

Measurements of perceived indoor air quality

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SUMMARY

Occupants in non-industrial indoor environments should decide whether the indoor air quality is acceptable or not. This paper describes the method by which the assessments of acceptability of air quality can be used for measuring short-term sensory effects on humans caused by indoor exposures. It also describes how this method can be applied to estimate the perceived indoor air quality used as a design criteria for the ventilation of buildings. The limitations of the method, the factors influencing the measurements and possible applications of the measured perceived air quality are discussed..

KEYWORDS

Indoor air quality; Perceived air quality; Sensory assessments; Acceptability

1 BACKGROUND

Humans are constantly exposed indoors to varying concentrations of organic chemical compounds. The compounds originate from outdoor sources, e.g. urban traffic, and from indoor sources such as people, tobacco smoking, and the building itself (building materials and furnishing, electronic equipment and heating, ventilation, and air-conditioning systems). A typical mixture of organic compounds indoors contains about 6000 compounds of which ca. 500 are human bioeffluents, ca. 500 are pollutants emitted by building materials and equipment and ca. 5000 are pollutants in tobacco smoke. These compounds can affect indoor air quality and thereby health, comfort and productivity of humans indoors. Numerous methods have been used to measure the effects of indoor air quality on human health, comfort and productivity. The measured effects can be used to set the limiting criteria regarding indoor air quality. This presentation focuses on the method used for evaluating sensory effects on humans. This measure can be used to assess indoor air quality as it is perceived by humans indoors, and to set the design criteria for ventilation of buildings, as is done in ventilation standards. Sensory effects are caused by stimulation of the olfactory sense, situated in a small area of the nasal cavity and sensitive to around half a million odours, the general chemical sense, situated all over the mucous membrane of the nose and sensitive to more than one hundred thousand irritants, and the thermal sense located in the nasal cavity and sensitive to varying levels of air temperature and relative humidity, providing that the air temperature is different from the mucosal temperature which is ~30-32°C. Certain harmful pollutants such as radon or carbon monoxide are not sensed by humans at all and cannot be quantified using sensory evaluations of air quality. The sensory effects may still in many cases provide a first indication of a possible health risk since human senses have an important warning function against danger in the environment. Several methods can be used to quantify the sensory effects on humans. The method described here is based on human observers rating the acceptability of air quality. The advantage of using acceptability is that this approach allows individual occupants of indoor

spaces to be the final arbiters of whether the indoor air quality is acceptable or not. The method assumes that the assessments of acceptability of air quality integrate different sensory stimulations into one measure from which the perceived air quality can be assessed. The method has been used extensively in numerous laboratory and field investigations.

2 DESCRIPTION OF THE METHOD USED FOR THE MEASUREMENT OF PERCEIVED AIR QUALITY

Acceptability of air quality is evaluated by human observers using a continuous visual analogue scale. Observers are instructed to indicate whether the quality of air to which they are exposed is acceptable or not. The scale is usually preceded by the following sentence: "Imagine that during your daily work you are exposed to this air. How do you assess the air quality?". This is done to create proper context. Assessments of acceptability of air quality are made immediately upon exposure to pollutants as the number of inhalations may cause olfactory fatigue (adaptation) and thus affect the sensory evaluations. Prior to the next evaluation, observers take several inhalations of unpolluted air. The exposure may be partial (e.g. nose or face) or full (whole body), the former being usually used in laboratory evaluations in which an assessment is typically made after just one inhalation of the air being evaluated and the latter in field measurements where observers render acceptability judgements after entering a space and take usually more than one inhalation. The type of exposure may also affect the sensory evaluations. All evaluations are rendered independently of other observers and without influence from a person conducting the measurements. The assessments in different locations are randomized and balanced for order of presentation. Using mean acceptability ratings, the percentage dissatisfied with the air quality can be calculated.

3 FACTORS INFLUENCING THE MEASUREMENTS OF PERCEIVED AIR QUALITY

The selection of human observers (subjects) evaluating the air quality can affect the results of the measurements of perceived air quality. Theoretically, the observers from the relevant population for which the measurements are addressed should be selected. This may be difficult to achieve in practice. A rational compromise is to select observers of a similar age, as age has been shown to have a major impact on sensitivity, while gender and smoking status are of less importance. The sensitivity of observers should nevertheless be documented separately. The number of observers evaluating the air quality affects the accuracy of measurements. This is due to considerable variation in ratings of acceptability of air quality among individuals as a consequence of variation in chemosensory sensitivity in combination with variables such as personality, preference, mood and prior experience. 30-40 observers are usually selected. Human senses exhibit reduction in sensitivity with time of exposure when the air is polluted by odours (adaptation) while augmentation of response with time of exposure when the air is polluted by irritants. It has been documented that the strong adaptation occurs already in the course of the first seven inhalations, corresponding to an exposure of about 24 seconds. As it is often difficult to conduct measurements in which observers take only 1 inhalation when rendering the assessment of air quality these results imply that some sensory adaptation would always be present when the measurements of perceived air quality are made. Studies have shown that perceived air quality is strongly influenced by the humidity and temperature of the inhaled air, even when the chemical composition of the air is constant, and the thermal sensation for the entire body is kept neutral. Consequently, when the air quality is measured using sensory assessments of acceptability, the thermal conditions of the inhaled air should be well documented.