Title of Contribution to ROOMVENT 2004

P.Svensson[1], D.Kristensson[2] and J.Kristensson[2]

Airson Clean Air Technology, Metallgatan 33, S-262 72 Engelholm, Sweden
email: pal@airson.se http://www.airson.se

Summary: *Experiences from Clean-room installations has frequently shown that displacement ventilation has a much higher efficiency than mixing ventilation with respect to particle and CO_2 reduction, cooling efficiency etc. Another clean-room experience is that low particle concentration benefits asthma and allergy sufferer. Low particle concentrations reduces the impact of other pollutants and enhance the quality of life for everybody. In an office, this means less tiredness, better concentration and lower absenteeism. Risk of indoor airborne infection transmission increase with decreasing ventilation efficiency. All these factors should conclude that a good indoor environment is a sound investment. How much more efficient is the displacement ventilation in a normal office environment? We made a case study where we compared vertically displacement ventilation versus state of the art mixed ventilation in an office environment.*

Keywords: *Ventilation efficiency, particle, energy.*
Category: *Case Studies, thermal comfort, indoor air quality*

1 Introduction

Full-scale trials were conducted at the Airson AB laboratory in Sweden, during the autumn of 2002 and spring of 2003, to compare the differences between vertical displacement ventilation and mixing ventilation with respect to particle concentration, CO_2-concentration and cooling energy. The air-lab where furnished and crewed as an office to simulating average conditions over a year. The aim where to explore the differences in ventilation efficiency and to evaluate the consequences regarding; inconvenience frequency due to air quality (Jansson et al 2000), risk of indoor airborne infection transmission (Rudnick et al 2003) and cooling energy consumption.

1.1 Trial set up

- Hermetic lab, 10 m^2, ceiling height 2.7 m.
- "Calibrated" particle generation, entry via airlock.
- Floor wet-mopped before each trial run.
- HEPA-filtered supply air.
- Person wearing office clothing.
- Specified pattern of movement.
- Computer, monitor and inkjet printer.
- Simulated mild insolation.
- Illumination 15 W/m^2.
- Air temperature measured at inlet, outlet and breathing zone.
- Particle concentration measured at inlet, outlet and breathing zone.
- CO_2 concentration measured at inlet, outlet and breathing zone

In our trials we used a Rotary air diffuser for mixed ventilation and an Air-shower for the vertically displacement ventilation. The outdoor air supply rate was 120 m^3/h, which

The particle concentration depends entirely on activity in the room, so a fixed pattern of movement was used throughout the trials. The particle concentration stabilises at an equilibrium level after a while.

Ventilation efficiency

Ventilation efficiency is a measure of how efficient pollutants are transported away and is calculated as the ratio between the values for supply air, exhaust air and air in the breathing zone. A higher number indicates higher efficiency removing the pollution. **It is important to be aware of that we only regard pollutants generated indoors.** Outdoor pollutants can be removed with effective filtration.

2 RESULTS

With the vertically displacement system the particle concentration is less than a quarter of the level with the mixing diffuser.

With mixing ventilation, the CO_2 concentration is equalised throughout the room just like the particle concentration. It took about half an hour to reach a fairly stable level about 190 ppm higher than that in the supply air.

After half an hour the CO_2 level has risen by only 75 ppm above that of the supply air, stabilising at 145 ppm higher than the supply air after an hour and a half.

To maintain the same room temperature (ca 21°C) the supply air temperature where ca 19°C with the displacement ventilation, and 15.7°C with mixing ventilation.

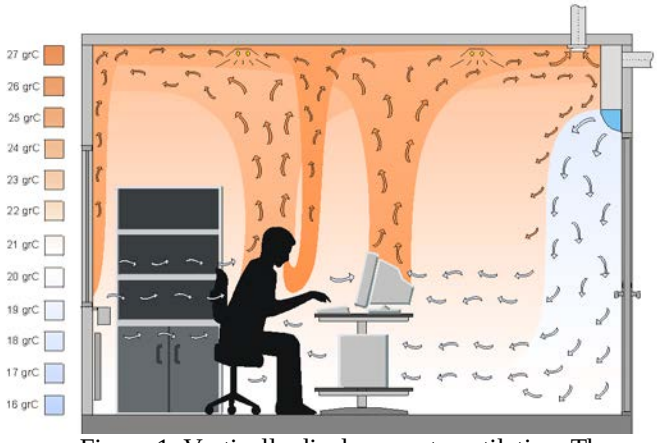

Figure 1. Vertically displacement ventilation. The inlet-air is supplied via air showers and does not disturb the convection currents from the heat loads in the room.

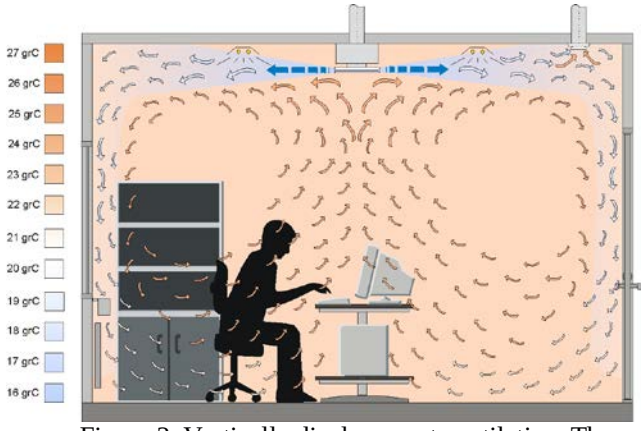

Figure 2. Vertically displacement ventilation. The inlet-air is supplied via air showers and does not disturb the convection currents from the heat loads in the room

3 CONCLUSIONS

In the displacement ventilation do not disturb the convection currents from the heat loads in the room. This can explain the differences in pollutant concentrations since particles and CO_2, that are generated by the person in the office, then follow the convection currents and rise freely to the ceiling where they are immediately evacuated. The mixed ventilation on the other hand, brakes the convection currents and spread out the pollutants in the whole room.

The Swedish National Institute for Working Life (www.arbetslivsinstitutet.se) has made measurements in a large number of premises (offices, schools, hospitals, etc.) and found a clear correlation between particle concentrations and frequency of symptoms

The particularly interesting finding from the trial at this Norwegian school is that absence due to sickness was halved, along with the particle count, in the classroom with vertical displacement ventilation.

Particle concentrations can be a better measure than CO_2 (or complementary) in the existing equations for Risk calculation of indoor airborne infection transmission.

Airson AB makes regular field measurements in its own open-plan office buildings with vertically displacement ventilation. Measurements of the particle concentration in the breathing zone during the working day show average readings of around 6500 particles/ft^3(Ø>0,5µm), qualified clean room in an office environment.

With the displacement ventilation we can maintain the same room temperature with a considerably higher supply air temperature, about 19°C compared to 15.7° with mixing ventilation. This has great economic significance: a building can be cooled with outdoor air for a much longer part of the year, the investment cost for cooling equipment is lower because it can be dimensioned for a smaller output, and finally the refrigeration plant costs less to operate.

References

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