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THERMAL ENVIRONMENT IN A MODEL HOUSE FOR THE AGED

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Abstract: Houses and instruments for the benefit of aged welfare have been developed as one of the solutions to this important problem of the next Century. To live in comfort and to save energy, the thermal environment in a model house for the aged has been monitored. It was made clear that floor heating and ceiling radiant cooling gave a comfortable environment to the aged due to uniform room temperature distribution and that air-conditioning cooling with a ceiling fan was energy efficient.

Keywords: Aged welfare, Thermal environment, Infrared monitoring

1 INTRODUCTION

Along with environmental preserving, food supplement, and energy conservation, aged welfare looms an important global problem of the next Century. There are many subjects in aged welfare maintenance, such as constructing institutions and houses, developing instruments and machines, taking physical and mental care in a hospital or at home, making amusement for the aged, confirming social supporting systems, and so many. A model house and some instruments in the house have been developed by one of the working groups (the authors are members) in Shiga Prefecture, Japan, supported by the New Energy and Industrial Technology Development Organization of Japan (NEDO). The working group built a model house called "Welfare Techno-House Shiga" and tested living conditions and environments in the house. This paper reports the experimental results of the thermal environment in the house, focusing on human comfort and energy-saving.

2 MODEL HOUSE

The "Welfare Techno-House Shiga" is a test house for providing a comfortable living environment and for developing useful instruments for home treatment of the aged. The house has the total floor area of 224.5 m^2, the first floor 131.7 m^2 and the second floor 70.3 m^2, and was built by National Housing Co., Ltd. in March 1996. The instruments installed in the house are air-conditioners, a home-elevator, a moving lift for transporting the aged from room to room, a chair lift set at the stairs, an electric wheelchair, and a care bed. A floor heating- or a ceiling radiant cooling-system is set, if necessary. The monitoring instruments are a radiant thermometer system, a contact thermometer system, and an infrared imaging camera. The radiant thermometer system made by Eto Denki Co. Ltd., Thermic 2100A, measures room temperature at 4 or 5 points in the room. This system has 8 channels of platinum resistance-element to make a measure of temperature, PT100, with an accuracy of 0.3 , and a data logger with sampling time of 1 min. Skin temperature of the subjects is measured by a contact thermometer system made by Tabai Espec Co. Ltd., which has 8 channels of thermistor elements with an accuracy of 0.5 , and a data logger with sampling time of 1 min. An infrared imaging camera, Thermofine TVS-800MkII made by Nihon Avio Co. Ltd, monitored the subjects and the circumstances of the test room.

3 EXPERIMENTAL RESULTS AND COMMENTS

The monitoring of the thermal environment in the model house is focused on providing human comfort and saving energy. We conducted two pair experiments; one is the pair of floor heating and air-conditioning heating and the other is ceiling radiant cooling and air-conditioning cooling. Our hypothesis for this experiment is that a uniform temperature distribution in a room is best for health and human comfort of the aged as reported elsewhere [1], [2].

Figure 1 and 2 illustrate examples of temporal changes of room temperature, skin temperature, and comfort of an elderly woman subject in the cases of floor heating and air-conditioning heating, respectively. From comparing the two figures, skin temperature difference of the subject in the case of floor heating is smaller than in the case of air-conditioning heating. So, floor heating gives a

comfortable environment to clients. Figure 3 and 4 show similar examples of temporal changes of room temperature, skin temperature, and comfort of the same subject in the cases of ceiling radiant cooling and air-conditioning cooling, respectively. From these figures, it is clear that the subject feels more comfortable in ceiling radiant cooling than in air-conditioning cooling due to the smaller difference in skin temperature.

Another experiment on saving energy has been done in the case of using a ceiling fan. The result is shown in Table 1. When the fan is working, mean skin temperature of the four subjects is lower by about 0.5 than without a fan.. Comfort level in the case of fan-working at 29 room temperature is similar to the case of fan-stopped at 27 room temperature. Therefore, the use of a ceiling fan can give a similar comfort level in a room that is 2 hotter than a room without a fan. This equates to a 2 energy-saving, that is, 750 Mcal/year. An air-conditioning cooling system with a ceiling fan is very effective to save energy.

This experiment in aged welfare was the first trial in Shiga Prefecture, Japan. Strong conclusions cannot be drawn immediately: we have to further discuss the problem of the aged welfare and to develop new technologies for this purpose from total aspects of health, mental care, comfortable environment, energy-saving, and so on.

Table 1 Mean skin temperature and comfort of 4 subjects in the experiment of ceiling fan effect

setting room temperature	27		29	
fan-situation	on	off	on	off
skin temperature				
morning	33.2	33.7	33.2	34.4
afternoon	33.6	34.3	34.2	34.2
comfort	medial	good	good	bad

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REFERENCE

[1]Shin-ichi TANABE: Effects of the thermal radiation on human comfort and methods of evaluation, Japanese Journal of Infrared Science and Technology, Vol. 2, No. 2, pp22/29 (1992)
[2]Christopher K. WILKINS and Risto KOSONEN: Cool ceiling system: a European air-conditioning alternative, ASHRAE Journal, Aug. pp41/45 (1992)

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