Priority Subjects — **Development of a Supply/Demand Infrastructure for Next-Generation Electric Power**

Evaluation of Energy Efficiency in Commercial Kitchens

Background and Objective

Commercial electric kitchens are becoming widespread, for the reason that they do not use exhaust combustion gas, emit less radiant heat, and are highly energy efficient. They can also contribute to energy-saving and reduction in indoor thermal environmental impact. However, the effects of energy-saving and size reduction on air conditioning systems for kitchens are not fully taken advantage of as the required ventilation air volume is currently regulated to conform to gas-fired kitchens.
In this project, we discover the adequate ventilation in an actual commercial kitchen, which does not lead to uncomfortable hotness, condensation, or an unpleasant smell. Moreover, we investigate the relationship between capture efficiency of exhaust hoods and air disturbance deriving from the cooker's movement or from air-conditioner.

Main results

1 Assessment of Ventilation Performance and Energy-Saving Effects of Reducing Ventilation in Commercial Kitchens

We have carried out an examination in an actual commercial electric kitchen in which the amount of ventilation changes between three values, 0.25m/s, 0.20m/s and 0.15m/s at a face velocity on an exhaust hood opening. The results of a questionnaire targeting the worker showed that changing the ventilation amounts had no clear difference on thermal comfort, condensation, and unpleasant smells in the kitchen, even in case of 0.15m/s which is half of design standard value*1 (See Fig. 1). Furthermore, we calculate the amount of annual energy-saving using a heat load simulation. The energy-saving effect was calculated to be 60% for ventilation and 11% for air-conditioning (See Fig. 2). (R12001)

2 Relationship between capture efficiency of exhaust hood and air disturbance derived from the cooker's movements

We investigated the capture efficiency of an exhaust hood while using a fryer and a noodle cooker. The capture efficiency for the fryer and noodle cooker is 92% and 93% respectively (See Table 1). Meanwhile, the respective capture efficiencies without air disturbance are 97% and 98%. The capture efficiency decreases 5 points due to air disturbance. This suggests that there is no remarkable reduction in the capture efficiency due to the air disturbance derived from a person's movement while cooking. (R12003)

3 Relationship between capture efficiency of exhaust hood and downward air current in front of the exhaust hood derived from an air diffuser

We developed equipment which is able to generate imitated downward air flow and control air flow velocity in front of an exhaust hood. We investigated the capture efficiency of the hood when the air flow velocity is changed as a parameter on a fryer and a noodle cooker. Provided that the downward air flow velocity is less than 0.4m/s, there is no remarkable reduction in the capture efficiency for both the fryer and the noodle cooker (See Fig. 3).(R12011)

*1 Design standard value of ventilation is 0.3m/s at a face velocity on an exhaust hood opening.

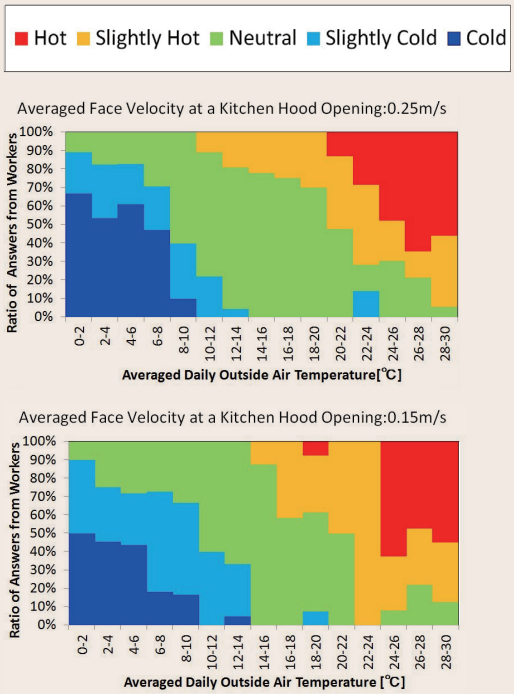

Fig. 1: Influence on thermal comfort by reducing ventilation amount

There was no clear deterioration of thermal comfort observed due to changes in the amount of ventilation, even in case of 0.15m/s which is half of standard value.

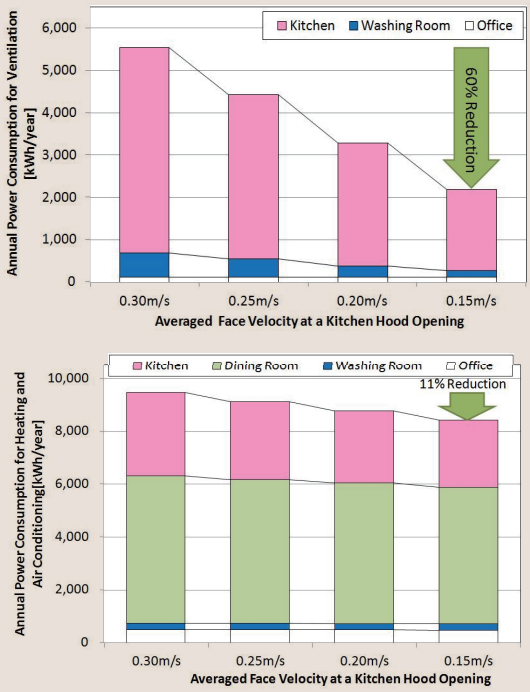

Fig. 2: Energy saving effect for ventilation (upper) and for air conditioning (lower) by reducing ventilation amount

The energy saving effects of reducing the ventilation amount to 0.15m/s, or half the standard value, were found to be 60% for ventilation and 11% for air-conditioning.

Table 1: Capture efficiency of exhaust hood while cooking

The capture efficiency on an electric fryer and an electric noodle cooker are 92% and 93% respectively.

Cooking Appliances	Cooking Behavior	Capture Efficiency	
		While Cooking	No Air Disturbance
Fryer	Tempura Cooking	92%	97%
Noodle Cooker	Boiling Noodles	93%	98%

Cooking tempura

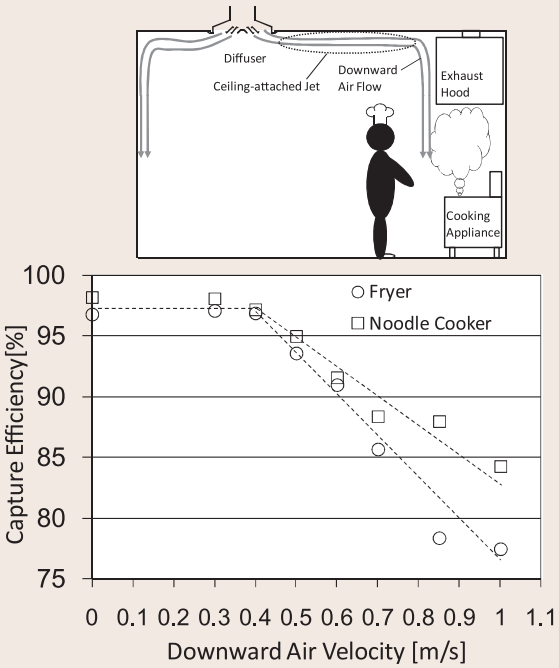

Fig. 3: Relationship between capture efficiency and downward air velocity in front of exhaust hood

Provided that the downward air flow is less than 0.4m/s, there is no remarkable reduction in capture efficiency of exhaust hood.