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High Quality Ventilation Systems - A Tool to Reduce SBS Symptoms

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High quality ventilation systems - a tool to reduce SBS-symptoms

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SYNOPSIS

The present case study refers to a larger office building in Sweden. The employees in this building, which was built in 1982, began to complain about the indoor environment around 1985-86. A preliminary examination of the building started in 1989.

The preliminary investigation showed that the concrete framed floors were levelled off with self levelling compound containing casein and that there were relatively high concentrations of ammonia under the PVC-flooring. Chemical measurements showed that the total VOC-concentration in the building was relatively low but that higher concentrations could be found in certain places. Average total VOC concentration 190 µg/m^3, maximum value 1230 µg/m^3, minimum value 80 µg/m^3. The concentration 2-ethyl-1-hexanol, plasticiser in PVC-flooring, was also measured. Average 2-ethyl-1-hexanol concentration 11 µg/m^3, maximum value 32 µg/m^3, minimum value 1 µg/m^3. Moisture measurements showed that the concrete frames were dry, the relative moisture in the concrete less than 60 %. Based on these findings measures relating to the floor were considered.

Next the chemical pollution in the actual ventilation system was investigated. Results showed that very high concentrations of total hydrocarbon were given off in the building at certain times and that these hydrocarbons reentered via the supply air as the ventilation system was of the recirculating type. The source of the periodically high concentrations of total hydrocarbon was a printing works located in the building. Based on these results it was decided that the device for recirculating the air in the ventilation system should be removed.

The reconstruction of the ventilation system was followed up partly with technical measurements, partly with a questionnaire among the employees both before and after the reconstruction of the ventilation system. The result of the questionnaires shows that complaints about the indoor air quality decreased to a level close to a "healthy building".

METHODS

The concentrations of carbon-dioxide, total hydrocarbon and the vapour concentration were measured with gas monitor Brüel & Kjær 1302. A sampling unit of type Brüel & Kjær 1303 was attached which made possible continuous measuring in up to 6 measuring points. Found concentrations for total hydrocarbon (THC) are given i ppm as methane. In certain reports the THC is also given as VOC_{PAS} when using this method of measuring.

The total VOC concentrations were measured using charcoal absorbents and analyses with GC-MS. The findings are given as toluene equivalents.

RESULTS

Ventilation system

Originally the ventilation system was equipped with a temperature controlled recirculation regulator with a regulation curve shown i figure 1.

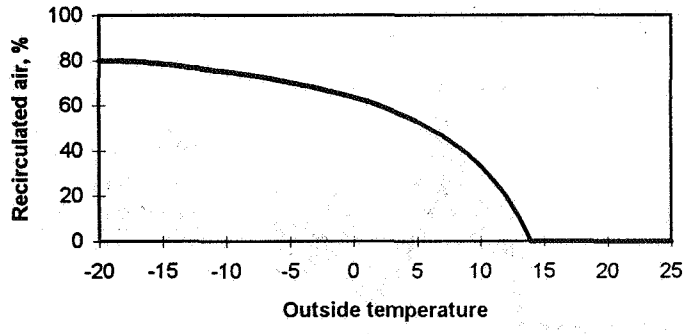

Figure 1, regulation curve

During a normal winter, November - March, the recirculation level will be on average 60 %.

The flow was originally ca 35 l/s and person, including recirculated air.

Before reconstruction the ventilation system was in use 24 hours a day.

Results of measurements taken before reconstruction of the ventilation system

The continuous measuring took place over 24 hours. VOC-sampling was carried out for 4 hours.

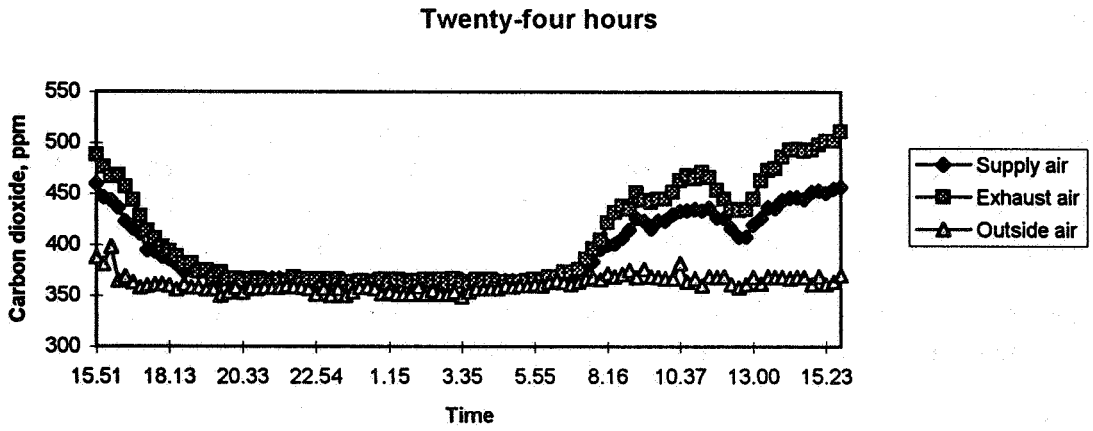

Figure 2, continuous measuring of CO_2 before reconstruction of the ventilation system

Figure 2 shows that the carbondioxide concentration in the building at the time of the measuring was fairly low, max ca 500 ppm. The variation in time agrees well with the activity in the building.

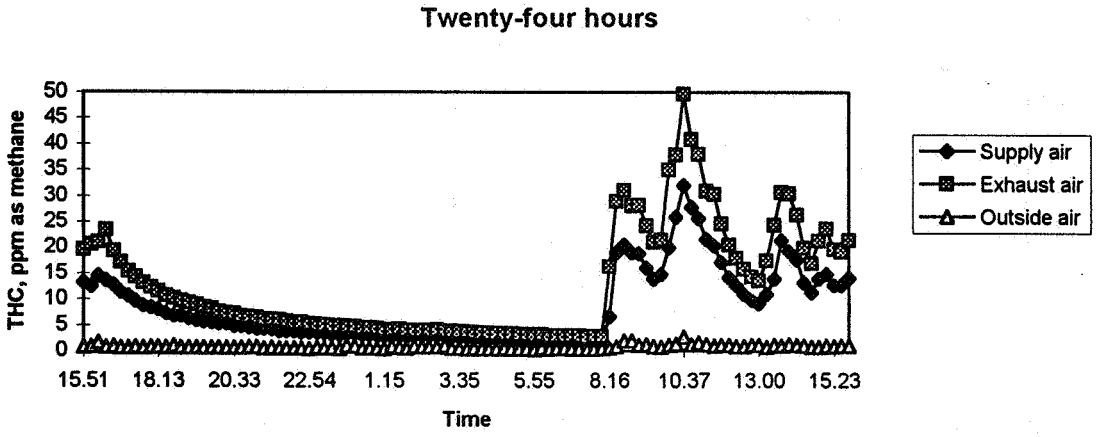

Figure 3, continuous measuring of THC before reconstruction of the ventilation system

Figure 3 shows that the THC varies considerably according to time and that the variation coincides with the variation in carbondioxide. The conclusion is, therefore, that it is not the building itself that is polluting the air but the activity in the building. This is supported by the fact that the THC concentrations diminish during the night when there is no activity in the building. In order to further illustrate this connection the carbondioxide and THC concentrations are shown together in figure 4.

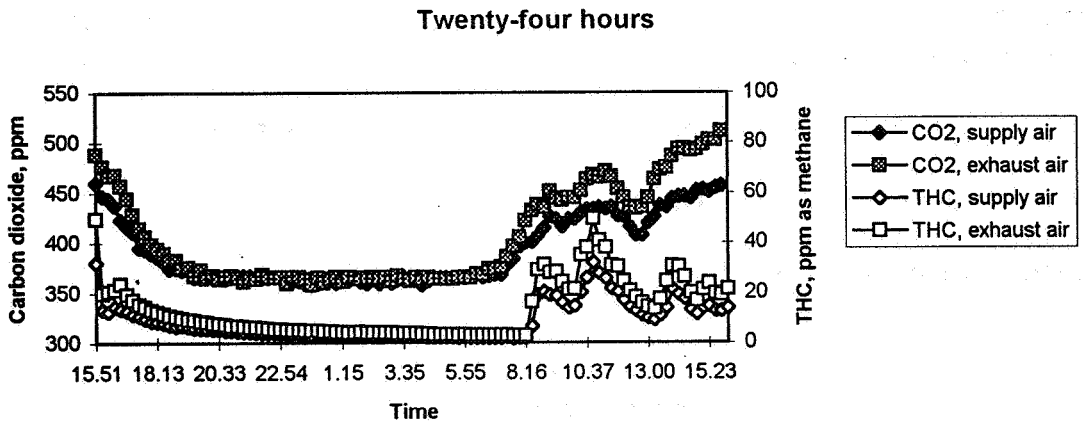

Figure 4, continuous measuring of CO_2 and THC before reconstruction of the ventilation system

Parallel with the continuous measuring VOC-samples were taken. The following results were obtained:

Supply air	3900	µg/m³
Exhaust air	5700	µg/m³
Outside air	73	µg/m³

The concentrations found in the supply air clearly exceed the values considered acceptable for the total VOC in the indoor air, ca 300 µg/m³.

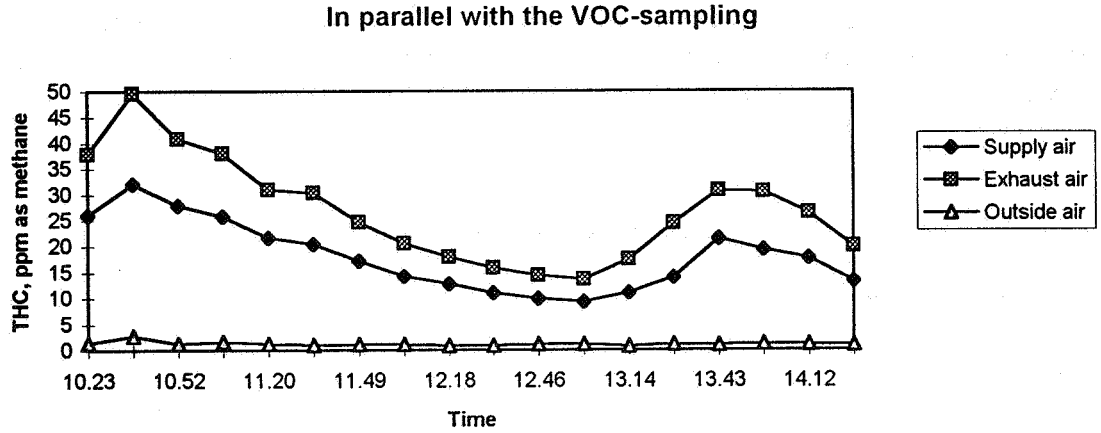

Figure 5, continuous measuring of THC before reconstruction of the ventilation system

The continuous measuring of the THC parallel with the VOC-sampling is shown in figure 5.

Reconstruction of the ventilation system

Based on results obtained it was decided that the device for recirculating the air in the ventilation system should be removed. To make heat recovery possible a heat recovery system based on fluids was installed.

In connection with the reconstruction of the ventilation system the air flow in the building was reduced from 35 to 20 l/s and person.

After the reconstruction the ventilation system continued to be in operation 24 hours a day.

Technical measurements after reconstruction

Measurements were taken in the same way after the reconstruction as before.

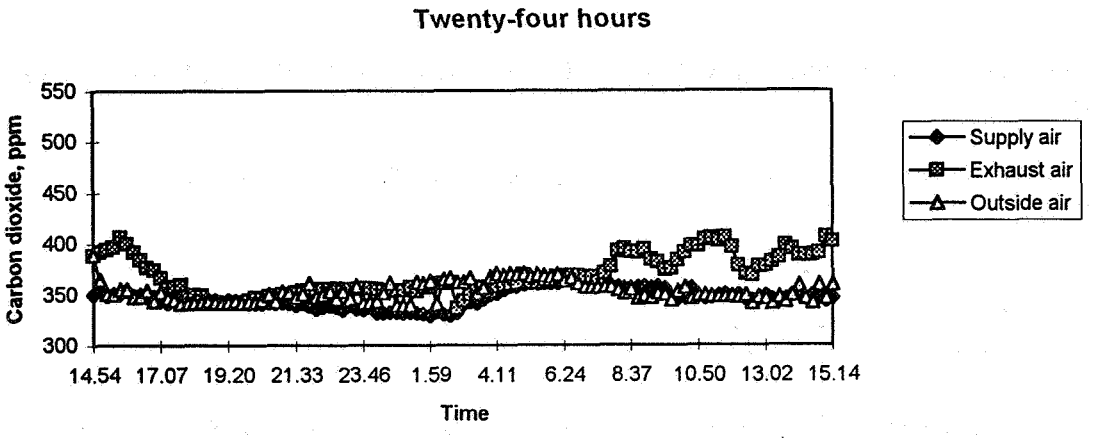

Figure 6, continuous measuring of CO_2 after reconstruction of the ventilation system

Figure 6 shows the carbondioxide concentration after the reconstruction of the ventilation system. The carbondioxide concentration in this measurement is somewhat lower compared with measurements taken before the reconstruction. It also shows that the supply air has the same concentration of carbondioxide as the outside air. In other words there is no recirculation.

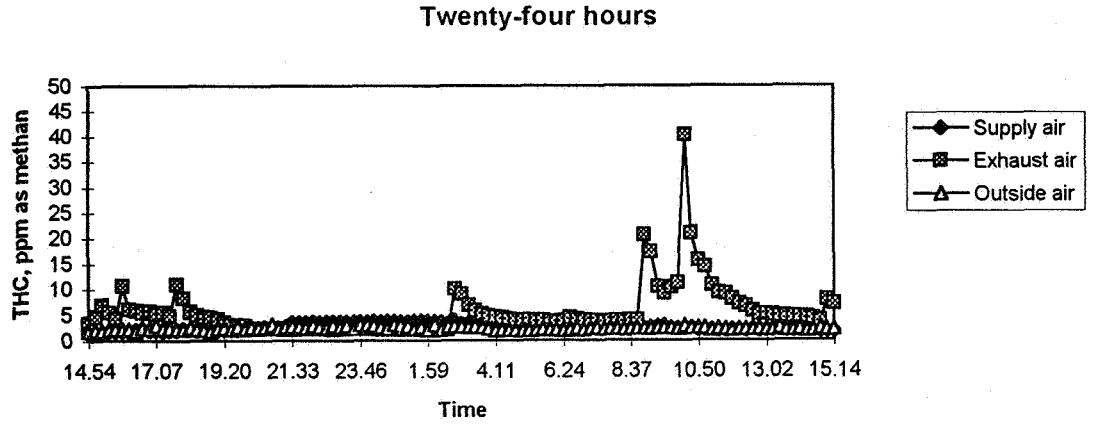

Figure 7, continuous measuring of THC after reconstruction of the ventilation system

Figure 7 shows the THC concentration after reconstruction. Also here the concentration is lower compared with measurements taken before the reconstruction. Finally it shows that the supply air has the same concentration of THC as the outside air.

Parallel with the continuous measuring VOC-samples were taken. The following results were obtained:

Supply air	40	$\mu g/m^3$
Exhaust air	1710	$\mu g/m^3$
Outside air	10	$\mu g/m^3$

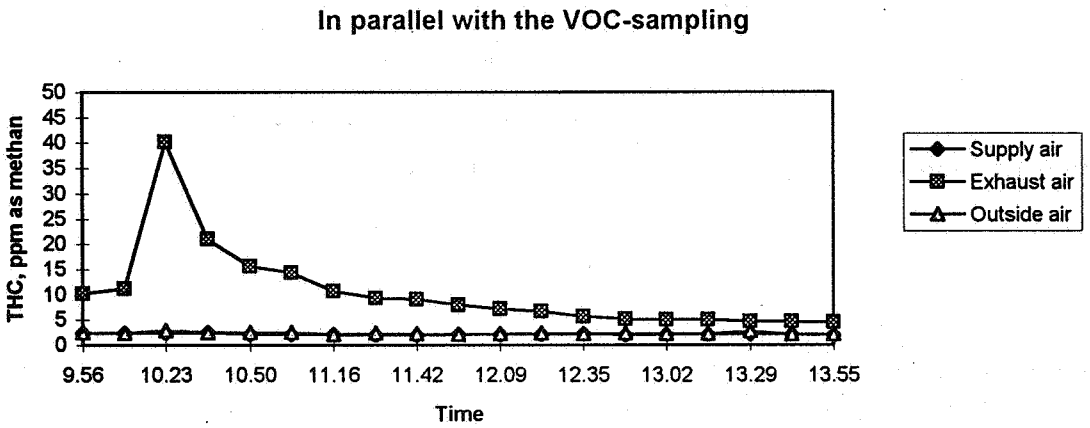

Figure 8, continuous measuring of THC after reconstruction of the ventilation system

The continuous measuring of THC parallel with the VOC-sampling is shown i figure 8.

The total VOC concentration and levels of 2-ethyl-1-hexanol in the indoor air were also tested after reconstruction. The average concentration of total VOC was found to be 155 $\mu g/m^3$, maximum value 450 $\mu g/m^3$, minimum value 50 $\mu g/m^3$. No detectable levels of 2-ethyl-1-hexanol were registered in the indoor air.

Questionnaire

A questionnaire was carried out before and after the reconstruction. The questionnaire used were taken from YMK Örebro.

The following results were obtained:

	Before reconstruction	**After reconstruction**
Background data		
Number of persons	229	216
Years in present employment	7	8
Proportion of women, %	58	60
Proportion of men, %	42	40
Proportion of smokers, %	19	18

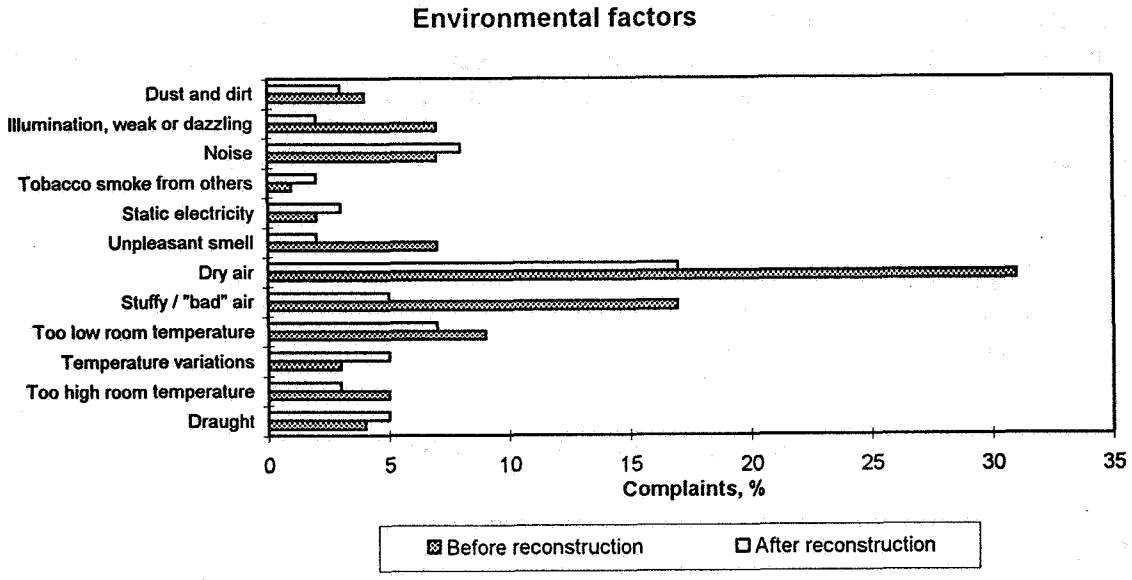

Figure 9, occurance of complaints on environmental factors

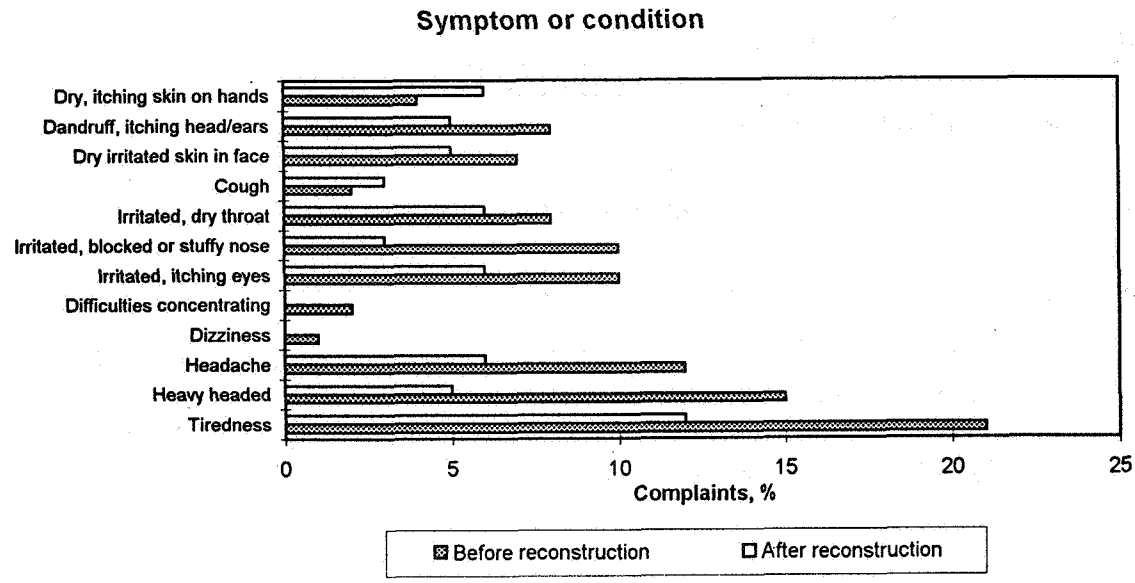

Figure 10, occurrence of self reported health symptoms

As the results show, the number of symptoms decreased after the reconstruction of the ventilation system.

CONCLUSIONS

The investigation shows that the indoor environment was considerably improved by the reconstruction of the ventilation system, in spite of the fact that no measures were taken relating to floor.

The results of the technical measurements were in full agreement with the result of the questionnaire.

The reconstruction of the ventilation system also led to a reduction in energy consumption by the fan motors of ca 50 %. This means that 130000 kWh are saved annually.