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PROVIDE GOOD AIR QUALITY FOR PEOPLE AND IMPROVE THEIR PRODUCTIVITY

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ABSTRACT

Three recent independent studies have documented that the quality of indoor air has a significant and positive influence on the productivity of office workers. A combined analysis of the results of the three studies shows a significant relationship between productivity and perceived indoor air quality. The impact on productivity justifies a much higher indoor air quality than the minimum levels prescribed in present standards and guidelines. One way of providing air of high quality for people to breathe, without involving excessive ventilation rates and energy use, is to provide "personalized air" to each individual.The application of this concept is discussed.

KEYWORDS Indoor air quality, Productivity, Ventilation, Personalized air

INTRODUCTION

In 1936, Yagou introduced a new philosophy for ventilation, the aim being to provide an indoor air quality that is perceived acceptable by people. This philosophy has since then dominated the thinking in ventilation standards for nonindustrial buildings. It is still the idea behind recent standards and guidelines such as the ASHRAE Standard 62 (ASHRAE, 1999) and the recent CR 1752 (CEN, 1998). But indoor air quality has an impact on humans beyond perception. Three recent studies have now documented that indoor air quality has a significant impact on productivity in offices and on SBS symptoms. These studies will be reviewed in the first section of this paper.

High air quality in a space can be achieved by decreasing the pollution sources, by increasing the ventilation rate, or by cleaning the air. But what really counts is the quality of the air that the occupants breathe. One option is to supply air of high quality direct to the breathing zone of each individual. The establishment of such "personalized air" will be discussed in the second section of this paper.

PRODUCTIVITY AND INDOOR AIR QUALITY

Three recent independent studies document that the quality of indoor air has a significant and positive influence on the productivity of office workers. In one study, a well-controlled normal office (field lab) was used in which two different air qualities were established by including or excluding an extra pollution source, invisible to the occupants (Wargocki et al., 1999). The two cases corresponded to a low-polluting and a non-low-polluting building as specified in the new European guidelines for the design of indoor environments (CEN, 1998).The same subjects worked for 4-1/2 hours on simulated office work in each of the two air qualities. The ventilation rate and all other environmental factors were the same under the two conditions. The productivity of the subjects was found to be 6.5% higher (P<0.003) in good air quality (Fig. 1) and they also made fewer errors and experienced fewer SBS symptoms. This study performed in Denmark has later been repeated in Sweden with similar results (Lagercrantz, 2000). A third study was performed in the Danish field lab with the same pollution sources present at three different ventilation rates: 3, 10 and 30 l/s·person. The productivity increased significantly by increased ventilation (Figure 2). The three studies involving seven experimental conditions and 90 subjects have been analysed as a whole, relating productivity to perceived air quality (Wargocki et al., 2000). The results are presented in Figure 3 and show a significant influence of perceived air quality on productivity in offices. An improvement of perceived air quality by 1 decipol increased productivity by 0.5%. The results of three blind studies document that improved air quality increases productivity significantly.

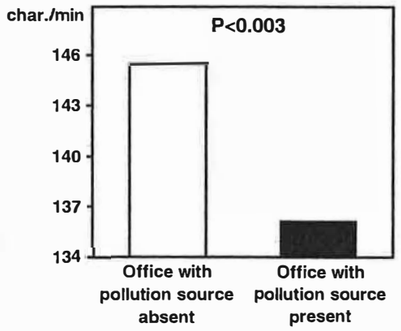

Fig. 1. Impact of indoor air pollution on productivity, i.e. number of characters typed on a PC (Wargocki et al., 1999a)

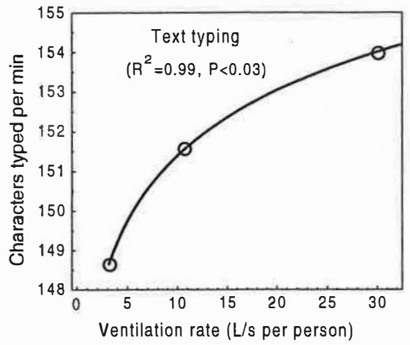

Fig. 2. Impact of ventilation rate on productivity (Wargocki, 1999b)

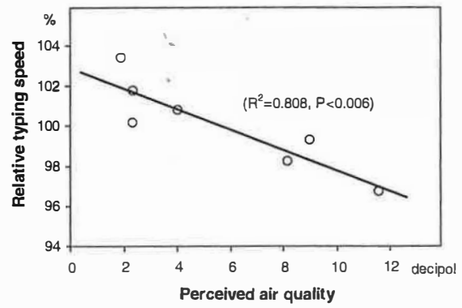

Fig. 3. Relation between perceived air quality and productivity (Wargocki, 2000)

PERSONALIZED AIR

In many ventilated rooms the outdoor air supplied is of the order of magnitude of 10 l/s·person. Of this air, only 0.1 l/s·person, or 1%, is inhaled. The rest, i.e. 99% of the supplied air, is not used. What a huge waste! And the 1% of the ventilation air being inhaled by human occupants is not even clean. It is polluted in the space by bioeffluents, emissions from building materials and sometimes even by environmental tobacco smoke before it is inhaled.

The idea of mixing ventilation is to provide the same quality of air in the entire volume of the space. This means that occupants will find the same quality of air for breathing whether they are sitting at their desk, standing on the desk or lying on the floor.

Displacement ventilation systems do acknowledge the air quality in the breathing zone but the ventilation effectiveness is usually only moderately better than with mixing ventilation. What I foresee in the future are systems that supply rather small quantities of clean air close to the breathing zone of each individual. The idea would be to serve to each occupant, clean air that is unpolluted by the pollution sources in the space. We would hesitate to drink water from a swimming pool polluted by human bioeffluents. Still we accept consuming indoor air that has previously been in the lungs of other persons and is polluted by human bioeffluents and other contaminants generated in the space. Why not serve small quantities of high-quality air direct to each individual rather than serving plenty of mediocre air throughout the space? Such "personalized air" (PA) should be provided so that the person inhales clean air from the core of the jet where the air is unmixed with polluted room air (Fig. 4). In an office the PA may, for instance, come from an outlet next to the PC on the desk. It is essential that the air is served "gently", i.e. has a low velocity and turbulence which do not cause draught (Fanger et al., 1988). By means of personalized air it is possible to provide breathing air of optimal quality. The air will be perceived as fresh and pleasant with a positive effect on human productivity as indicated in Fig. 3.

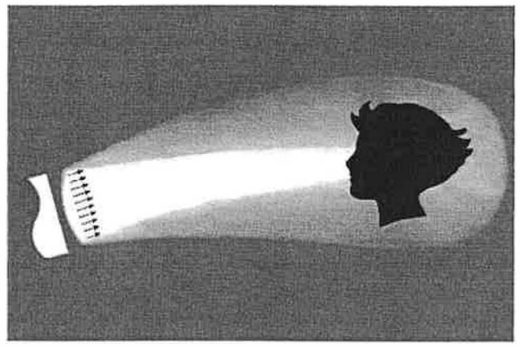

Fig. 4. The principle of personalized air (PA): small amounts of clean air supplied directly and gently to a person's breathing zone (Fanger, 2000)

The challenge for HVAC engineering in the future will be to develop conditioning and cleaning processes so that air is perceived optimally and to develop appropriate methods for transporting this air to the breathing zone of each individual without mixing with room air.

CONCLUSIONS

- Three different studies have documented a positive effect of perceived indoor air quality on productivity in offices.
- Personalized air supplied to the breathing zone of each individual is a promising concept, allowing a quality of the air for breathing that is optimal for human perception and productivity. Further work on studying and developing this concept is recommended.

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