ODOR DETECTION THRESHOLD
OF \(n\)-BUTANOL IN INDOOR AIR

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DLA MIESZANIN \(n\)-BUTANOŁU I POWIETRZA WEWNĘTRZNEGO

Summary: The concentrations of the odor detection threshold \(C_{th}\) for \(n\)-butanol in mixtures with indoor air were determined for individual assessors as well as for the whole sensory panel. 22 panelists that participated in the odor sensory assessment in more than two sessions were recognized as trained. The rest of the research participants constituted the so-called untrained panel. 684 results of the sensory determination of the \(C_{th}\) concentrations were statistically analyzed. The obtained results were categorized according to the gender, age and sensory assessing practice of the panelists. The dependencies show that the women in the trained panel are distinguished by a lower \(C_{th}\) concentration. The age of the panelists who assessed the odors was also important in determining the \(C_{th}\) concentrations. The research participants were divided into two age groups. The first one consisted of assessors that were younger than 25 years of age, the second made up people that were 25÷50 years of age. In case of the latter group the \(C_{th}\) concentrations were higher. It has been also stated that most likely there is a way to train people to assess odors which enables to lower their \(C_{th}\) concentrations. The presented results together with further research concerning other typical indoor air odor pollutants may explain why women more often suffer from the negative effects connected with the so-called sick building syndrome - SBS. Moreover, they may indicate the way to select the sensory panels depending on the purpose of the building and the diversification of the people using it.

Keywords: sensory measurement, differences in odor perception, odor pollutants, odor detection threshold, \(n\)-butanol, indoor air quality

Olfactory is measurement of the responses of assessors to olfactory stimuli. Odor detection threshold is such odorant concentration which odor is detected by half of sensory panel members. The panel members are assessors who are qualified to judge samples of odorous gases and are representative for a population [1]. Most of researchers indicates that odor detection threshold is dependant on the people’s gender and age [2-4]. The demonstrated differences concern both the intensity, the hedonic tone and the detection threshold concentrations \(C_{th}\) of the odorants. Assuming that these differences do exist, they should be taken into account during the indoor air quality assessment. The age and gender of the room users shall then be important while assessing the effects connected with the sick building syndrome (SBS) or the so-called multiple chemical sensitivity (MCS) [5, 6]. This data can also be significant for research and actions dedicated to the improvement of the perceived indoor air quality. For example the age and gender shall be significant for the correct selection of the sensory panel [4]. The results of the tests shall then have direct practical implications. The odor pollutants in the air in concentrations exceeding their detection thresholds deteriorate the indoor air quality [7]. Therefore the knowledge of the detection threshold concentrations \(C_{th}\) of typical indoor air odor pollutants is so important. The \(C_{th}\) of bioefluents emitted by people are important as well. The aim of this paper was to determine the detection threshold of \(n\)-butanol, which can be considered as a model

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substance [1, 8] and to make these thresholds conditional upon the gender, age and assessing practice of the sensory panel.

**Experimental procedures**

The sensory analysis and sample preparations were carried out in an air quality laboratory at the Faculty of Environmental Engineering of the Lublin University of Technology. The scheme of odor assessments set up and the sample preparation procedure is shown in Figure 1.

![Scheme of measurement setup and sample preparation procedure](image)

Fig. 1. Scheme of measurement setup and sample preparation procedure

The odor detection threshold concentrations of \( n \)-butanol in dynamically diluted mixtures with indoor air were evaluated using a modified ECOMA TO7 olfactometer [9]. The olfactometer with diffuser tubes for sensory assessments together with the assessors’ seats were located inside the environmental chamber. The dosimetric and control part of the olfactometer was beyond the assessors’ view. Charcoal-filtered and conditioned outdoor air with the temperature of 23°C and the relative humidity of 45% and flow of 0.9 dm\(^3\)/s was supplied to the environmental chamber through the inlet located on the bottom of the wall.
opposite the chamber’s entrance. The exhaust air exited the chamber through two outlets situated over the olfactometer diffusers (Fig. 1) and was directed to the ventilation system exhaust in order to avoid the contamination of the room’s air.

The sensory panel consisted of both male and female, trained and untrained, non-smoking persons. 22 panelists that participated in the odor sensory assessing in more than two sessions were recognized as trained [1]. The rest of the research participants constituted the so-called untrained panel. The sensory panel was divided into two age groups. The first group consisted of panelists under 25 years of age and the second group consisted of panelists form 25 to 50 years of age. 684 results of the sensory determination of the $C_{th}$ concentrations were statistically analyzed [1, 10, 11]. Each sample was evaluated by at least twelve panelists. The sessions of the $C_{th}$ evaluation consisted of three series. Between the series there were short, few minute breaks. During each series the panelists had to assess not only samples with the given mixture, but also blank samples (clean, odorless air) in randomized order [12]. The blank samples constituted 20% of all the assessed samples. The mixture inhalation time was set to 2.2 s.

**Results and discussion**

Data obtained for trained and non-trained panels and for different gender and age groups are presented in Figures 2-4. The mean odor detection threshold concentration values of $n$-butanol in mixtures with indoor air for groups of men and women are presented in Figure 2. This figure also presents the dependency of $C_{th}$ on the level of training of the sensory panel.

![Fig. 2. Odour detection threshold concentration in dependences on gender and training of assessors](image)

It can be seen from the diagrams that women are characterized by a lower odor detection threshold concentration than men. This applies for both trained and untrained panelists. Generally it can be stated that training the sensory panel causes the lowering of the $C_{th}$. Such changes which are dependant on the participation of the same group of men and women in subsequent sessions are shown in Figure 3.
Fig. 3. Odor detection threshold concentration in dependence on sensory sessions

For both gender groups the participation in subsequent sessions resulted in the lowering the odor detection threshold for the investigated n-butanol in the mixtures with indoor air. Therefore, it can be stated that most likely there is a way to train people to assess odors which will enable to lower their $C_{th}$ concentrations.

Attempts were also made to examine the influence of the assessors’ age on their ability to detect odors. The results of the initially conducted research suggest that such a dependency may take place. The $C_{th}$ value diagrams for the two age groups (under 25 years of age and 25÷50 years of age) for trained men and women are presented in Figure
4. It can be stated that younger panelists are characterized by a lower odor detection threshold. This concerns both men and women.

Fig. 4. Odor detection threshold concentration in dependence on age of assessors

Conclusions

On the basis of the initial research of the odor detection threshold concentrations of n-butanol in the mixtures with indoor air the following can be stated:
- women are characterized by a lower \( C_{th} \) concentrations of \( n \)-butanol,
- the untrained sensory panel is distinguished by higher \( C_{th} \) concentrations,
- the assessing practice of panelists lowers their \( C_{th} \) concentrations,
- higher \( C_{th} \) concentrations were observed for older panelists.

If the observed relations were confirmed by extended future research, also concerning other typical odor pollutants that are present in the indoor air, they could have many practical implications. In particular they could help to answer the question why women complain about problems connected with the effects of poor indoor environment quality more often than men. They could also indicate the way of selecting the indoor air quality assessors depending on the gender and age of the persons occupying the given room.

References

STĘŻENIA PROGOWEJ WYCZUWALNOŚCI WĘCHOWEJ DLA MIESZANIN n-BUTANOLU I POWIETRZA WewnĘTRZNEGO

Streszczenie: Zaprezentowano wyniki określania stężeń progowej wyczuwalności węchowej $S_{pw}$ dla n-butanolu w mieszaninach z powietrzem wewnętrzny. Stężenia te określono zarówno dla poszczególnych osób oceniających zapachy, jak i dla całego panelu testującego. Uzyskane wyniki, przedstawione w formie tabel i wykresów, skategoryzowano według płci i wieku oceniających, a także według tzw. stopnia wytrenowania. Za trenowane uznano 22 osoby uczestniczące w badaniach i oceniające zapach mieszanek n-butanolu i powietrza wewnętrznego na więcej niż dwóch sesjach pomiarowych. Pozostałe osoby uczestniczące w badaniach stanowiły tzw. panel nietrenowany. Zbiór wszystkich 684 wyników sensorycznego oznaczania stężen $S_{pw}$ poddano statystycznej analizie. Uzyskane zależności pozwoliły stwierdzić, że w trenowanym panelu kobiety charakteryzują się niższym stężeniem $S_{pw}$. Przy określaniu stężenia $S_{pw}$ istotny był również wiek osób oceniających zapachy. W pracy porównano te stężenia dla osób poniżej 25 roku życia i dla osób z przedziału wiekowego 25÷50 lat. Dla osób w wieku 25÷50 lat stężenia $S_{pw}$ były znaczno wyższe. Stwierdzono także, że istnieje realna możliwość trenowania osób oceniających zapachy, pozwalająca na obniżanie dla nich stężeń $S_{pw}$. Wyniki zaprezentowane w pracy, poszerzone o wyniki badań dla innych typowych zanieczyszczeń zapachowych, obecnych w powietrzu wewnętrznym, mogą mieć szereg praktycznych implikacji. Mogą między innymi tłumaczyć częstsze wśród kobiet występowanie negatywnych skutków związanych z tzw. syndromem chorych budynków - SBS. Ponadto mogą wskazywać, w jaki sposób dobierać panele testujące w zależności od przeznaczenia pomieszczeń i zróżnicowania osób użytkujących te pomieszczenia.

Słowa kluczowe: sensoryczne pomiary, różnice w percepce odorów, zanieczyszczenia zapachowe, stężenie progowej wyczuwalności węchowej, n-butanol, jakość powietrza wewnętrznego