determination of the emission of volatile organic compounds – Sampling, storage of samples and preparation of test specimens, ISO 16000-6 (2005) Determination of volatile organic compounds indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and chromatography using MS/FID, ČSN EN 13 725: Quality of Air – Determination of concentration of odour matters by dynamic olfactometry

The test method with these steps:

1. lacquers are coated on the glass
2. glass with lacquers is weighted
3. Immediately after the coating lacquers the emissions are collected on TENAX TA in the thermal desorption, time of collection 1200s.

Fig. 1.
Equipment for measuring emitted emissions

The following equipment was used for collection and analysis VOC:

a. Short path thermal desorption tube, Silco trated Thermal Desorption Tube 786090-100, inner diameter 4mm, fill in with 100mg of Tenax TA (Scientific Instrument Services company) for collection of VOC emissions emitted from tested samples in to the air in chamber
b. Air sampler Gilian-LFS 113 SENSIDINE with air flow 6l/h and 12l/h
c. Gas chromatograph Agilent GC 6890N with MS (mass spectrometer) detector 5973 with cryofocusation, thermal desorption and library of spectra NIS 05, column type HP – 5 (AGILENT)
d. Gas chromatograph with detector FID Agilent 4890
e. Sniffer 9000
f. Weight

Fig. 2.
Equipment for testing VOC emissions

Tested materials: the following materials were used during the tests:
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Modern contemporary finished surfaces: water borne lacquers, oils lacquers,
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RESULTS AND DISCUSSION

The quantitative and qualitative composition of VOC emitted by turpentine, by shellac lacquers, oils and water borne lacquers are published In the table 1 -10 for the comparison the emitted emissions. On the figures 4, 5, 6 and 8 there are the comparisons of VOC emitted emissions. On the figure 7 there is duplicated hedonic tone of shellac lacquers.

Table 1

Emissions emitted by turpentine, solvent in classic finished surfaces

Compounds volatile organic	Percentage of contains % volume
α-Pinene	44
3-Carene	37
Limonene	4
δ-Carene	5
Diethyl-Phthalate	7
Other compounds	3

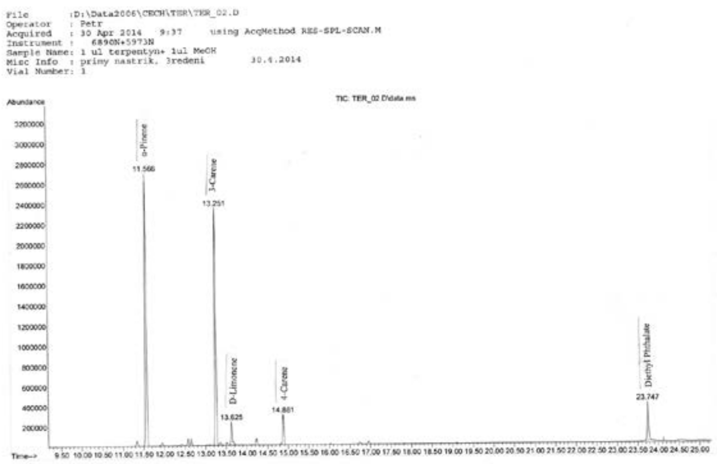

Fig. 3.
Chromatogram of VOC emissions emitted by turpentine

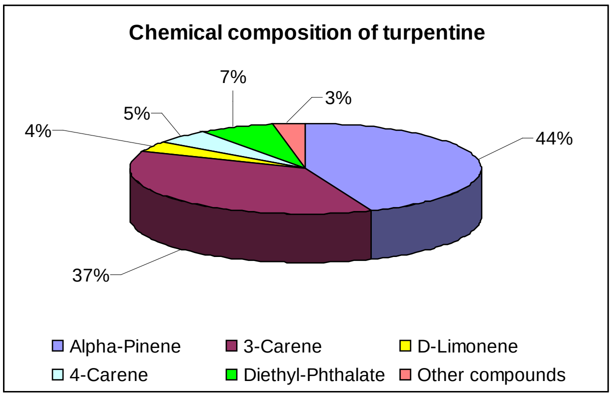

Fig. 4.
Chemical composition of Turpentine

Table 2

Emissions emitted shellac lacquer

Number	Compounds	SHELLAC_1	SHELLAC_2	Blanc	Hygienic Limite **
	Units	µg/m^3	µg/m^3	µg/m^3	µg/m^3
1	Ethyl acetate	(710.3 ± 213.1)	(1877.5 ± 563.3)	(138.2 ± 41.5)	NLK
2	Benzene	(0.6 ± 0.2)	(0.6 ± 0.2)	(0.3 ± 0.1)	7
3	1-Methoxy-2-Propanole	(13.7 ± 4.1)	(13.8 ± 4.1)	(25 ± 7.5)	NLK
4	Pentanale	(5.2 ± 1.6)	(5.3 ± 1.6)	(3 ± 0.9)	NLK
5	Trichlorethylene	(0.1 ± 0.03)	(0.1 ± 0.03)	< 0.1	150
6	Toluene	(1250.5 ± 375.2)	(2695.5 ± 808.7)	(420 ± 126)	300
7	Hexanale	(14 ± 4.2)	(25.8 ± 7.7)	(6.3 ± 1.9)	NLK
8	Tetrachlorethylene	(0.1 ± 0.03)	(0.1 ± 0.03)	(0.1 ± 0.03)	150
9	n-Butyl acetate	(195.7 ± 58.7)	(198.1 ± 59.4)	(184 ± 55.2)	NLK
10	Ethylbenzene	(40.1 ± 12)	(39.2 ± 11.8)	(42.6 ± 12.8)	200
11	m,p-Xylene	(129 ± 38.7)	(129.5 ± 38.9)	(120.3 ± 36.1)	200
12	Styrene	(262.8 ± 78.8)	(238.7 ± 71.6)	(58.2 ± 17.5)	40
13	o-Xylene	(21.9 ± 6.6)	(20.1 ± 6)	(18.7 ± 5.6)	200
14	Butoxy-Ethanole	(22.6 ± 6.8)	(22.5 ± 6.8)	(28.9 ± 8.7)	NLK
15	α-Pinene	(0.8 ± 0.2)	(0.8 ± 0.2)	(0.5 ± 0.2)	NLK
16	Camphene	< 0.1	< 0.1	(0.1 ± 0.03)	NLK
17	3-Ethyl-Toluene	(8.5 ± 2.6)	(7.4 ± 2.2)	(3.7 ± 1.1)	NLK
18	4-Ethyl-Toluene	(3.8 ± 1.1)	(5.2 ± 1.6)	(1.8 ± 0.5)	NLK
19	1,3,5-Trimethyl-Benzene	(4.5 ± 1.4)	(4.9 ± 1.5)	(1.2 ± 0.4)	NLK
20	β-Pinene	< 0.1	< 0.1	< 0.1	NLK
21	2-Ethyl Toluene	(3.3 ± 1)	(3 ± 0.9)	(1.5 ± 0.5)	NLK
22	Myrcen	< 0.1	< 0.1	< 0.1	NLK
23	1,2,4-Trimethyl-Benzene	(30.2 ± 9.1)	(24.4 ± 7.3)	(11.6 ± 3.5)	NLK
24	α-Phellandrene	< 0.1	< 0.1	< 0.1	NLK
25	3-δ-Carene	(0.5 ± 0.2)	(0.5 ± 0.2)	(0.3 ± 0.1)	NLK
26	1,2,3-Trimethyl-Benzene	(7 ± 2.1)	(6.2 ± 1.9)	(1.4 ± 0.4)	NLK
27	Limonene	(2.6 ± 0.8)	(2.2 ± 0.7)	(1.3 ± 0.4)	NLK
28	γ-Terpinene	< 0.1	< 0.1	< 0.1	NLK
29	Bornyl Acetate	(0.2 ± 0.1)	(0.3 ± 0.1)	(0.3 ± 0.1)	NLK
30	$TVOC_{MS}$	(2741 ± 822)	(4496 ± 1349)	(548 ± 164)	NLK

Table 3

Emissions emitted by two kinds of teak Oils

Surafce	Blanc	Glass	Glass
Oil	Blanc	Oil Teak	Oil Teak
VOC	ug.m-3		
Formaldehyde	0,0	0,0	0,0
Ethyl acetate	35,7	26,4	8,4
Benzene	0,7	0,7	0,3
I-methoxy-2-propanole	6,2	6,7	2,0
Pentanale	2,2	5,6	0,3
Trichlorethylene	0,2	0,4	0,2
Toluene	133,0	547,9	68,1
Hexanale	9,4	333,6	26,2
Tetrachlorethylene	0,2	0,4	0,2
n-Butyl acetate	6,6	89,4	30,1
Ethylbenzene	7,6	11,0	4,5
Σ m,p-Xylene	29,2	48,1	20,0

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Styrene	0,2	0,6	0,2
o-xylene	4,8	10,2	4,2
Butoxy-Ethanole	0,5	2,6	1,1
α-Pinene	1,0	539,7	160,8
Camphene	0,0	5,9	1,7
3 nebo 4-Ethyl-Toluene	1,5	3,1	1,1
1,3,5-Trimethyl-Benzene	0,6	1,1	0,4
β-Pinene	0,4	309,6	98,5
2-Ethyl Toluene	0,6	4,7	1,5
Myrcene	0,0	0,0	0,0
1,2,4-Trimethyl-Benzen	2,7	5,0	1,7
α-Phelandren	0,0	0,0	0,0
3-δ-Carene	0,2	1,0	0,3
1,2,3-Trimethyl-Benzen	0,7	1,0	0,3
Limonene	1,3	77,6	30,9
γ-Terpinene	0,0	0,9	0,4
Bornyl Acetate	0,0	0,0	0,0
Suma VOC	245,6	2033,3	463,3
TVOC	323,7	3226,7	3362,9

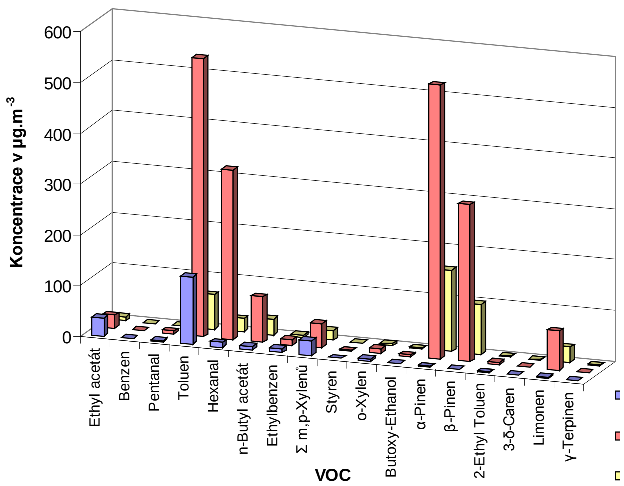

Fig. 5.
Emissions VOC emitted by oils (teak)
Red sample 1, Yellow sample 2, Blue blackground

Table 4

Emissions of water borne lacquers

VOC	Background	Water borne lacquers		
		1	*2*	*3*
Formaldehyde	0	0	0	0
Ethyl acetate	149,2	7,2	206,4	107,7
Benzene	2,3	2,0	2,5	2,1
1-Methoxy-2-propanole	3,7	0,5	0,2	0,2
Pentanale	0,5	0	0,8	0,4
Toluene	52,3	49,6	128,4	69,4
Hexanale	0,8	0,7	1,5	1,0
n-Butyl acetate	194,0	147,5	311,4	188,2
Ethylbenzene	56,0	48,2	106,8	60,7
m,p-Xylene	184,0	163,7	347,3	192,7
Styrene	0,4	0,4	1,0	0,5
o-xylene	23,6	22,8	52,9	25,7
Butoxy-Ethanole	0	1,8	0	0
a-Pinene	1,9	1,9	2,52	1,5

Camphene	0,1	0,1	0,1	0,2
3 nebo 4-Ethyl-Toluene	1,30	0,8	8,2	0,9
1,3,5-Trimethyl-Benzene	0,2	0	0	1,5
2-Ethyl Toluene b-Pinene	1,2	0,2	0,3	0,1
Myrcene	0,4	0,9	1,8	0,9
1,2,4-Trimethyl-Benzene	5,7	0,4	0,8	1,3
a-Phelandrene	0	0,5	0,	0
3-d-Carene	3,3	3,5	6,5	4,1
1,2,3-Trimethyl-Benzene	1,0	0,8	1,5	1,0
Limonene	2,8	2,4	4,9	3,6
g-Terpinene	0,1	0,1	0,1	0,1
Bornyl Acetate	0	0,1	0,1	0,1
ΣVOC	684,9	459,9	1194,0	667,9
TVOC	678	2493	3137	2274

Table 5

Hedonic tone and intensity of odors

Emitted emission VOC by tested coating materials during the drying, curing and forming lacquer films										
very unpleasant	unpleasant	mind it	could mind it	rather don´t like it	Don´t mind it	rather like it	could like it	Pleasant	Very pleasant	Very pleasant glow
- 5	- 4	- 3	- 2	- 1	0	1	2	3	4	5

Table 6

Hedonic tone of shellac lacquers

VOC	Shellac lacquers
after application (h)	24
Toluene	-2
Σ m,p-Xylene	-1

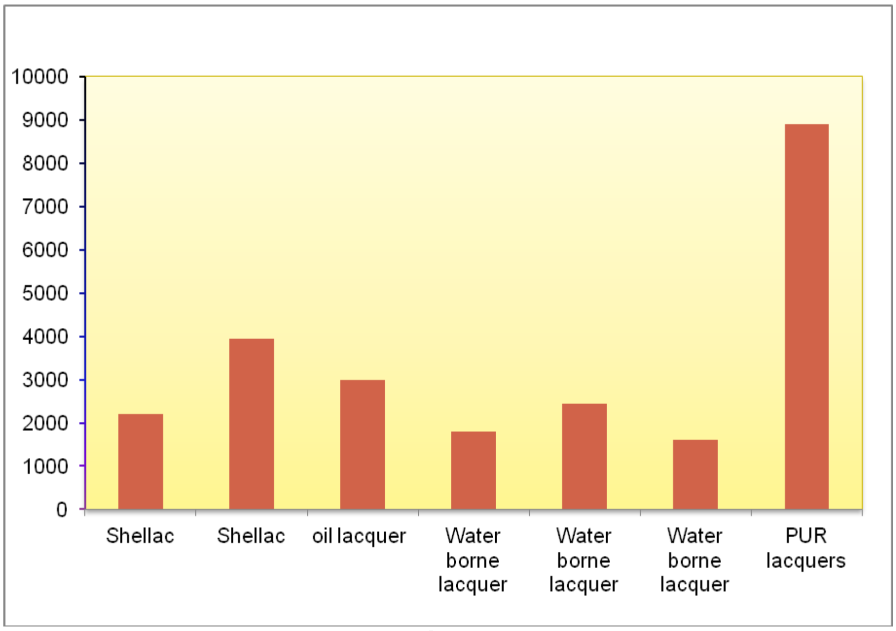

Fig. 7.
Emitted emission TVOC by tested coating materials during the drying, curing and forming lacquer films

CONCLUSIONS

Classical coating materials have approximately the same influence on quality of air in working indoor environmental as the modern coating materials so called ecological lacquers.

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