It is common practice, (5) and (6), to estimate capture efficiency from data obtained by sampling from locations in a grid (η_{le}^{2}). However, no sampling strategy is descibed. In this study two different strategies are applied: (a) sampling at centres of surfaces of a cube without taking knowledge of airflow patterns into account (η_{le}^{2a}), and (b) sampling at centres of surfaces of a cube taking knowledge of airflow patterns into account (η_{le}^{2b}). As observed from Table 2, η_{le}^{2a} is at a level comparable to η_{le}^{2b}. This outcome is to be considered as a coincidence, due to inconsistent data, e.g. as observed in Table 1 at surface No. 1 (box B). A high concentration at the surface indicates a flow of contaminants from the source out of the box. However, a high value of α_i indicates a contaminant transport into the box.

It is emphasized that as the number of sampling points increases and information on air movements at the boundary of the control box is improved, η_{le}^{2b} tends to approach the true value of capture efficiency, η_{le}^{d}. Therefore it is unexpected that $\eta_{le}^{1} > \eta_{le}^{2b}$ (Table 2) as η_{le}^{1} is an underestimate of η_{le}^{d}. The sampling strategies and experimental methods applied in this study are therefore considered insufficent, and further development is needed.

For field application, the following approach for estimation of local exhaust direct capture efficiency is recommended:

- Control box definition: Only areas where contaminants are acceptable are included in the box.

- Sampling strategy: Sampling locations are equally distributed over the faces of the control box. To check that $\eta_{le}^{2} \leq \eta_{le}^{tot}$ sampling at the exhaust duct is included.

- Estimate direct capture efficiency from Equations 6 and 7.

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SANITARY-HYGIENIC ASPECTS OF FLOOR-LEVEL AIR DISTRIBUTION

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ABSTRACT

This paper reports results of a sanitary-hygienic study of the floor air distribution system in a computation centre room. This air distribution technique is shown to be economically advantageous, although it requires more observation of the personnel's working conditions, which restricts its applicability - especially in the cooling mode.

INTRODUCTION

One of the actual and important tasks in air conditioning technology is to provide adequate air exchange in computer rooms at computation centres and to comply with both the technical and sanitary'hygienic requirements. The increasing heat and air loads upon air conditioning systems and the economically justified requirements to distribute supply air directly into the work area make it expedient to use air distribution devices that form jets with faster damping velocities and excessive temperatures up to the amount that ensures personnel well-being. Technical development of such devices should, therefore, be invariably accompanied by a sanitary-hygienic analysis into the conditions they create, beginning from air temperature and velocity combinations in the attended area. This concerns particularly the floor-level air distribution technique that creates contrasting temperature and velocity fields which are not yet completely understood as to the optimum and permissible combinations in the people affected (1,2,3).

RESULTS

In order to provide air supply into the work area in the upward pattern, and taking into account specific features in design and layout solutions, floor air distribution panels of 500x500 mm in size have been worked out in two versions, i.e. cast aluminum and drop-forged panels (4). The experimental research results helped obtain main characteristics for the lean-on flow which develops across the floor surface:

$$V_x^{max} = 0.36\ V_o x^{-0.84} \tag{1}$$

$$\Delta t_x^{max} = 0.27\ t_o x^{-0.58} \tag{2}$$

where: V_x^{max} and Δt_x^{max} are, respectively, maximum velocity and excessive temperature at the distance x (m) from the panel centre; V_O and Δt are air velocity and excessive temperature at the outlet from the floor device.

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Full-scale sanitary-hygienic investigations were made in order to get recommendations for optimum and permissible air temperature and velocity combinations in the work area when the above air distribution panels are used. These investigations covered 9 air distribution regimes with different air velocity and temperature combinations at the outlet and location of work posts at different distances from the flow of air distribution devices.

The analysis of the information that was received demonstrates that the most sensitive index at the floor-level air distribution is the temperature of the human toe (t^{st}), whiCh has the highest correlation with the subjective heat-sensation estimation. The lowering of thermometric indexes, in time, as well as subjective index deterioration is typical. The pulse frequency, which is connected more with the individual peculiarities of the testers, turned out to be the less sensitive index.

The maximum stability, in time, was shown by the temperature of the forehead and chest surfaces, and that is why the difference between t^{Chest} -t^{tst} noticeably increases with the increase of body cooling and sensation time degree. The analogical tendency is shown by the average suspended skin temperature (CBTK) which value indicates body cooling. Even at the meteorological condition considered to be comfortable, some decrease in CBTK can be noticed, indicating light cooling. The dependency of cooling degree on the air parameters t/V, and the cause of it, is shown in figure 1. From the figure you can see that thermal comfort is determined as the lower limit of those indexes. Also, the zone limits mapping of the permissible t^{perm} and v^{perm} combinations for the computer rooms at computation center.

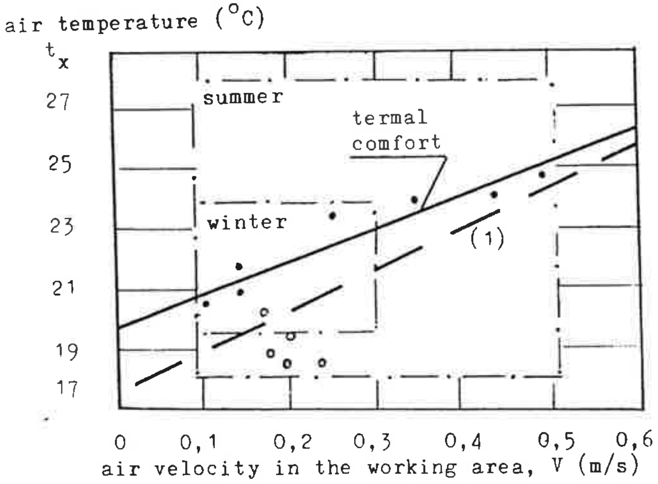

Fig. 1. Zones of permissible temperature and velocity combination in the work area of rooms, boundaries of zones permissible of t and V combinations in summer and winter, respectively, and thermal comfort by the results of full-scale hygienic investigations.

$M/F_{D\mu}$ = 75 kkal/m²h, Fanger P.O. (1)

In figure 1, you can also see the comfort line at the level of φ=50% estimated according to the method of professor Fanger (1;3). According to the tests, the results of sanitary-hygienic investigation correspond with the ones obtained by domestic and foreign hygiene-physiologists.

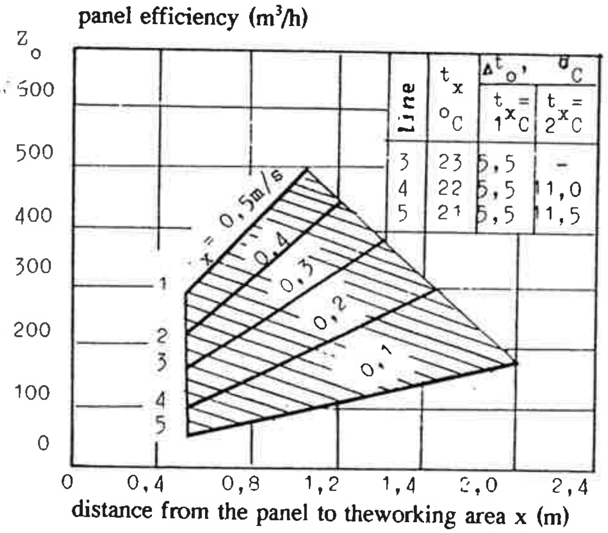

Fig. 2. A diagram determining air parameters (Δt_o,Z_o) at the outlet from a floor air distribution panel.

recommended region for t_x and V_x combinations:

1. t_x = 25 °C V_x = 0.5 m/s
1. t_x = 24 °C V_x = 0.4 m/s
1. t_x = 23 °C V_x = 0.3 m/s
1. t_x = 22 °C V_x = 0.2 m/s
1. t_x = 21 °C V_x = 0.1 m/s

The mutual solution from equations 1;2, on the basis of results of the natural sanitary-hygienic tests, let us to present the sphere (figure 2) of optimum thermal and air loads combinations on the floor-level distribution panel locating it in the permanent work place zone. It should be mentioned that the floorlevel air distribution sharply limits its efficient use when it is supplying cool air. However, for the air heating regime, particularly in tall buildings, the supply air jet located in the floor may result in a considerable temperature drop when the warm air jet stream comes up ar;d the uniform floor heating increases comfort.

The results from these investigations are generalized in Figure 2 as a zone of permissible combinations of air minimum temperature t_x and its maximum velocity V^{max}, as they are shown in their relation to air parameters at the outlet (V_O, Δt_o) and at different distances from the air distribution panel center

CONCLUSIONS

The use of floor-level air distribution allows to reduce the number of air exchanges up to 40% in comparison with the air distribution in the downward pattern. Using removable floors saves metal owing to elimination of supply air ducts, but strict requirements should be applied to the air tightness of the raised floor space and the thermal conductivity of the floor material. Floor-level air distribution technique is applicable to regimes of both heating and cooling in thermally loaded rooms.

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COMPUTED TOMOGRAPHY AND INFRARED ABSORPTION: DEVELOPMENT OF A NEW TECHNIQUE FOR THE STUDY OF INDOOR AIR POLLUTANT TRANSPORT AND DISPERSION

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ABSTRACT

We present the idea of applying optical remote sensing and computed tomography (CT) to the study of indoor air quality and pollutant transport. Potential applications include research on the motion and mixing of indoor air, leading to better-designed heating, cooling and ventilation systems, and remote locating of pollutant sources in indoor and outdoor settings. A source-detector combination for infrared sensing of the tracer gas sulfur hexafluoride (SF_6) has been constructed and calibrated. We have designed a proof-of-principle experiment to measure the distribution of SF_6 in a plane with this infrared detection method combined with CT. A computed tomography program based on an iterative algorithm has been written for the proof-of-principle experiment and has performed well on synthetic data. Several general factors critical to the successful application of the suggested new method are discussed.

INTRODUCTION

Air mixing and pollutant dispersal in indoor spaces are generally poorly characterized and not well understood. The rates at which indoor air mixes and the extent to which pollutants, such as environmental tobacco smoke, disperse are frequently unknown (1). Solving the governing equations of indoor transport and dispersion is difficult. Direct measurement of pollutant dispersion by point sampling is intrusive, time and labor intensive and suffers from poor spatial and/or temporal resolution. Therefore, the simplifying assumption of complete and instantaneous mixing is commonly made when investigating indoor air quality. The validity of this assumption often goes untested due to experimental limitations. Yet, ventilation standards are based on this premise. A new experimental tool is therefore needed to efficiently measure pollutant or tracer gas concentrations in indoor air non-intrusively and with high spatial and temporal resolution.

Non-intrusive measurements of gas concentration can be made with remote sensing technologies. Such optically based methods have become widespread in the last few years for sensing outdoor pollutants. However, most of these technologies yield only path integrated concentrations, along a laser beam, for instance. To determine the spatial distribution of contaminant gas by remote sensing, the domain under consideration may be crossed from various directions by many intersecting beams. One may then calculate the distribution of species concentration in a plane section from its average value along these various paths by means of computed tomography. Computed tomography is most commonly known for its use in medical imaging (2). It has also recently been suggested as a tool for monitoring indoor workplaces for gaseous contaminants (3).

The purpose of this research is to explore whether computed tomography coupled with optical remote sensing could be developed into a new tool for studying pollutant transport and dispersion in indoor air. To this end, a bench-top proof-of-principle experiment was designed to reconstruct gas concentrations in the cross-section of a neutrally buoyant cylindrical plume of sulfur hexafluoride (SF_6). This gas is frequently used as a tracer gas in ventilation studies.