Guidelines for the Classification of Indoor Climate and of Air Distribution Systems

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Background

Sweden has initiated a series of Fenno-Scandinavian guidelines for the qualitative classification of HVAC systems. These guidelines are issued by SCANVAC (the Federation of the Societies of Heating, Air-Conditioning, and Sanitary Engineers in Denmark, Finland, Iceland, Norway and Sweden) and are aimed to facilitate communication between the proprietors of the building and the HVAC consultants insisting proprietors to give measurable specifications early on in the project. Hopefully this will secure a good indoor climate and low energy requirements for new and retrofitted buildings, since adequate specifications can be set up by the builder or the building owner before, or early on, in the design stage. The indoor climate guidelines take into account the fact that the indoor climate is a complex factor and that people perceive it individually.

The reason for the guidelines is partly that the Swedish Building Code was changed in 1989 to give general functional specifications instead of detailed technical ones. The industry must produce guidelines to fulfill the general specifications according to "good industrial practice". The first two published guidelines deal with Indoor Climate and with Air Distribution Systems, respectively. Two more guidelines are under publication; One concerning Commissioning of HVAC systems, mainly Balancing and Functional Performance Rating, and one concerning Operation and Maintenance Instructions, respectively.

Classification of Indoor Climate

Indoor Climate is classified according to the PPD index (Predicted Percent Dissatisfied). There are three thermal, two air quality, and two noise level classes, and also one user-defined class in each class type. These different types of classes can be combined freely.

The measurable parameters are given in accordance with well known Standards, such as ISO 7730, ANSI/ASHRAE 55-1981 or WHO-IAQ. The PPD indices and the resulting values of some thermal parameters are shown in Table 1. The best thermal quality class TQ 1 requires individual temperature control.

In the guidelines four methods are given for calculating the outdoor airflow rate requirements for a room . They all take into account emissions from both humans (mainly CO_2 and cigarette smoke) and building materials (mainly volatile organic compounds, VOCs). The outdoor air must fulfill certain criteria if the indoor air quality classes in their turn shall be fulfilled.

The methods are

- Standard Method I
- Standard Method II
- Physical Method
- Olf Method

The two Standard methods uses three material emission classes (MEC) to take into account the emissions from building materials and furnishing. Tables are also given which divide various types of common building materials into these emission classes. The Standard methods take into account indoor air quality class, occupants per floor area, percentage of smokers and material emission classes. Standard method I can be used when solely the dominating emission class is known. The method uses an equation that involves constants depending on each of the four factors above.

Standard method II can be used when the Area Load Factor (area building material of a certain class per room volume) is known. Two different equations are used depending on the material emission classes and smoking is not taken explicit into account. With Low/Medium emitting materials and about 30% of smokers, the outdoor

Table 1. PPD Indices for Thermal Comfort Quality Classes and Indoor Climate Factors. Examples of acceptable values for measurable thermal climate factors for various quality classes.

Thermal Comfort Quality (TQ) - Percentage of dissatisfied for different quality classes and indoor climate factors

Indoor Climate Factor	Quality Class			
	TQ1	TQ2	TQ3	TQX
Operative temperature	<10%	10%	20%	As specified
Air velocity	10%	10%	20%	As specified
Vertical temperature difference	<10%	10%	20%	As specified
Radiant temperature asymmetry	<10%	10%	20%	As specified
Floor temperature	<10%	10%	20%	As specified

Indoor Climate Factor	Factor Value in Quality Class			
	TQ	TQ2	TQ3	TQX
Operative temperature t_o [°C]				
WINTER MODE				
Highest value	23.0	24.0	26.0	As specified
Optimum value	22.0	22.0	22.0	As specified
Lowest value	21.0	20.0	18.0	As specified
SUMMER MODE				
Highest value	25.5	26.0	27.0	As specified
Optimum value	24.5	24.5	24.5	As specified
Lowest value	23.5	23.0	22.0	As specified
Air velocity within the occupation zone [m/s]				
WINTER MODE	0.15	0.15	0.15 (0.25)	
SUMMER MODE	0.20	0.25	0.40	As specified

airflow rate must be increased by about 50%. With Medium/High emitting materials the airflow rate increase must be about 25 %.

The influence of the building material emissions on the outdoor airflow rate, according to Standard method II, is shown in Figure 1.

The Physical method demands that all emission source strengths are known, which means that it seldom can be used with present level of knowledge. The same applies to the Olf method, as the Olf source strengths also seldom are known.

Classification of Air Distribution Systems

The main new feature of this guideline is a classification of the energy efficiency of the air distribution system. The Specific Fan Power {SFP [kW/(m^3/s)]} is used as a means of expressing the electrical efficiency of the air distribution system. The SFP is defined as the design power of all fans in the air distribution system divided by the design airflow rate through the building, in Scandinavia typically the exhaust airflow rate. This definition is more or less in accordance with the ASHRAE/IES Standard 90.1-1989.

The energy efficiency classification should preferably be done according to the System Specific (electrical) Energy use {SSE [(kWh/year)/(m^3/s)]} as this includes the electricity to all fans, refrigerant chillers etc in the Ventilation and Air-conditioning System (VAS). This value also takes into account the control strategies of the HVAC system. So far VAS classes have been established solely according to the Specific Fan Power due to lack of knowledge. The classification system can be expanded to include the

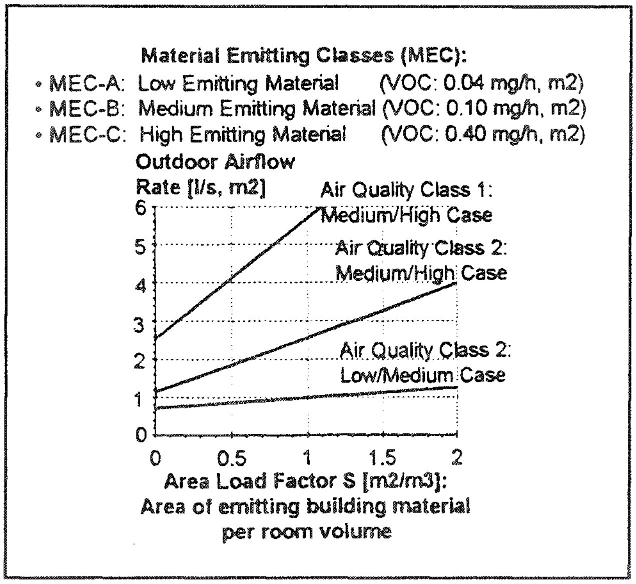

Figure 1. Outdoor Airflow Rate for 1 Person per 10 m² Floor Area. Low/Medium (LM) and Medium/High (MH) building material emission classes, respectively. According to Standard Method II with 0% of smokers.

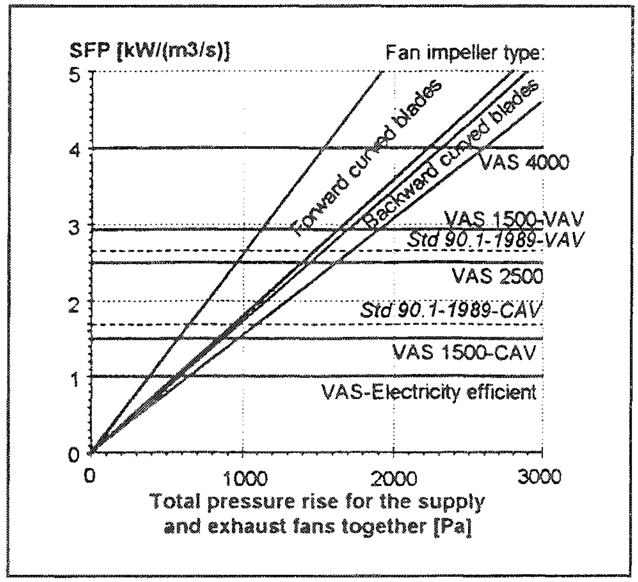

Figure 2. Specific Fan Power, for Various VAS Classes, as a Function of the Total Pressure Rise for the Supply and Exhaust (Return) Air Fans Together, Depending on the Fan Efficiency. For fans with a motor power of 3 - 10 kW. Prescriptive criteria from ASHRAE/IES Standard 90.1 - 1989 are shown for comparison.

Specific Fan Energy {SFE}, the Specific System (electrical) Power {SSP} and the Specific System (electrical) Energy {SSE}.

Three quality VAS classes are established together with a special electricity efficient class {SFP < 1.0 kW/(m³/s)}, and one user-defined class as well. Instead of defining twodifferent SFP values at design conditions for CAV and VAV systems, respectively (as in ASHRAE/IES 90.1-1989), the same SFP value shall be applied for CAV systems at design conditions, and for VAV systems at an airflow rate of 80 % of the designed. As a result the VAS 1500 class provides about the same fan power criteria as the ASHRAE/IES Standard 90.1-1989.

Figure 2 shows the Specific Fan Power, for various VAS classes, as a function of the total pressure rise for the supply and exhaust (return) fans together, depending on the fan efficiency.

Beside electrical efficiency, the guidelines also give specifications for measuring, balancing, cleaning and duct leakage as the most important factors. The specifications for measuring and cleaning are mainly given because a new Swedish law states that almost all ventilation systems should be functionally tested (and possibly cleaned) at certain prescribed time intervals. For day-nursery buildings, schools and hospitals, this interval is one year, and for most other commercial buildings, such as office buildings, it is three years.

References

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