6863

THE IMPACT OF AIR WASHING ON ENVIRONMENTAL TOBACCO SMOKE ODOR

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Abstract

Sixteen subjects evaluated the air quality in an environmental chamber polluted with tobacco smoke, with and without an air washer in operation in the recirculation loop of the air conditiong system. Four concentrations of tobacco smoke were investigated corresponding to CO-concentrations ranging from 0 to 5 ppm. The subjects assessed odor intensity, acceptability and freshness of the air. A total of 20 two-hour tests were carried out, with 6 to 10 subjects participating in each test. Although the odor intensity did not decrease when the air washer was in operation, the air in the chamber was perceived significantly more fresh and more acceptable than without the air washer. A reduction in the ventilation requirement can be achieved by using an air washer.

Introduction

Environmental tobacco smoke is a common indoor air pollutant. Ventilation and filtration through various solid media (e.g. activated carbon) are possible ways of reducing the odor caused by tobacco smoking. But only little attention has been given to the possibilities of removing the odor by air washing.

In 1936 Yaglou and colleagues (6) found that the intensity of body odor was greatly reduced when air passed wetted surfaces in the recirculation loop of an air conditiong system. Later studies by Kethley (4) and by Pedersen and Fisk (5) verified the finding that air washers were capable of removing odorous and irritating compounds from the air. The purpose of the present investigation was to study the impact of air washing on odor from environmental tobacco smoke.

Facilities

The tests took place in two adjacent stainless steel environmental chambers (2.5 x 3.6 x 2.5 m), each with a total air volume, including recirculation ducts of 29 m^3. In each chamber air was supplied through a perforated floor and exhausted through four return ducts in the ceiling. Recirculation at 54 h^{-1} kept the air in each chamber well mixed. One of the chambers was equipped with a sniffing box of 0.10 m^3, supplied by air from the adjacent chamber where cigarette smoking took place. The box allowed the subjects to evaluate the quality of the air in the smoking chamber without entering it. A Dravniek binary dilution olfactometer (2) which emitted eight concentrations of the standard matching odor 1-butanol was placed next to the sniffing box.

The recirculation loop of the smoking chamber was equipped with a spray-type air washer. The 2.4 m long air washer contained eight spray-nozzles supplying a total of 0.73 l/s of water. The temperature of the water was maintained at 11.5 ± 0.3 °C, which is equivalent to the average daily dewpoint temperature of the outside air in May and June. Therefore the air washing did not change the relative humidity of the air significantly. The air flow through the air washer was 430 l/s. The air in the smoking chamber was monitored by a Thermo Electron Carbon Monoxide Analyzer Model 48, and a GCA Mini Ram Particle Analyser model PDM-3. Humidity and temperature were measured with a wet bulb - dry bulb psychrometer.

Subjects

Seven men and nine women (18-25 yrs) served as odor judges. Three women and three men among the judges were smokers, but they were not allowed to smoke during the two-hour sessions. Five other people served as smokers generating tobacco smoke while seated in the smoking chamber.

Procedure

Each session lasted two hours with a given constant smoke concentration produced by the five smokers. The cigarettes smoked were of the brand "Prince", an 84 mm filter cigarette made in Denmark. By smoking the cigarettes at a predetermined rate and adjusting the air flow to the chamber, the desired concentration of smoke in the chamber was maintained.

Before the tests the judges were familiarized with the sniffing box and with the use of the olfactometer in a one-hour introductory session. Groups of six to ten judges participated in each test. The judges were seated in the well ventilated chamber equipped with the sniffing box. One at a time they went to the sniffing box, where they evaluated the quality of the air from the adjacent smoking chamber. Immediately after sniffing the air the judge rated the odor intensity on a scale containing the six annotations previously used by Yaglou (6): 0) no odor, 1) slight odor, 2) moderate odor, 3) strong odor, 4) very strong odor, and 5) overpowering odor. This assessment served to capture the immediate impression of odor intensity. The judge then chose from the olfactometer a concentration of 1-butanol that matched the odor intensity in the sniffing box. The judge also assessed whether or not the odor would be acceptable if experienced in an every day situation during work. Finally the judge evaluated the freshness of the air on a five point scale with annotations: very stuffy, slightly stuffy, neutral, fresh, very fresh. Each judge performed the one-min assessment every ten minutes.

Four concentrations of smoke with corresponding levels of carbon monoxide of 0, 1.0, 3.0 and 5.0 ppm above outside air were tested with and without the air washer in operation. The tests with the air washer operating comprised a 50 min period without air washing followed by a 70-min air washing period. As a control the same procedure was repeated without the air washer operating. The order of the tests was random and no

information was given to the subjects concerning the air washer or the environment they were exposed to. The temperature was kept constant at 22 ± 0.5 °C, and the relative humidity was betweeen 35 and 60%. A total of 20 two-hours tests were performed during the early summer of 1986.

Results

In figure 1 the perceived odor intensity is shown as a function of time for the tests performed at 5 ppm. In figure 2 the percentage of dissatisfied is plotted against time for the same concentration of smoke. Each point in the figures represents the mean evaluation of the 16 judges. Whereas no significant effect of the air washing was observed on odor intensity, the air washing caused a considerable decrease in the percentage of dissatisfied. This can also be seen in figures 3 and 4 where odor intensity and percentage of dissatisfied are plotted against the smoke concentration for all conditions tested. In these figures each point is the mean of 80 evaluations. The tobacco smoke odor, although equally intense, probably changed character and became more acceptable by passing the air washer. The same conclusion can be drawn from figure 5, where percentage of dissatisfied is plotted against odor intensity for all conditions tested. Each point on the figure represents 80 evaluations. The air washing also caused a rise in the perceived freshness of the air (not shown in the figures).

Discussion

The present study found that tobacco smoke odor changed character and became more fresh and more acceptable when passed through an air washer. Thus the ventilation requirement necessary to control odor from environmental tobacco smoke can be lowered by air washing. However, it is not possible to quantify the decrement in ventilation requirement based on the results obtained in the present study. The percentages of dissatisfied found in the present study were generally high compared to the 20% dissatisfied defined by ASHRAE (1) as the upper limit for acceptable indoor air quality. This was probably due to build-up of residual odor from previous tests, since the air handling system was not cleaned between the experiments.

In the present study the relative humidity varied between 35 and 60%. However, in a previous study by Clausen et al (3), where the perception of tobacco smoke odor was studied under various environmental conditions, no practical changes in odor intensity and acceptability were observed with relative humidities between 30 and 80%.

More research with different types of air washers and air-to-water ratios is recommended to quantify the decrement in ventilation requirement that can be obtained when using an air washer to reduce odor from environmental tobacco smoke.

Conclusions

Air washing had no significant impact on the intensity of tobacco smoke odor. However, the character of the odor changed so that it was felt to be more acceptable and fresh.

Air washing may permit a reduction in ventilation requirement in spaces where tobacco smoking takes place.

Acknowledgement

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