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QUALITY INSPECTION OF NAIL POLISH REMOVERS AND ASSESSMENT OF HEALTH HAZARD ASSOCIATED WITH THE USE OF THE REMOVERS

KONTROLA JAKOŚCI ZMYWACZY DO PAZNOKCI ORAZ OCENA ZAGROŻENIA ZDROWIA PRZY ICH STOSOWANIU

Abstract: The volatile organic compounds content in nail polish removers available on the home market was determined. Qualitative and quantitative analyses of acetone, methanol, ethanol, isopropanol and ethyl acetate were performed. Theoretical VOCs concentrations in the standard room and time for reduction to low values were calculated.

Keywords: nail polish removers, volatile organic compounds, indoor air quality

According to accessible literature, people spend about 80% of the time in the indoor areas [1-3]. For reasons of safety, the indoor air quality (IAQ) is important. Nitric and carbon oxides, volatile organic compounds (VOCs) and particulates are the most common indoor air pollutants [3]. One of sources of VOCs are consumer products, such as paints, polishes, cleaning products, deodorizers, glues, sealants and cosmetics.

Components of nail polish removers directly react on a nail plate. Due to this fact, in recent years producers have limited use of acetone in nail polish removers. Acetone dries a nail plate when it is often used. Other solvents, eg ethyl acetate, are gentler [4].

Taking into account the hazardous effects of acetone, consumers, examining the declared by producers ingredients used to production, nowadays choose acetone free products more often than they used to. Considering the cost of chemical agents, production of acetone free products is obviously more cost-consuming than production of the removers containing acetone. This fact may be used by unfair producers to reduce costs. The goal of this work was studies of available on the home market nail polish removers and determination of VOCs emission to indoor air.

Materials and methods

Nail polish removers available on the home market where used as the samples. The products were grouped into two classes: 10 removers with declared acetone content (class A) and 7 acetone-free removers (class B).

The studies of VOCs content in nail polish removers were performed by gas chromatography method. The applied method enables a selective determination of organic solvents in consumer products.

The samples of analyzed product (5 mm^3 of nail polish removers) were injected into 1114 cm^3 glass containers, tightly closed with the screw caps containing the silicon membranes. After equilibration the gas samples were drawn with a Hamilton gas-tight syringe and analyzed on a gas chromatograph. The qualitative and quantitative analyses of

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polish removers components were performed using a CHROM 5 gas chromatograph with FID detectors. The chromatograph was provided with two steel chromatographic columns. Column I was 2 meter long of 3 mm inside diameter packed with 8% SE-30 + 0.21% Carbowax 20M on Chromosorb W NAW (60÷80 mesh). Column II was 1 meter long of 3 mm inside diameter packed with Chromosorb 102 (80÷100 mesh). The following temperatures were applied: column I 50ºC, column II 100ºC, injectors 120ºC, detectors 150ºC. Nitrogen (40 $cm^3 \cdot min^{-1}$) was used as the carrier gas. Identification of removers' ingredients was performed on the both columns. Quantitative analyses of ethyl acetate and *n*-butyl acetate were performed on column I. Analyses of acetone, methanol, ethanol and isopropanol were performed on column II. The apparatus was calibrated using standard gas mixtures prepared in the same containers in which the measurements were carried out.

Results and discussion

17 samples of nail polish removers were examined. Results of the analyses of VOCs content in the examined samples are given in Table 1.

Table 1

Contents of volatile organic compounds in the nail polish removers

Product	Substance	Content in product [g·100 cm^{-3}]	Summary VOCs content in product [g·100 cm^{-3}]
A1	acetone	18.62	18.62
A2	acetone	76.75	76.75
A3	acetone	58.80	70.32
	ethanol	11.52	
A4	acetone	75.88	75.88
A5	acetone	66.80	66.80
A6	acetone	70.83	70.83
A7	acetone	64.65	64.65
A8	acetone	59.17	65.82
	ethanol	6.65	
A9	acetone	71.63	71.63
A10	acetone	67.35	67.35
B1	acetone	50.42	72.21
	isopropanol	21.24	
	ethyl acetate	0.55	
B2	acetone	23.05	40.69
	methanol	17.64	
B3	methanol	5.64	71.15
	ethanol	23.76	
	ethyl acetate	41.75	
B4	acetone	17.39	84.12
	methanol	66.73	
B5	acetone	1.67	94.66
	methanol	0.30	
	ethanol	9.06	
	isopropanol	31.94	
	ethyl acetate	51.69	
B6	acetone	45.01	65.49
	isopropanol	20.48	
B7	methanol	0.07	87.39
	isopropanol	2.26	
	ethyl acetate	85.06	

Substances contained in nail polish removers may significantly affect indoor air quality. For that reason an attempt to determine concentration of those substances in indoor air was undertaken.

In order to determine the average use of nail polish removers a group of 10 women was questioned. The average use was determined to be 2.5÷4 cm^3 of product. Considering very high volatility of nail polish removers ingredients it may be assumed that all the ingredients are emitted into the air in very short time being a source of VOCs emission, the initial concentrations of VOCs in the standard room of volume 17.4 m^3 [5] were calculated. Results are presented in the Table 2. VOCs concentrations were strongly high (> 3 $mg \cdot m^{-3}$) [6] and were in the majority of cases over 100 $mg \cdot m^{-3}$.

Table 2

The initial concentrations of VOCs in the standard room and the time to reduce of concentrations to low values

Product	**VOCs emission [g]**	**Initial average concentration of VOCs [mg·m^{-3}]**	**Time to reduce of VOCs concentration to 0.25 mg/m^3 [h]**
A1	0.47÷0.74	34.78	7.12
A2	1.92÷3.07	143.35	9.16
A3	1.76÷2.81	131.34	9.04
A4	1.90÷3.04	141.73	9.15
A5	1.67÷2.67	124.77	8.96
A6	1.77÷2.83	132.30	9.05
A7	1.62÷2.59	120.75	8.92
A8	1.65÷2.63	122.94	8.94
A9	1.79÷2.87	133.79	9.06
A10	1.68÷2.69	125.80	8.97
B1	1.81÷2.89	134.88	9.08
B2	1.02÷1.63	76.00	8.25
B3	1.78÷2.85	132.90	9.05
B4	2.10÷3.36	157.12	9.30
B5	2.37÷3.79	176.81	9.47
B6	1.64÷2.62	122.32	8.93
B7	2.18÷3.50	163.23	9.35

The time necessary to reduce the concentration of VOCs in the standard room to low concentration level (0.25 $mg \cdot m^{-3}$) was determined [6]. Changes of VOCs concentration in the standard room may be presented in a geometric progression:

$$C_t = C_0 \cdot N^t$$

where: C_0 - initial concentration, C_t - concentration at the time t, N - air exchange rate, t - time.

Concentration of volatiles in indoor air is regarded as a low, when its values is below 0.25 $mg \cdot m^{-3}$ [6]. Transforming the above relation we obtain relation from which we may calculate the time necessary to reach the assumed concentration:

$$t > \frac{\log 0.25 - \log C_0}{\log N}$$

To estimate the necessary time to obtain concentrations below 0.25 $mg \cdot m^{-3}$, an average air exchange rate N of 0.5 h^{-1} was applied [5]. Results of calculations are presented in

Table 2. The time to reduce of VOCs concentrations to low values appears to be in the range of 7÷9.5 hours.

Conclusions

Analyses of 17 nail polish removers available on the home market were performed. In the products there were identified very volatile organic compounds such as acetone, methanol, ethanol, isopropyl alcohol and ethyl acetate.

Calculated VOCs concentrations in the standard room during application of the tested products are strongly increased. Nail polish removers are a significant source of VOCs emission into the indoor air. The time to reduce of VOCs concentrations to low values appears to be in the range of 7÷9.5 hours.

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KONTROLA JAKOŚCI ZMYWACZY DO PAZNOKCI ORAZ OCENA ZAGROŻENIA ZDROWIA PRZY ICH STOSOWANIU

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Abstrakt: Przeprowadzono badania zawartości lotnych składników zmywaczy do paznokci dostępnych na rynku krajowym. W badanych produktach zidentyfikowano i oznaczono ilościowo aceton, metanol, etanol, izopropanol i octan etylu. Określono teoretyczne stężenia lotnych związków organicznych wydzielających się ze zmywaczy do paznokci w pomieszczeniu standardowym i wyznaczono czas niezbędny do uzyskania niskich wartości tych stężeń.

Słowa kluczowe: zmywacze do paznokci, lotne związki organiczne, jakość powietrza wewnętrznego