If You Can't Stand the Heat, It's Time to Fix the Kitchen

Photo 1: Spot cooling laminar flow units.

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After selecting equipment for a commercial kitchen, the next step is to determine the exhaust duct path from the hood to the fan. Then, size the duct and design of the fan system in accordance with National Fire Protection Association 96-2004: *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.*[1] The design provides for a replacement air system. And, the hood's exhaust capacity is selected either using a code [2] formula or is based on manufacturers' recommendations for airflows for listed hoods.[3]

Recent research has resulted in reasonable capture/containment design rates relative to cooking surface temperatures and duty classification of the cooking equipment. These cooking temperatures determine the force of the rising thermal plume from the cooking surface to the hood canopy. ANSI/ASHRAE Standard 154-2003, *Ventilation for Commercial Cooking Operations,* addresses the cooking surface temperature relationship to cooking process and type of duty.

Kitchen supply air and replacement air terminals allow for hood capture and offer some thermal comfort for staff. The improvement of kitchen hood operations and reduction of exhaust air requirements based on current research, resulted in efforts to provide reasonable comfort conditions.

Industry research shows a velocity greater than 50 fpm (2.5 m/s) at the hood's lower edge disrupts capture and containment. Codes[4] require tempering replacement air in winter conditions. However, kitchen staff demand cooling in warmer times of the year. If the kitchen is too hot, the staff leaves for the nearby cooler kitchen, making it difficult to staff a hot kitchen.

Define Comfort

The kitchen includes the general food

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preparation area and the cooking line. The general food preparation area has lights, people and equipment loads that produce the heat. The cooking line has hot surfaces that radiate heat to the kitchen, making this space hot and uncomfortable. ANSI/ASHRAE Standard 55-2004, *Thermal Environmental Conditions for Human Occupancy,* temperature recommendations for a kitchen are 68°F to 74°F (20°C to 23°C) in the winter and 73°F to 79°F (23°C to 26°C) in the summer. These ranges are acceptable for the general kitchen space.

However, what is a reasonable space temperature when standing in the cooking line? To be comfortable on the cooking line, provide a draft (air motion) to supply an effective temperature of temperature ranges listed previously.

The components that make up effective temperature are temperature, humidity and air motion. The air motion must be a draft that provides comfort and not a draft that disturbs the rising thermal plume from the cooking surface. Still air should be 50 fpm (2.5 m/s) in the occupant level. One-hundred fpm (5 m/s) of air leaving a low velocity supply air terminal is an appropriate draft blowing down over the cook. This draft does not disturb the capture and containment feature of the hood. Humidity is not an important concern in the kitchen area if temperature and air motion are acceptable.

The kitchen supply air and the transfer air generally have been dehumidified. Therefore, only the replacement air needs to be heated and cooled.

Photo 2: Dish machine hood.

Air-Side Heating and Cooling System

Heating and cooling comes from three air sources: the kitchen system supply air (heated and cooled); the replacement air system for the hood exhaust (often heated and seldom cooled); and transfer air (heated or cooled) from an adjacent space. (*Figure 1* shows typical kitchen HVAC systems.) The primary focus of the exhaust system is to remove the heat, smoke, moisture and odors from the kitchen. Comfort at the cooking line is dependent on either a cool area or cooling with a draft.

A traditional overhead air system supplied through ceiling slots or diffusers heats and cools the general kitchen space. These terminals should have a high air diffusion performance index (ADPI). Slots and vane-type diffusers have acceptable ADPI ratings. However, these devices should be installed or directed away from the hood canopy. They can cause unacceptable drafts that disturb the hood capture and containment.

Industrial ventilation technology provided the basis for the original design values for kitchen hoods. These code formulas used the principle of capture velocity under the hood area. As technology advanced, the exhaust process evolved to allow the rising thermal plume to carry the effluents to the hood canopy, allowing the duct/fan system to transfer this material to the outdoors.

Operation economics drove the replacement air to be heated to the minimum code requirement of about 50°F (10°C) and no cooling. This led to the development of the short circuit hood, where the replacement air was neither heated nor cooled. This concept worked better in the warmer climates. However, cold untempered air formed frost on the filter banks in the colder climates. The heat melted the frost, and moisture dripped onto the cooking surface, which was unacceptable.

Using short circuit hoods is no longer popular. The reason is industry research reduced the airflow needed to remove the contaminants, and the UL 710, *Standard for Safety for Exhaust Hoods for Commercial Cooking Equipment*, rating system became the minimum airflow required for capture and containment of effluents.

Choosing to Cool

The economics of retaining a good kitchen staff has raised the focus on making the hot zone of the kitchen more comfortable. Technology has made the hoods work better with less exhaust and, thus, less replacement air. The next problem was to treat the replacement air for maximizing worker comfort. Various replacement air outlets have been used. (*Figure 2* shows replacement air options.) There are hood front-face grille/perforated plates, hood frontline air curtain slots, back wall supply ducts, and displacement air terminals. All of these work to some degree. The designer can select the type most appropriate for the area's climate. The downside of the above-mentioned units is as follows:

- Front-face outlets. They air condition the general kitchen space but not the cooking line;
- Hood frontline air curtain slots. They cool the cooking surface and disturb the rising thermal plume;
- Back wall supply ducts. They take up rear utility connection space (gas, electricity, water) and produce cold area near the staff's feet; and

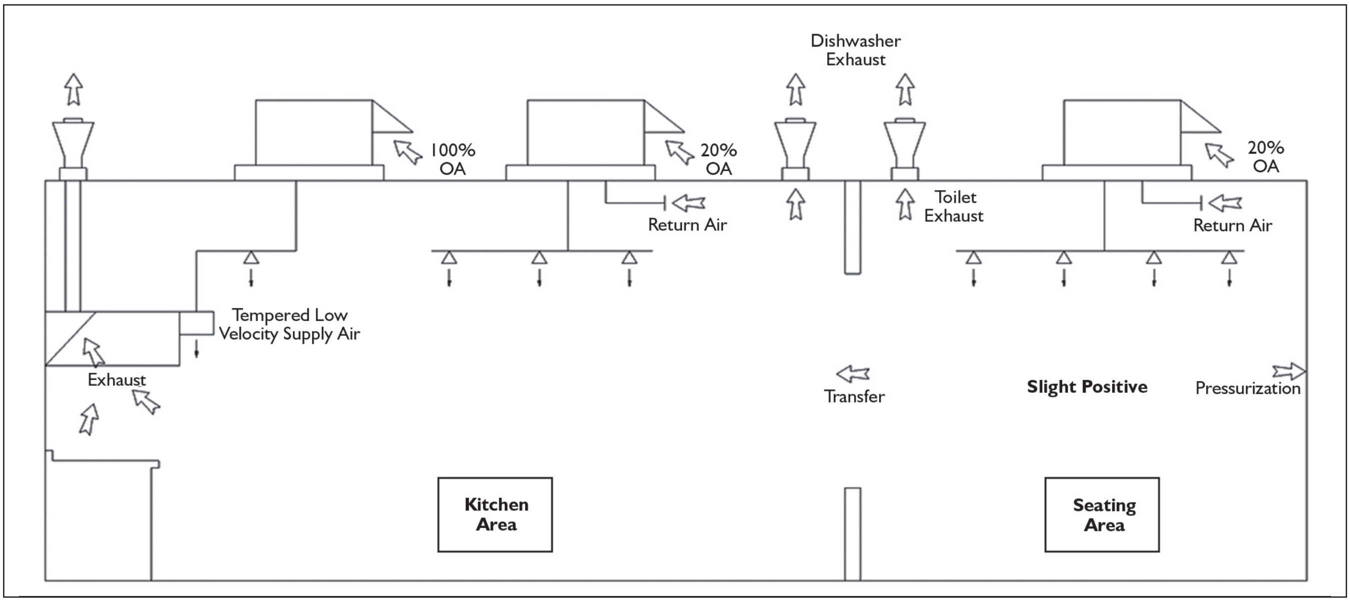

Figure 1: Typical HVAC systems for kitchens.

- Displacement air terminals. It is difficult to find wall space for these units in a kitchen.

Designers have turned to the appropriate draft, spot cooling laminar flow technology used in hospital surgery rooms and cleanroom designs. The airflow is straight down and the terminal velocity is acceptable at about 50 fpm (2.5 m/s) at the hood lip (*Photo 1*). This 100 fpm (5 m/s), at the outlet and 50 fpm (2.5 m/s) at the hood lip, translates to a range of 110 to 125 cfm per linear foot (170 to 195 L/s per linear meter) of hood for most units on the market. Units are available with the front face and the bottom face perforated and an adjustable damper to divide the flow between the two outlets.

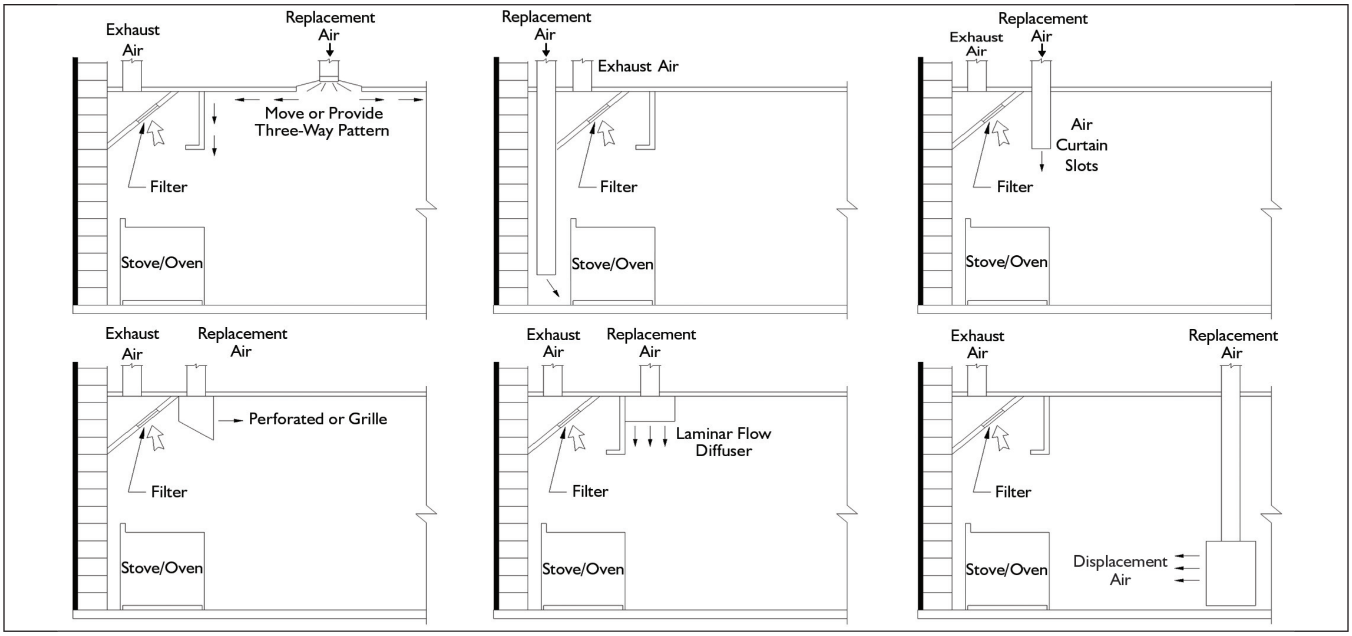

Figure 2: Replacement air options for kitchens.

Constant Volume/Variable Air Volume

Further industry economic analysis has led to variable supply air systems and variable exhaust systems. Variable flow on the supply side is a temperature control strategy only to supply enough air to cool the occupants. Variable flow on the exhaust side minimizes the cost of the air treatment for air that is thrown away. The exhaust can be reduced when no contaminants need to be removed.

Advertisement formerly in this space.

The design problem is to maintain a constant replacement air source that matches the variable exhaust air quantity. The design problem is solved by connecting the two systems together with a control system designed for this use. The variable operation can be a two-speed operation or variable speed drives on the fans.

Control of Other Heat Sources

Provide a capture hood over the dish machine rather than a ceiling grille in the general area (*Photo 2*). Locate the cooler, refrigerator and freezer condensing units outdoors, not in a ceiling space above the units. Consider an air curtain at the service door if the door is left open for a long period during the stocking of kitchen supplies.

Summary

We have technology developed for the proper capture and containment of effluents from the heat sources in the commercial kitchen. The key is to use UL 710-listed hoods relative to the correct range of cooking surface temperatures and cooking process. However, remember that UL 710 exhaust cfm is only a laboratory minimum for capture and containment, and the manufacturers' recommendations should be followed for a given cooking process. Verify that the hood overhang is suitable for the equipment under the hood. Use partial end (side) panels to improve hood performance. End panels and low velocity laminar flow diffusers are available from most hood manufacturers.

Finally, we can focus on the staff comfort in the general kitchen area and in the warmer zone of the cooking line. Maintaining staff is the driving force behind air conditioning kitchens. General kitchen comfort results from normal heating and cooling systems sized for people, lighting and equipment loads. Using a system that supplies a reasonable heating/cooling temperature, and a draft motion down over the cooking staff provide a comfortable environment.

References

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