

Office with Fan Assisted Natural Ventilation, Malmo

Building Description

The Tage Møller building (see Figure 1) is used as an office by an architectural firm and is located in a mostly residential and very flat area on the shore of Öresund. There is very little protection against wind from the surroundings. The building was constructed in 1996 and has a floor area of 300 m². The structure is partly heavy (walls of brick, mineral wool, expanded clay and floor of concrete slab on grade) and partly light (roof of wood-frame with cellulose). The south façade is all windows. The building is equipped with a floor heating system.

The main part of the building is designed as a single story open plan office with a high ceiling. In the northern part of the building there are two stories. In the eastern part of the building there are two cell type offices on top of each other (see Figure 2). All along the south side of the building there is an attached greenhouse with large green plants. The greenhouse acts as a buffer, particularly during periods of warm weather.



Figure 1: View of the Tage Moller Building, Malmo

Ventilation Philosophy and Aims

The owners, who are also the architects of the building, wanted a building which used natural materials and had an inexpensive, uncomplicated ventilation system. This simplicity would provide the good indoor air quality and the adequate

summer indoor air temperatures desired at a low cost.

The ventilation concept is the same all the year around: Outdoor air is supplied through temperature controlled inlets and open windows. Air is exhausted through open windows and three small exhaust fans. One of the fans is operated continuously to give a minimum air flow rate, and the other two are operated manually. The ventilation is, to a high degree, dependent on the users i. e. opening/closing windows and/or adjusting air flow rates with the fans. The ventilation system can be described as a fan assisted natural ventilation system. The greenhouse has two small exhaust fans, which run when the temperature in the greenhouse exceeds 25 °C .

Ventilation Technology

The building has a fan assisted natural ventilation system. A minimum ventilation rate of 50 l/s (i.e. 7l/s.person or 0.17 l/s.m²) is provided continuously by an exhaust fan. The air is exhausted from the two toilets and the boiler room. Temperature controlled supply vents (temperature range -5°C to wide open at

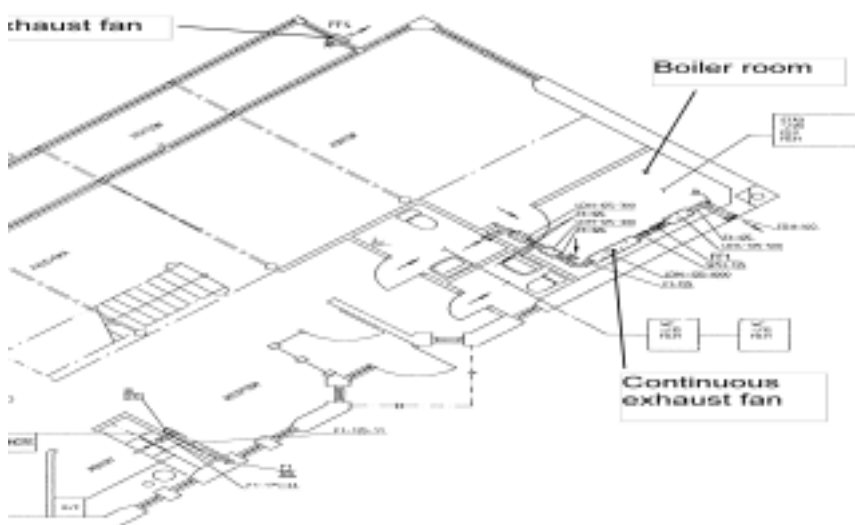


Figure 2: Plan of the Ground Floor

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10°C) are located in the 14 m² office on the ground floor, the 17 m² office, the 24 m² studio on the second floor and by the dormer windows. The two office rooms are connected to a separate manually operated exhaust fan. The studio is equipped with a separate manually operated exhaust fan.

Air is exhausted by two small fans from the attached sunspace directly to the outside, when the air temperature in the greenhouse exceeds 25°C. Replacement air is supposed to enter through ducts between the outside and the greenhouse. This is done in order to protect against high indoor temperatures in the office. There are no vents, but openable windows, in the wall separating the the greenhouse and the office. In winter air is usually not drawn through the greenhouse for preheating.

The building meets the stringent requirement for energy conservation according to the Swedish Building Code.

Summer Monitoring Results

Ventilation: Average ventilation rates (see Table 1) were measured between 25th August and 15th September 1997. They show, that the requirement

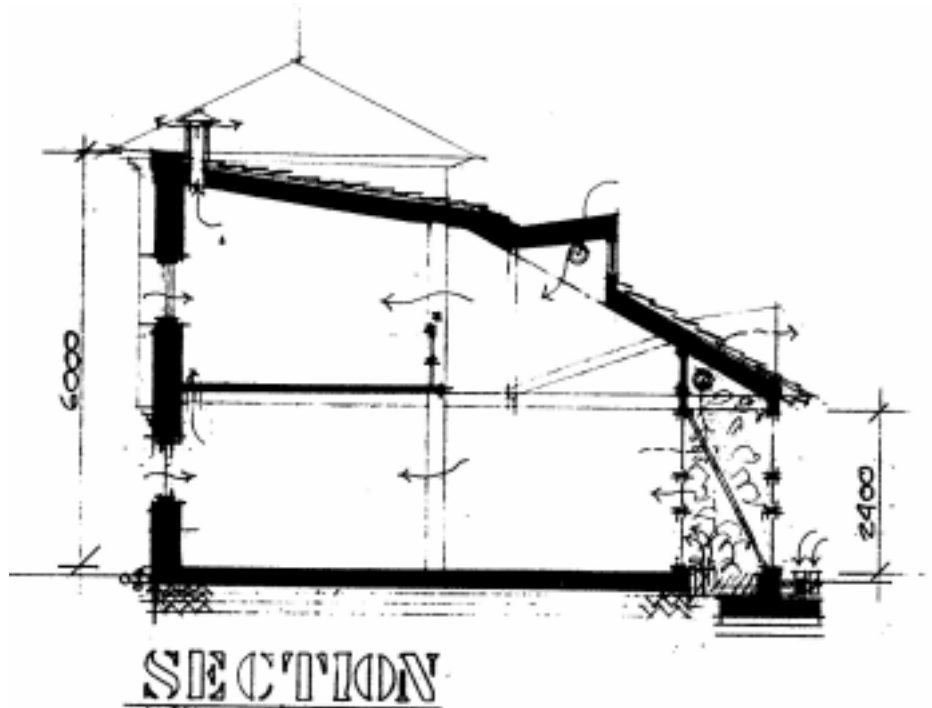


Figure 3: Ventilation Concept

according to the Swedish Building Code i.e. 0.35 l/s.m² is probably fulfilled most of the time. The recommendation of the Building Code i. e. 7 l/s.person is also fulfilled most of the time. During the monitoring period the weather was typical for a Swedish warm summer and windows were used for airing.

Thermal Comfort: Figure 4 shows that in the summer (1st – 31st August 1997) the air temperature i.e. the average for the monitored rooms, was above 26°C for 90% of the time. August 1997 was, however, much warmer than normal: the monthly average temperature was 5°C higher than the normal monthly average.

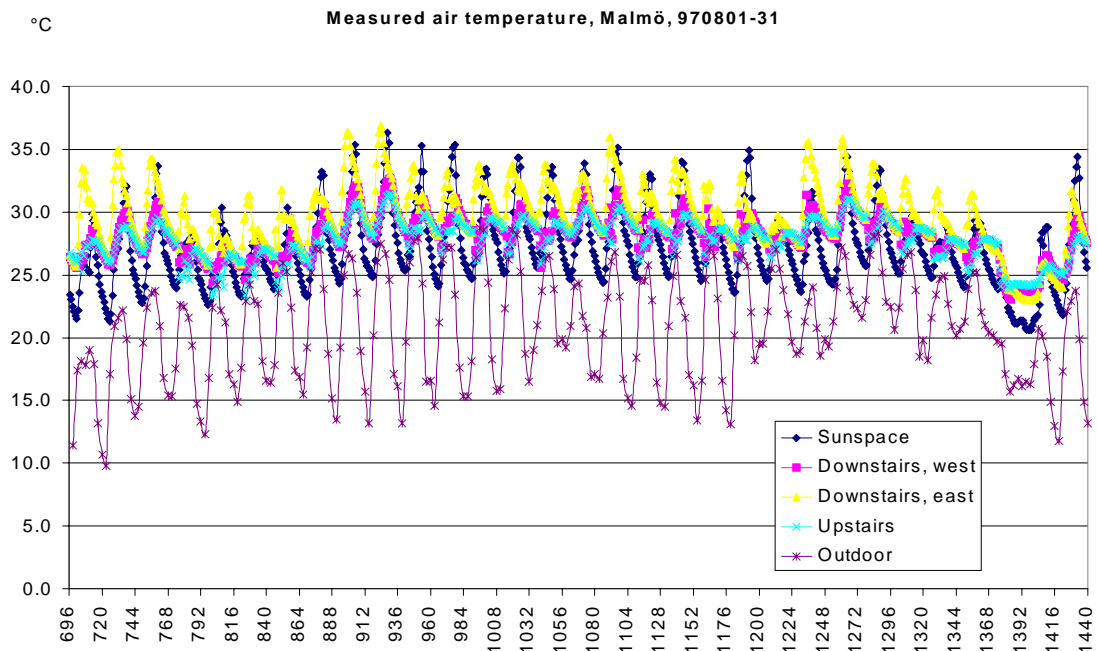


Figure 4: Summer Results. Indoor and Outdoor Temperatures Measured between 1st and 31st August 1997

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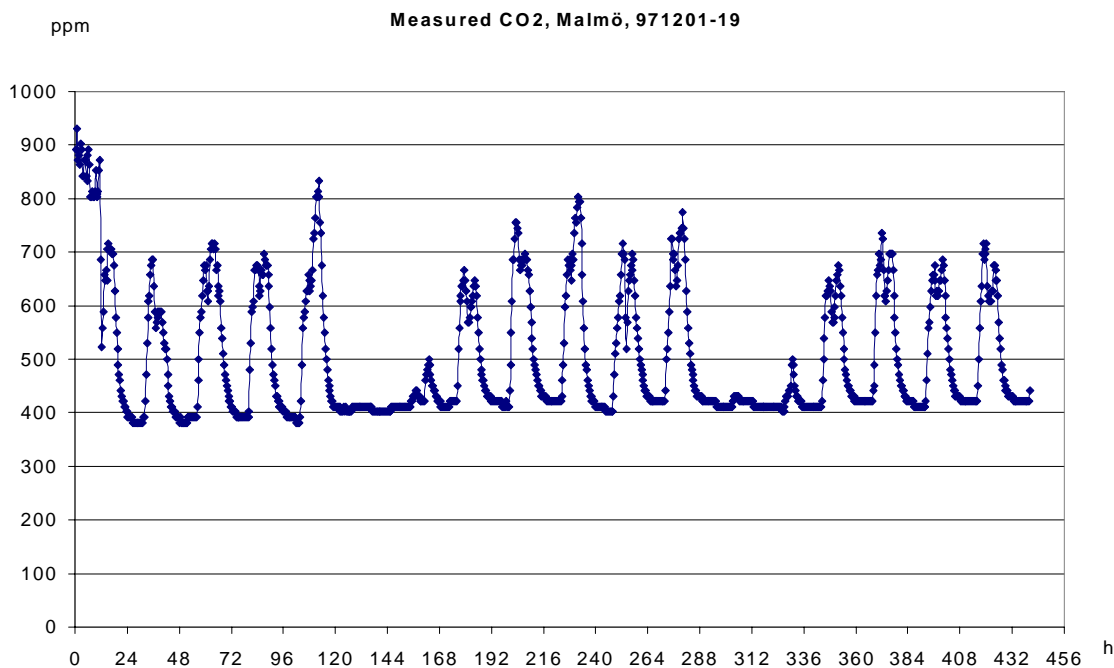


Figure 5: Winter results. Measured Carbon Dioxide Concentration between 1st and 19th December 1997.

Indoor Air Quality: During the monitoring period (3rd July – 22nd September 1997) the CO₂ concentration varied between the background level and an occasional maximum of 600 ppm. The Swedish Board of Occupational Safety and Health recommends a maximum level of 1000 ppm. The weather was fairly hot for a Swedish summer and windows were open most of the time during the day. The relative humidity was more or less the same as outside.

Winter Monitoring Results

Ventilation: A constant flow passive tracer gas technique was used to measure average ventilation rates over 24 hours. The results for the period between 3rd and

19th December 1997 are shown in Table 2. They illustrate that, for a typical winter period, the requirement according to the Swedish Building Code i.e. 0.35 l/s.m² is fulfilled most of time. The recommendation of the Swedish Building Code i.e. 7 l/s.person is almost fulfilled in all rooms. For a couple of rooms the ventilation rate was monitored separately during office hours. The difference between day and night ventilation is fairly large, with a higher (40 %) ventilation rate during office hours. During the monitoring period the weather was typical for a winter in southern Sweden.

Thermal Comfort: During September and December the indoor temperatures were acceptable. During December the air

temperature varied between + 20°C and + 25°C. The variation in indoor temperature was mostly due to control problems with the floor heating system.

Indoor Air Quality: The CO₂ concentrations were higher during the winter period. Hardly any airing took place. The concentrations varied between the background level and maximums of between 700 and 900 ppm. These levels are acceptable. During this monitoring period the average outside temperature was 3°C, with a minimum temperature of -7°C and a maximum temperature of 8°C.

The relative humidity levels were of course lower during the winter period. During the measuring period (1st – 19th

	l/s	l/s.person	l/s.m ²
Total ventilation	160	23	0.53
Exhaust fan air flow	50	8	0.17

Table 1: Summer Measured Ventilation Rates

Room	l/s	l/s.person	l/s.m ²
Total ventilation	164	23	0.55
Exhaust fan air flow	50	7	0.17

Table 2: Winter Measured Ventilation Rates

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December 1997) they varied between 25 % and 35 %. A reasonable level is above 30 %, which is difficult to fulfil without a humidifier in most buildings in Sweden during winter.

Energy Use: The electricity use for space heating, 128 kWh/(m²year), and the use of electricity (excluding electricity for heating), 45 kWh/(m²year) were reasonable. Compared with new Swedish office buildings and refurbished office buildings the use of electricity (excluding electricity for heating) was low and the use of energy for heating high. The total use of energy (space and hot water heating and lighting) was however similar. The high energy use for space heating was partly due to problems with the control system.

Evaluation of Occupants Reactions

For the summer week when the survey was done (when the weather was unusually hot), the indoor air temperature was perceived as uncomfortably hot, but overall comfort was perceived as satisfactory. The windows were open most of the time during the day. Air quality was perceived as satisfactorily fresh without any odours.

According to the questionnaire, hardly any airing took place during the winter. Measurements relating to thermal comfort showed that, occasionally during the winter, temperatures could be characterised as slightly cool. The overall comfort was, however, perceived by the occupants as being fully satisfactory. The air quality was also perceived as fully satisfactory

Lessons Learnt and Suggestions for Improvements

The main problem in summer was overheating and the following suggestions are aimed at reducing overheating.

- introducing night cooling, e. g. by running all the fans.
- improving the shading of the windows, preferably with exterior shading devices, to reduce the direct solar gains. Interior venetian blinds were installed after the monitoring period.
- installing modern energy efficient lighting i.e. HF neon tubes, instead of the old ones. This measure would reduce the internal heat loads

- adjusting the control system for the floor heating in order to stop the system from running during summer. This was done after the monitoring period.

For winter the following improvements have been suggested:

- adjust the floor heating system in order to reduce the use of energy for space heating. This improvement was carried out after the monitoring period.
- increase the air-tightness of the building by installing weather stripping in the windows which lack it at the moment.
- install a ground source heat pump.

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The NatVent Project

Natvent is aimed at reducing energy consumption and carbon dioxide emissions by developing and demonstrating natural ventilation solutions. This project is targeted at climates in which overheating can be avoided by good architectural design and by minimising internal heat gains. By introducing natural ventilation, the complexities of mechanical systems and associated energy demand is eliminated, while the need for air conditioning is minimised. These case study summaries are intended to provide innovative examples of the use of natural ventilation and to demonstrate performance, pitfalls and solutions.

The NatVent Partners

Project Partners are:
Belgium: Belgium Building Research Institute,
Denmark: Danish Building Research Institute,
Netherlands: TNO Building Construction and Research, Delft University of Technology,
Norway: Norwegian Building Research Institute,
Sweden: J&W Consulting Engineers AB,
Switzerland: Sulzer Lab,
United Kingdom: Building Research Establishment, Willan Building Services.

European Joule Project

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