MANIKIN TECHNIQUES AND THERMAL COMFORT CRITERIA IN HEATED INTERIORS

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INTRODUCTION

A major aim of buildings is to protect us from unpleasant outdoor climate. Man stays inside buildings most of his life and this environment becomes a significant factor affecting his general health. From the point of view of building construction and heating systems, the quality of the indoor climate must be satisfying to human physiological requirements, as well as subjective sensations. Therefore, suitable heating systems should be designed and operated to maintain acceptable levels of thermal comfort in interiors [5]. Requirements for indoor thermal comfort result from the physiological and hygienic conditions of the occupants. Thermal comfort criteria in heated interiors of dwellings must be met by adjusting the physical properties of the building construction and by the performance of the heating system.

THERMAL COMFORT CRITERIA IN HEATED INTERIORS OF DWELLINGS

Thermal comfort criteria in heated interiors of dwellings are affected by the following thermal properties: thermal resistance and thermal capacity of structures, thermal reception of floors, thermal stability of 'rooms, water condensation on structures, and air infiltration through structures. Heating systems are designed after specification of the thermal envelop has been completed. Then the criterion for their design becomes some ambient temperature: i.e., a globe temperature or an operative temperature. However, thermal comfort of heated interiors must be guaranteed not only by setting optimal parameters (globe temperature, horizontal and vertical temperature gradients, surface temperature of the floor, thermal radiant intensity, relative air humidity and air velocity), but also by giving admissible values and their ranges [3].

THERMAL MANIKIN TECHNIQUE

Although the principle of thermal manikins is well **known,** there are significant'differences between actual types and, therefore, the "EIT-MAN" (ETI-Hungarian Institute for Building Science) version is briefly described. The "ETI-MAN" thermal manikin is a sophisticated measuring instrument consisting of the thermal body, and a controlling and data acquisition system with two microprocessors and a computer for higher level evaluation of measured data. The manikin body is a full-scale male plastic model. Neglecting here the description of construction details, it has to be mentioned that the manikin body is divided into 18 segments in the sitting position and 16 in the standing position.

The principle of the thermal manikin involves measuring the supplied electric heating power necessary to maintain the temperatures of individual body segments at prescribed values with high accuracy. The following quantities are measured by the data acquisition system: deviation of the average temperature at the segment from the prescribed value, heat transfer per unit area through the segment surface, thermal resistance between the segment surface and the ambient air expressed in clo, and finally the ambient temperature sensed by the segment [4].

EXPERIMENTAL MEASUREMENT

The aim of the experimental measurement is to deterine the following quantities in a room heated by different convective, radiant, and combined heating methods [2]: a. the relation between the convective and radiant heat flow to the human subject, b. the ratio of convective and radiant components in the mathematical expression of the operative temperature, c. the global thermal states at different places and points.

The listed quantities were measured using the thermal manikin in the microclimatic laboratory, where typical heated interiors of dwellings were simulated. Two basic measurements were made at **4** different points (A-in the corner, B-in front of a window, C-in the middle of the room, and D-in the front of the outside wall) when: a. the surface temperatures of all walls and the indoor air temperature were kept at **18, 20, or 22 C,** and **b.** surface temperatures were maintained at Fanger's optimal value of **22,5C**.

RESULTS

From the point of view of place (A, B, C, or D), there is a great thermal comfort difference between pairs of points A,B, and C,D. A convective heating system characterized by a radiator placed in front of the window was not suitable, especially at points C,D, where a so called cold radiant heat flow was observed. A floor heating system was found to be the most acceptable for an occupied zone, i.e. in the middle of heated interiors. while in front of outside walls with windows, thermal comfort was compromised. A ceiling radiant heating system is not suitable for this application, especially for points A,B, where a significant cold radiant heat flow was recorded. A wall radiant heating system guarantees the best thermal state in front of the outside windows and provides acceptable thermal comfort in other places as well. A combined heating system (basic floor heating with radiators) was acceptable in all places of heated interiors.

CONCLUSIONS

It can be claimed that according to the described experimental evaluation of heated interiors of dwellings from the point of thermal comfort criteria: a. Subjects preferred radiant heating over convective heating, b. The coeficient for mean radiant temperature in the mathematical expression of the operative temperature must be greater than the coeficient for the indoor air temperature, **c.** Global thermal comfort from the aspect of heat exchange between the human body and heated interiors is best for combined and wall radiant heating systems.

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