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METHODS TO ASSESS THE PERCEIVED INDOOR AIR QUALITY

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Abstract: The perceived air quality in indoor environments is presently assessed by a combination of methods, developed and used for the characterization and quantification of indoor odor problems. In this paper the main principles of the methods are described. For a proper understanding of the different tools used in the odor research on different products we first consider the different odor methods used worldwide. After that specific examples of odor research on products with indoor applications will be taken of.
The goal is to create a basic and complete framework in developing an unequivocal gauge to evaluate the perceived air quality in indoor environments.

Keywords: perceived air quality, odor, measurement techniques.

1. Introduction

The human with a normal odor sense can differentiate between app. 10.000 odors. Presently no measuring device exists to directly evaluate the air quality perceived by humans [15]. The human odor organ assesses the entirely of an odor. The perception of air is greatly influenced by the effects of positive substances on the emotional senses of the room occupant.
Indoor air substances and odor active substances are present in every room. If certain perceptions of odors cannot be clearly attributed to common activities usually performed in rooms, such as cleaning or preparing food, but are emanating from various materials like building products, indoor materials or domestic appliances, odors may often cause fears concerning disturbances of health due to the emissions from materials [6].

Odorous substances are among the key factors that influence Indoor Air Quality (IAQ). Depending on the odor types, their concentration and intensity, they can cause a variety of discomfort to room occupants, resulting in negative side effects such as headaches, nausea and loss of appetite. Previous researches of the authors [10, 13, 14] have demonstrated that even in indoor air which is free of odor, there would still be a percentage dissatisfied, because the acceptance of the indoor air also depends on the presence of positive odors. It

has proven to be complicated to determine the threshold levels at which the odors commence to exhibit their negative effects. In particular, attempts to identify odors and their concentrations using detectors or electronic sensors have largely failed to deliver the required results.

2. Odor methods

2.1. Olfactometry

Odor concentration measurements are carried out by diluting an odorous air sample with odor free air and offering the dilutions to a panel of test subjects. The olfactometer consisting of a dilution unit, an operator cabin and several separate cabins for panelists, is generally built in a van. This offers the opportunity to move the olfactometer to measuring site instead of taking samples to the laboratory. This is an advantage especially in large projects. A partially flow of the dynamically diluted odorous air is simultaneously offered to the persons for assessment. These persons are seated in separated sniffing cabins, to prevent possible mutual influencing during observations. Each sniffing cabin has some cups, one of them flowing the diluted odorous air; from the other odor free air. The test subjects indicate from which cup the diluted odorous air comes; even though they may not observe a difference at times, they must make a choice. Five to seven odor dilutions are offered to the panelists successively, each dilution being higher in concentration. All observations results of the panelists are incorporated in a computer program, calculating the dilution factor where 50% of the panel is able to distinguish the diluted odorous air from odor free air. Odor free air is obtained through carbon filters. In order to keep the air in the odor measuring room odor free, this air is led over a special activated-carbon filter about 40 times an hour. Furthermore, a slight overpressure is maintained to prevent the leaking in of odorous air from outside. This procedure is in accordance with the draft European standard CEN TC 264/WG2 [1]. In the research on odor emissions from indoor products the olfactometry represents a mean to quantify emission rates from the products [11, 12]. Depending on the characteristics of a product a specific procedure for sample preparations is set up.

Type of projects:

- comparison of different components of a product with regard to odors, to be able to focus further actions at the essential odor emitting parts (for example the comparison of different parts of consumer electronics);
- determination of odor emission change of a product over them;
- to select low odor products;
- determination of the odor emission of a product at different stages in the production process, to find the stage which essentially causes the odor of the product; optimization actions can then be directed to that particular stage.

2.2. Aromagrammes

In olfactometry odors are assessed sensorically, no information being obtained about the composition of the odor. But the knowledge about specific compounds in the odor from a consumer product can be of value for optimization of that product or its

production process. For the purpose of getting more detailed information odors can be analyzed by a combination of sensory and analytical techniques, resulting in aromagrammes. The instrumental investigation of odors is performed by gas chromatographic analyses. Odorous compounds are brought on the chromatographic column, for example after concentration on an absorbent at very low temperature and by heating the absorbent quickly at the head of the column.

Usually the gas chromatogram is composed of many peaks, not all of them being important for the total odor. The odor character and intensity of each of the peaks is now determined separately in the following way. The end of the chromatographic column is connected with a splitter which leads part of the effluent to a detector and the other part to a sniffing-port. At this port the effluent is conditioned for sensory evaluation (humidification and dilution with clean air to reach the concentration of the original sample). The odors at the sniffing-port are detected as a function of time by a number of experienced odor researchers. In this way most of odor peaks can be evaluated and peaks with a certain specific odor can be recognized. In a next step all peaks of interest are identified with a combination of gas chromatography and mass-spectrometry (figure 1).

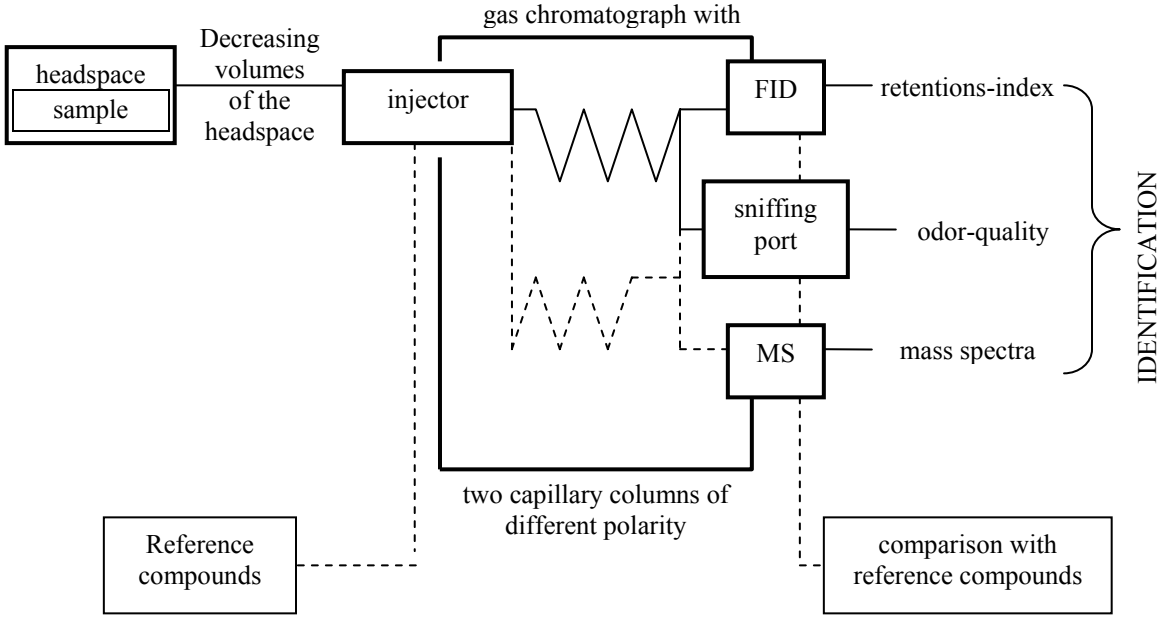

Figure 1. Principle of the combination of gas chromatography – olfactometry and gas chromatography- mass spectrometry

From these observations the contribution of the different known odor compounds to the total odor cannot be quantified in absolute terms (due to interactions between compounds in the perception), but it is certainly possible to give valuable indications. In a number of cases this has proven to be helpful in drawing up programs for odor reduction from consumer products [2, 9].

2.3. Decipol method

This method uses two units (olf and decipol) to quantify air pollution sources and perceived air quality indoors. In its development the decipol method has strongly been connected to research on the sick building syndrome [5]. Measurements on perceived air quality, to determine the value in olfs and decipols, are carried out with trained panelists. They assess the indoor air in, for example office buildings and value it with regard to perceived quality. The higher the value is, the worse the indoor air is in that case.

The decipol method is directly fully at the perception of an odor, with quality as the determining factor. Olfactometry may be seen as a complementary method, because it only measures amount of odor, without any link to quality. Knowing that perception does not totally depend on the quality of an odor, but partly also on the intensity/concentration a relation may be expected between results of olfactometry and decipol method on specific odors. A comparison of the two methods was made on a number of odor emitting consumer products, showing a useful relationships at higher odor loads [7].

Together with arommagrame method and olfactometry, the decipol method can be valuable in projects aiming at reduction of odor from indoor products. The decipol method may be used to assess the perception of odors from an optimized product in relation to the product at the start of the project.

The perceived air quality is expressed as follows:

$$PD = 395 \times EXP\ (-3{,}25 \times C^{-0{,}25}) \quad (1)$$

where PD is the percentage dissatisfied (%) and C is the perceived air quality (decipol) [5].

3. Practical examples

In the development of low-solvent paints other compounds than solvents have to be used in the paints to keep the adhesive properties and other characteristics at a suitable level. A number of these compounds appear to be odorous and give the paints another type of odor than the usual solvent-odor. Especially in indoor applications (decorative paints) this is an annoying in the search for solvent-free paints [8,9]. The previous methods offer the opportunity to improve the selection of base materials for the paints and to redesign the composition of some solvent-free paints.

By comparing the basic materials of consumer electronics the most important emitter of odors may be identified. As a first step different laminates types are compared with regard to odor emission by means of olfactometry. The samples with a known surface area are sealed in teflon bags filled with a known volume of clean and odorless air. The test samples are kept at a temperature of approximately 20^{o} C. The odor concentration in the bags is measured at different time intervals after the start of the experiments. On the basis of the measurements the odor emission rates were calculated and expressed in odor units per square meter and per day.

With the value for odor emission of a certain type of laminate, tentative calculations can be made on the odor concentration in indoor air in rooms with new electronic appliances. In this case information is needed about the surface area of printed

circuit board available in the appliances, about the volume of the relevant indoor space and about the aeration rate.

Recent studies [3,4,14] were performed on television sets to compare the perception of odors, using the decipol method. The sets were located in climate chambers and turned on for longer periods, this causes heating which enhances odorous emissions.

4. Conclusion

Reduction of odor emissions from consumer products, aiming at prevention of indoor odor complaints, is possible with a combination of odor research techniques. How a project has to be set up in a specific case, depend on the type of product and type of problem to be solved.

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