Room Air Conditioning Strategy

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Introduction

At present there is no unambiguous classification for the room air conditioning strategies or terminology. Traditionally the room air conditioning classification has been based on the room air distribution methods. The most used division has been the division into mixing and displacement, while the other methods have been varied.(2,7) In German guidelines the division has been made based on the resulting air flow pattern within the room rather than distribution methods.(8) Etheridge and Sandberg suggested the air distribution methods to be classified as jet controlled or thermally controlled, which raises the important question how well the room air flow patterns are controlled by the air distribution method.(5)

The direct application of air distribution methods to describe the strategies has led to the wild usage of different terms with unclear definition. Additionally, in some cases the same term has been used to describe both the air distribution method and air supply devices or in some cases even the whole air conditioning system. Using a wrong term can also lead to a complete misunderstanding of the physical phenomenon in the room. For example, the term "displacement" is currently used for the room air distribution method in which room air flows are primarily driven by the buoyancy of the thermal sources inside the room and not by the supply air that is introduced to replace (substitute) the air removed by the sources in order to prevent the return flow back to the occupied zone. Thus the term "replace" (substitute) gives a correct picture of the phenomenon, while "displace" may mislead the user to believe that the flow field is created primarily by the air distribution method. The results of this inconsistency can also be seen in the presentations of experts in scientific conferences, but much more confusion is caused in everyday construction business, where the customer often doesn't have any expertise in our technology field.

This paper introduces a new strategy approach for the room air conditioning including classification and terminology.(1) The basis of the classification is different aims or ideas of the temperature, gas, particle or humidity distributions and air flow patterns that can be created within the room. The distributions are often described by using contaminant removal and temperature effectiveness-coefficients.(5)

The aim of this classification is not to value one strategy over another. They all have their advantages and disadvantages and it is up to the designer to select the most desirable strategy for each case. In practice a certain type of room air conditioning strategy can be applied by using different kinds of air distribution installations and air supply devices. How well the real situation will fulfill the aim of the ideal strategy is dependent not only on the physical installation itself, but also on the operating parameters as well as the characteristics

of other internal sources that influence the supply air flow patterns and the room air flows, such as heat and contaminant sources, cold drafts, room heating and cooling methods. It is therefore important to separate the ideal strategies from the practical room air conditioning solutions.

Classification for Room Air Conditioning Strategies

As the focus of the proposed classification differs from the present practice it is necessary to explain the used terminology. The aim of the room air conditioning is to maintain desired conditions, **target levels**, in the room during different operating conditions in the most economical way (energy, cost efficiency). Depending on the design criteria the designer has different strategies to choose in order to achieve specified targets. The room air conditioning design and evaluation process is illustrated in Figure 1.

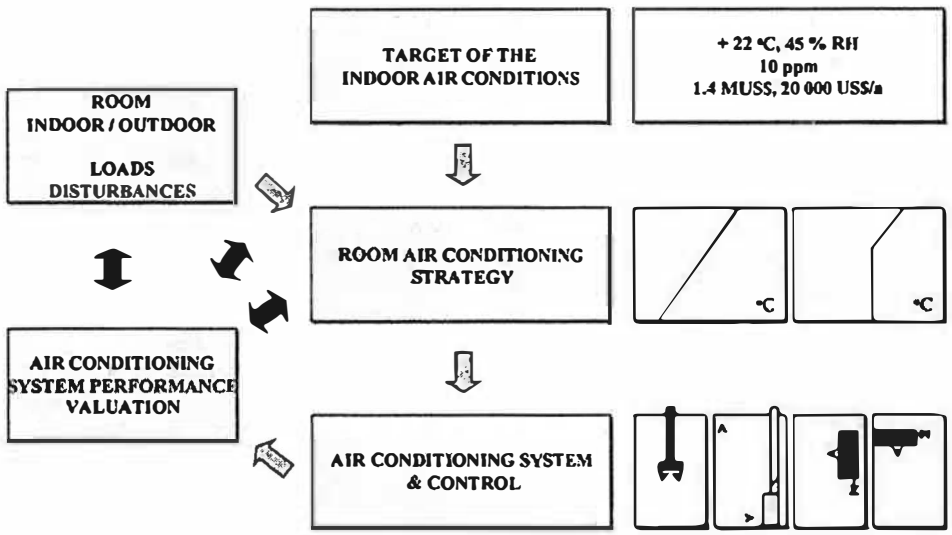


Figure 1. The Room Air conditioning and Evaluation Process

The room air conditioning **strategy** is a fundamental scheme that describes the targeted temperature, humidity and contaminant distributions as well as air flow patterns within the air-conditioned room. The room air conditioning **system** consists of different methods and their controls that all together create the system performance. The system performance is evaluated by comparing the reached conditions to the chosen strategy. Both the **methods** (room air distribution, exhaust, room heating and cooling, etc.) and processes and disturbances inside the room influence the resulting conditions. As an example of the terminology we can use the system consisting of low impulse air devices supplying directly into the occupied zone (often called displacement ventilation) and cooled ceiling methods. In Roomvent '98 conference there were presented three separate papers, which proved the system to behave almost as a complete mixing strategy instead of replacement.(3,4,6)

Though the following presentation discusses the room air distribution method as a principal parameter to apply a certain room air conditioning strategy and heating and cooling as

assisting methods, it must be noted that in some cases a strategy can be fulfilled also without any mechanical air distribution installations using buoyancy forces. The classification of ideal room air conditioning strategies is summarized in Figure 2 and explained more in detail in the text. Though the main emphasis of this presentation is on the general room air conditioning, the same ideas of different strategies can be used also for local ventilation. Additionally, as ideal, the classification doesn't make a difference whether the flow direction is horizontal or vertical (upwards or downwards).

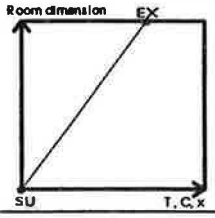
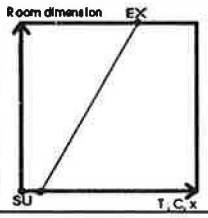
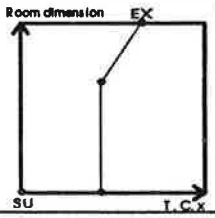
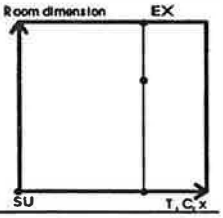
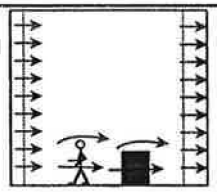
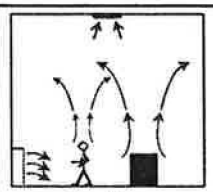
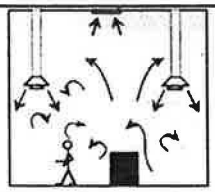
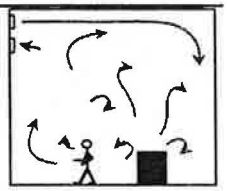
AIR CONDITIONING STRATEGY:	PISTON	STRATIFICATION	ZONING	MIXING
DESCRIPTION	To create unidirectional air flow field over the room area by supply air.	To support flow field created by density differences by replacing the airflow out from the room area with supply air	To control air conditions within the selected zone in the room by the supply air and allow stratification of heat and contaminants in the other room areas	To provide uniform conditions throughout the ventilated space
HEAT, HUMIDITY AND CONTAMINANT DISTRIBUTION (Pictures) X-axis: °C, mg/m^3, g/kg Y:axis: Room dim. (e.g. height) SU=supply, EX=exhaust				
MAIN CHARACTERISTICS:	Room air flow patterns controlled by low momentum unidirectional supply air flow, strong enough to overcome disturbances	Room air flow patterns controlled mainly by boyancy. Supply air distribution with low momentum.	Room air flow patterns controlled partly by supply and partly by boyancy.	Room air flow patterns controlled typically by high momentum supply air flow.
IDEAL EFFICIENCY	$\varepsilon_t = (t_{ex} - t_0)/(t_{oz} - t_0)$ $\varepsilon_c = (C_{exh} - C_0)/(C_{oz} - C_0)$ 			
TYPICAL APPLICATION (An example of a general room air distribution method)				

Figure 2. The summary of the ideal room air conditioning strategies

Conclusions

The room air conditioning strategy should be used as a target for design and construction of the room air conditioning system. Often it would be desirable to apply several strategies during different operating conditions (e.g. summer-winter). The selection of the system and the set of methods should be made in such a way that the different strategies can be applied most efficiently. The clarification of the room air conditioning strategies and their separation from the practical methods at present creates space for creativity and new innovations and their evaluation. Naming a practical room air distribution method according to a certain strategy may lead to misunderstanding of its performance in varying operating conditions.

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