VERTICAL PROFILE OF CONTAMINANT CONCENTRATION IN SICKROOM WITH LYING PERSON VENTILATED BY DISPLACEMENT

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INTRODUCTION

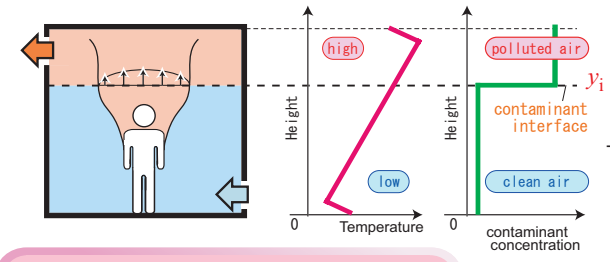
In the sickroom, high indoor air quality and thermal comfort is essential for the treatment of patients.

Therefore it is proposed to use displacement ventilation for the whole room ventilation and the radiant panel for the thermal comfort of each bed.

Indoor air quality → Energy saving → Displacement ventilation + Radiant panel

Thermal comfort → Energy saving → Displacement ventilation + Radiant panel

WHAT IS DISPLACEMENT VENTILATION?



Supply fresh air with a low velocity at floor level. Withdraw the warmer, polluted air at the ceiling.

The air quality in the occupied space should be good.
Two-zone flow pattern is established, a lower zone with clean air, and an upper one of more polluted air.
The height of interface between the two layers is referred to as the "interface height."

The airflow rate balance at the interface height can be expressed by

$$Q_s = NQ_p(y_i) + \sum_{k=1}^{n} Q_{uk}(y_i) - \sum_{k=1}^{m} Q_{dk}(y_i)$$

Supply air flow rate — The airflow rate of plume

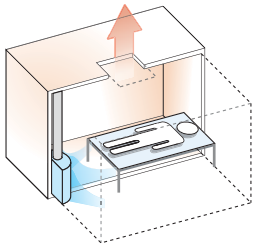
Substituting the vertical distributions of airflow rate of each flow element into equation, interface height can be obtained.

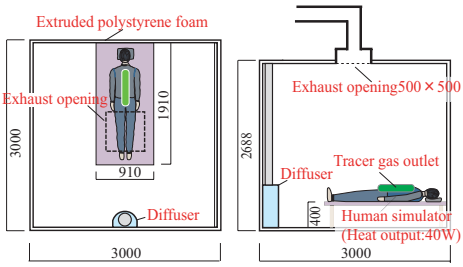
EXPERIMENTAL METHOD

The displacement ventilated room is set up in an air conditioned room.
Room air temperature, wall surface temperature and contaminant concentration are measured.

Heat source is a mannequin twisted around with heating-cable.
It is located on the bed in the center of displacement ventilated room.

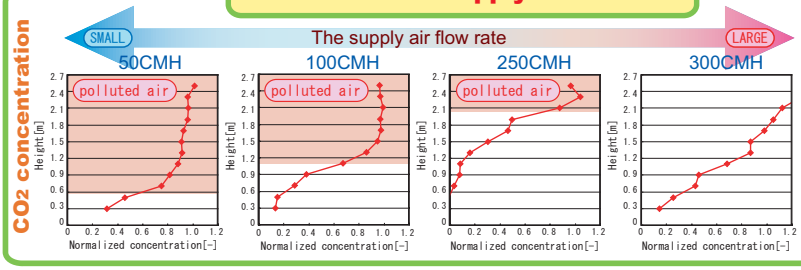
To simulate heat sources other than human, additional heat sources are used.
CO2 is used as tracer gas. The CO2 supply tube is located on the mannequin.





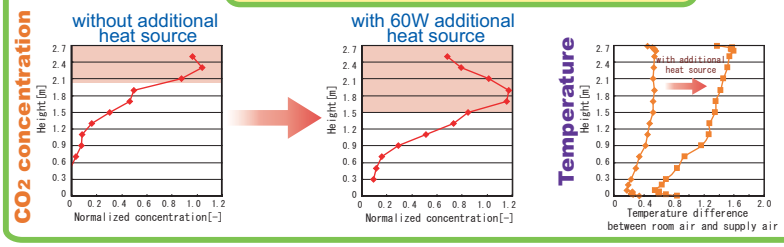
EXPERIMENTAL RESULTS

Influence of the supply air flow rate



The experimental results indicate that the contaminant interface is formed at upper level of the room, but it becomes obscure with increasing supply air flow rate

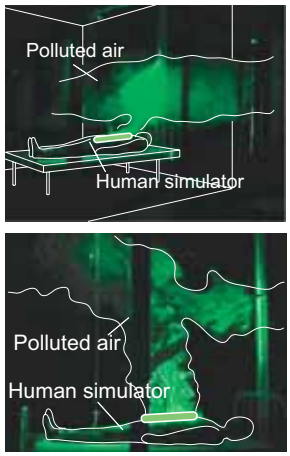
Influence of the heat emission rate



Obvious thermal stratification is formed in the case with additional heat source.

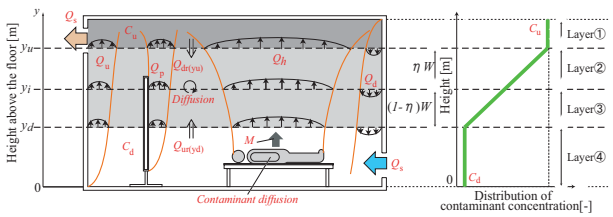
Additional heat source makes the contaminant interface clearer, but the height of interface moves lower because of the plume of additional heat source.

Flow visualization



Polluted air from human can't come down below contaminant interface

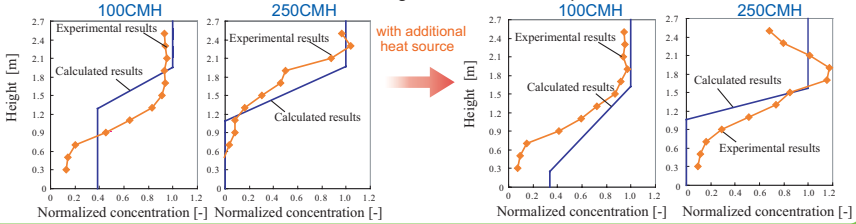
MODEL VALIDATION



In order to predict contaminant concentrations in the displacement ventilated room, interface layer model is used. This model is based on contaminant balance by convection and diffusion.

Calculated result

Calculated results don't coincide with the experimental ones so much without additional heat source .
The calculated results with additional heat source relatively coincide with experimental ones. This is because the thermal stratification becomes strong due to the thermal plume from additional heat source.



DISCUSSION

The temperatures and contaminant concentrations in displacement ventilated room are measured and compared with calculated results by the interface layer model. As a result it is indicated that the contaminant concentration can be predicted with using interface layer model. In further work, the temperature profile in the room will be tried to predict.