Design Support for Electric Kitchens

Background and Objective

Commercial electric kitchens are becoming widespread, because they have features such as no exhaust of combustion gas, emitting less radiant heat, and being highly energy-efficient. They can contribute to energy-saving and reduction in indoor thermal environmental impact. But the effects of energy-saving and reduction in size on air-conditioning systems for kitchens are not actually brought out enough, because the required ventilation air volume is determined in conformity to the gas-fired kitchens. In this project, we aim to develop a design support tool for commercial kitchens and element technologies for efficient ventilation and its accurate measurement.

Main results

1. Verification of calculation accuracy of design support tool

We simulated temporal variations in temperature and humidity in a dining hall by using the design support tool for commercial kitchen. The results showed a good agreement with the measurements. It proved that the tool had sufficient calculation accuracy (Fig. 1). It is applicable to both electric and gas kitchens, and available for rational selection of ventilating and air-conditioning equipments and prior confirmation of indoor thermal environment at the design phase [R10036].

2. Development of measurement method for collection efficiency of oil-mist

To measure and evaluate collection efficiency of oil-mist at kitchen exhaust hood precisely, we developed an oil-mist generator which imitated particle size distribution and amount of oil-mist emitted during actual cooking [V10015].

3. Detection Method of Walking Person by Spatio-Temporal Data

To evaluate the influence of cooks' movements on buoyant plume generated from cooking appliances, we developed a system that automatically detected walking cooks and tracked them in dynamic picture image [R10031].

4. Investigation on heat and fluid flow above a cooking oven

The availability of a numerical simulation technique of non-steady heat and fluid flow for development of effective exhaust methods was confirmed by revealing effects of a cooking pan on buoyant plume generated from a gas range (Fig. 2) [N10022]. Experimental data on velocity and temperature of air flow near a heat source were acquired to make use of the simulation [N10030].

5. Examination on Design Standard for Commercial Kitchen Ventilation in ASHRAE

We examined the design standard for commercial kitchen ventilation in ASHRAE, which the Japanese standard is based on, through bibliographical surveys. The ASHRAE standards have been updated regularly, and the definition which the Japanese standard was compliant with has been taken off from the current standards. The ventilation air volume is defined in terms of exhaust hoods and kitchen instruments in it [R10002].

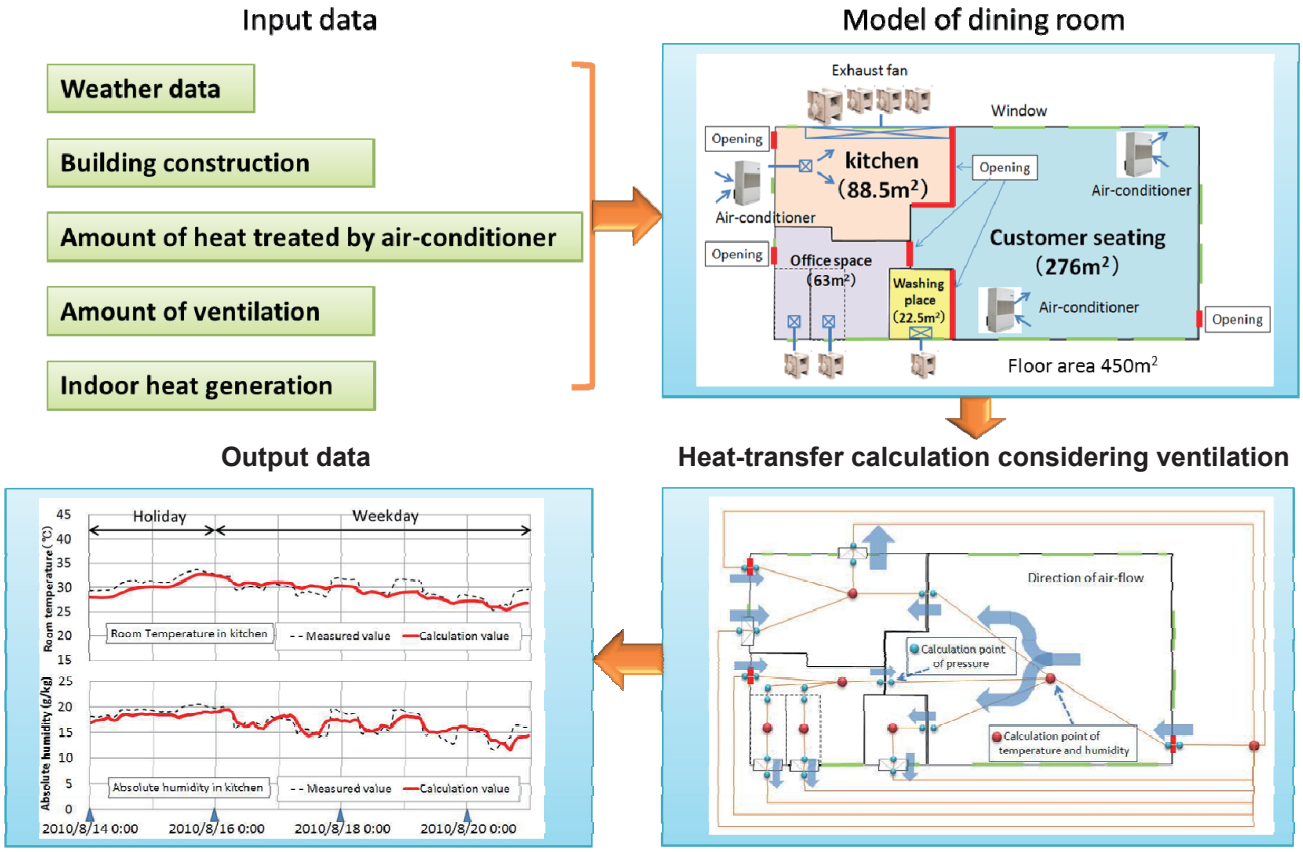
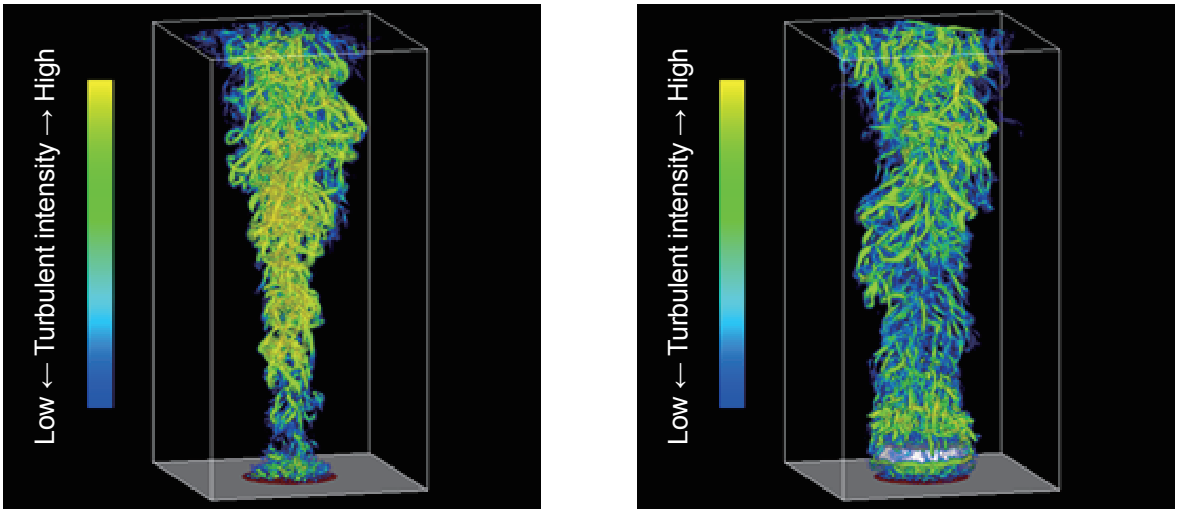


Fig. 1 Calculation flow of design support tool for commercial kitchens

The simulation results on temporal variations in temperature and humidity in an actual dining hall showed a good agreement with the measurements. It proved that the tool had sufficient accuracy.



(a) Case without a cooking pan **(b) Case with a cooking pan**

Fig. 2 Buoyant plume generated from a gas range

Yellow and blue correspond to high and low turbulent intensity in buoyant plume, respectively. The turbulent intensity becomes low and the plume width expands by setting a cooking pan on a gas range.