Project Research — **Development of a Supply/Demand Infrastructure for Next-generation Electric Power**

# Design Support for Electric Kitchens

## Background and Objective

Commercial electric kitchens are becoming widespread, as they feature a lack of exhaust combustion gas, they emit less radiant heat, and they 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 actually brought out enough, as the required ventilation air volume is determined in conformity to gas-fired kitchens. In this project, we develop a design support tool for commercial kitchens and element technologies for efficient ventilation and the accurate measurement thereof.

## Main results

### 1 Development of a Test Facility for Ventilation Performance and the Measurement of the Ventilation Efficiency of Commercial Electric Kitchens

In order to precisely measure ventilation efficiency (ratio of the oil mist generated from cooking appliances to that collected from an exhaust hood), we developed a test facility to control ventilation air volume accurately (Fig. 1). We also developed a tracer oil mist generator that imitated the particle size distribution of oil mist generated from griddles, fryers, and steam convection ovens. By using the facility, we obtained results showing no descent in ventilation efficiency by cutting down ventilation air volume to 70% of the current standard value under calm conditions (R11005, V11024).

In order to evaluate the influence of air turbulence generated by a cook's motion on ventilation efficiency, we analyzed a cook's motion in an actual kitchen in detail and modeled such. We found out that the descent in ventilation efficiency caused by air turbulence generated from a board imitating a cook's motion (a turbulence generator) was only slight (Fig. 2) (R11016, R11023).

### 2 Measurement of the Energy Consumption and Thermal Environment of an Actual Commercial Kitchen (Comparison of Before and After Electrification)

We carried out a long-term measurement of consumption of electricity, gas, and water, along with the indoor thermal environment of an actual commercial kitchen, before and after electrification (Fig. 3) (R11006).

### 3 Examination of the Design Standard for Commercial Kitchen Ventilation in VDI

We examined the design standard for commercial kitchen ventilation in VDI, which is widely applied to Europe, through bibliographical surveys. The VDI standard has features that allow transient air leakage from the exhaust hood and that collect such gradually, therefore sufficiently suppressing the required ventilation air volume. This enables us to achieve energy-savings in air conditioning and to reduce the size of air conditioning systems for kitchens (R11004).

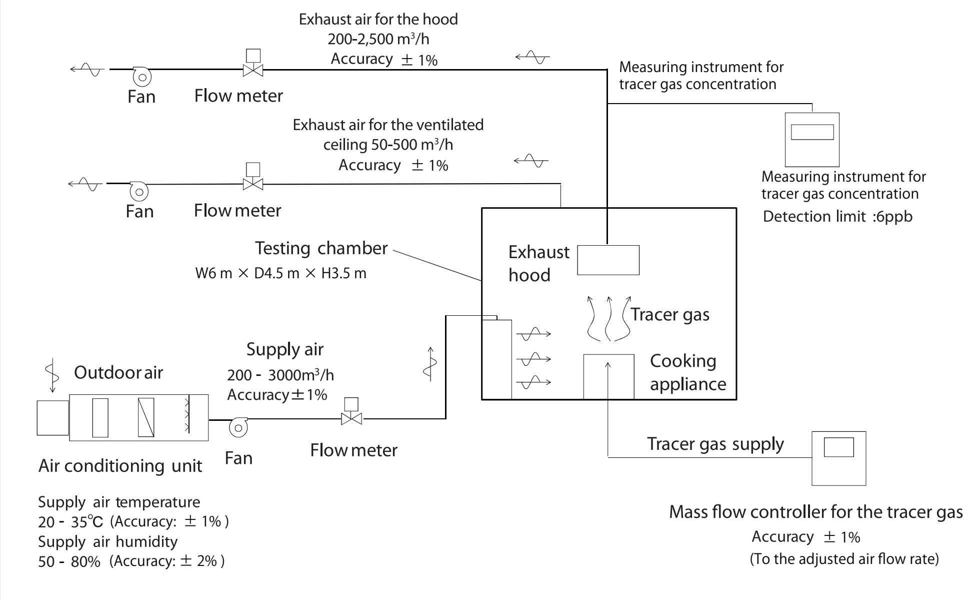
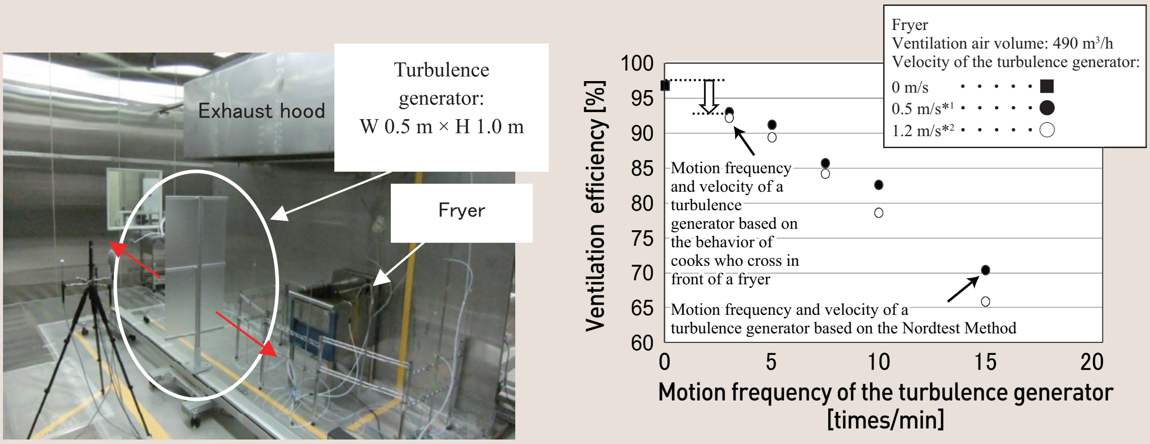


Fig. 1: Outline of the test facility for commercial kitchen ventilation

The test facility enables us to accurately control ventilation air volume, supply air temperature, and relative humidity.



A board moves automatically and repeatedly from end to end in order to generate air turbulence.

*1 Velocity derived from the Nordtest Method VVS088

*2 Average velocity of cooks who cross in front of cooking appliances

Fig. 2: Relationship between the ventilation efficiency of the hood and the motion frequency of the turbulence generator

There is no remarkable reduction in ventilation efficiency at the velocity and the frequency of an actual cook's motion in front of cooking appliances.

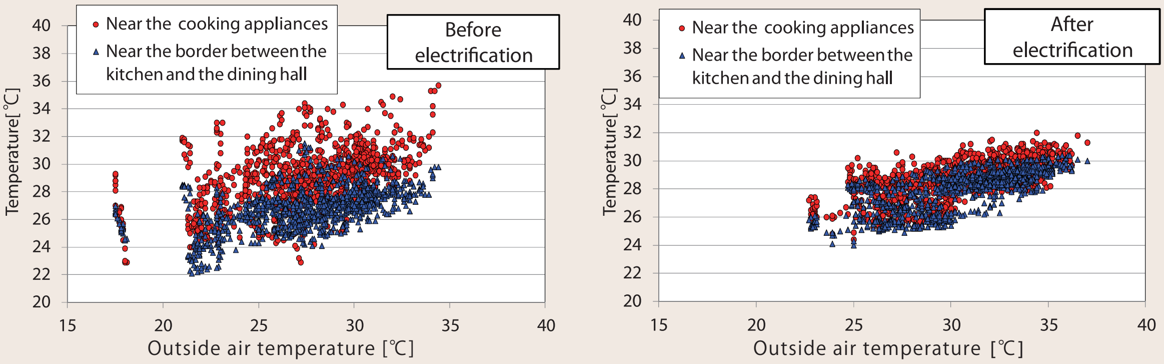


Fig. 3: Temperature in the kitchen in the summer

The gaps in temperature in the kitchen have decreased due to electrification repair work. Excessive rises in temperature are not observed even near the cooking appliances. The thermal environment in the kitchen has improved.