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The kitchen is too hot. Work areas are drafty. Grease is deposited on the roof. Neighbors complain about cooking odors. Utility bills are too high. Do you have a kitchen with these problems? All of them can be traced to ventilation conditions. This article describes steps to improve problems related to Type I hood systems that collect and remove grease. Kitchen cooking smoke also emanates from these Type I hoods.

Until laboratory capture/containment testing information was available, the design of kitchen ventilation systems did not advance. With the results from the testing, required exhaust cfm values changed dramatically. Industry and ASHRAE-sponsored research has studied cooling of the replacement air for better staff comfort and analyzed what is going up the stack. This research has led to a dynamic time for kitchen ventilation design.

Containment Problems

The principle purpose of the kitchen hood system is to capture and contain the rising thermal/effluent plume coming off the cooking equipment. The circumstances that cause containment problems are air disturbance of the rising plume and lack of overhang to capture the heat or effluent.

The first step in any hood with capture and containment problems is to observe airflow conditions. Introducing hot

chemical smoke under the hood canopy helps to show air disturbance conditions or lack of removal by the exhaust flow. The hot smoke source is produced by placing a small can of sand into a boiling pan of water then lighting a smoke bomb in the sand inside the can. A smoke puffer also can be used to observe the airflow path of the cooling and replacement air systems to see which way the air is traveling toward the exhaust hood, the other exhaust systems, or the return air to the HVAC units.

Another place to check for capture is the front and side overhang of the hood above the cooking equipment. Cooking equipment should be pushed as far back as possible toward the rear of the hood. Front overhang should be 12 in. (305 mm) at minimum, which is based on ASHRAE and industry research. On

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Light Duty	Low Temperature	Under 450°F	150 cfm/linear foot
Medium Duty	Medium Temperature	450°F to 600°F	250 cfm/linear foot
Heavy Duty	High Temperature	More Than 600°F	300 cfm/linear foot
Extra Heavy Duty	Wood Burner	More Than 700°F	500 cfm/linear foot

Table 1: Exhaust flow rates based on cooking duty and temperature.

convection ovens, the front overhang should be 6 in. (152 mm) past the open door at a 90 degree angle from the oven. This often translates into an 18 in. (457 mm) overhang. Wiring and gas piping can be revised to provide space in the rear of the hood for the equipment to be pushed back. Hood side panels are also an aid in improving hood side overhang and side draft disturbance problems. These side panels are available from all hood manufacturers as a retrofit item.

Evaluating Current Conditions

To solve a problem, you must know the current conditions. Start with the cooking equipment. Obtain the kitchen equipment supplier's recommended cooking surface temperature to determine if the equipment is considered light (450°F [232°C]), medium (600°F [316°C]), heavy (700°F [371°C]), or extra heavy duty (more than 700°F [371°C] or solid fuel).

Next, measure the hood's airflow. This can be done by measuring the airflow velocity through the filter bank and using the filter's appropriate correction factor to arrive at the exhaust rate in cfm. Another method is to measure the discharge fan velocity and the size of the discharge outlet to arrive at a cfm value.

Once the exhaust cfm value has been determined, this number should be compared to current industry values. These exhaust values are based on capture and containment of the heat and effluent rising from a hot surface. The UL 710, *Standard for Safety for Exhaust Hoods for Commercial Cooking Equipment* requirements rating system became the airflow minimums.

The hood manufacturers use the UL 710 test as the beginning basis for their hood exhaust rates, and we should use them as a minimum checkpoint. The exhaust rate is based on cfm per linear foot of hood front face, cooking temperature and cooking duty. These rates are for wall-mounted canopy hoods. Other minimum hood values are listed in the *2007 ASHRAE Handbook—HVAC Applications*, Chapter 31, Table 3, as well as applicable local mechanical codes (*Table 1*).

Hood Front Draft Turbulence

The location of supply air diffusers or grilles within the general vicinity of the hood front face often creates turbulence at the hood front lip, which results in the cooking effluent spilling out from under the hood. The solution is to redirect the supply air away from the hood face with diffuser baffles or by moving the diffusers farther away. The concept of a short-circuit hood was developed to supply untempered replacement air directly to the hood's interior space. This air was directed toward the filter bank and often caused turbulence that resulted in the effluent spilling out from under the hood. Lower exhaust rates and the

requirement for heat tempered replacement air have made the short-circuit hoods obsolete.

Cooking Line Thermal Comfort

The warmest workstation in a kitchen is in front of the cooking equipment. In recent years, a heating/cooling supply terminal has been located near the hood front face to improve working conditions for cooks. Also in these same design times, replacement air outlets were also located near the cooking line. These designs were the downblow slots in the front hood lip and the front face grilles/face perforations. These designs were an attempt to supply air near the cooks and not create hood face drafts that would disturb the capture and containment. Slot ceiling diffusers also were used to direct the air near the hood face, but still direct the air away from the hood face.

The best solution is to revise the location and type of supply air outlet. Close off all the existing hood supply downblow grille or front face outlets, and use a low velocity laminar flow outlet (*Photo 1*). Hood manufacturers have created a perforated perimeter downblow supply (laminar) unit that can be installed in front of the hood. The discharge velocity is about 100 fpm (0.5 m/s) and reaches 50 fpm (0.25 m/s) at the hood lip. The conditioned air can cool the cook and not create turbulence at the hood lip.

Grease in the Exhaust Duct or on the Roof

This problem is the result of the grease not being removed at the hood filter face or secondary removal system. First, check the exhaust cfm relative to the cooking temperature and the hood duty recommendations. The exhaust rate is most often found to be below the recommended cfm/linear foot. When the cfm rate is increased to the recommendations, the filters create turbulence and surface cooling, which results in the grease being captured at the filter face.

A simple solution is to check with the supplier for a source that uses less grease in their products. This solution is often used for side wall exhaust systems that show grease dripping down from the wall louver outlet. Basic hood grease filters are a baffle type with which the grease is extracted by centrifugal force through an aluminum or stainless steel baffle path.

Another solution is the use of an extractor cartridge, which has a longer baffle path. A newer type of filter is known as an extended surface filter. This unit has a longer baffle path and more cooling surface. However, any change of a filter unit from the basic filter to the type with more surface area will require modification to the exhaust fan because of high static pressure requirements. Avoid adding other expensive technologies, such as water cooling/cleaning units, cartridge filters, and electro-



Photo 1 (left): Low velocity laminar flow replacement air outlet. Photo 2 (right): Stack extension on an upblast power roof ventilator.

static precipitators to control the stack effluents until all the basic options have been exhausted.

Cooking Odor Complaints

The cooking odors are transmitted through the hood/filter system with nothing to remove them. The odors leave the exhaust fan discharge and are free to reenter the outside air inlets of nearby HVAC systems. The hazardous chemical industry has the same problem. Their simple solutions are to direct odors away from the inlets and to dilute the effluent. The typical outlet veloc-

ity of an upblast power roof ventilator is only about 1,000 fpm (5.1 m/s). This is about 11 mph (18 km/h). If an outside air intake is nearby, a 10 to 15 mph (16 to 24 km/h) crosswind will direct the odor into the system, which may result in complaints. Photo 2 shows the addition of a stack to an existing power roof ventilator (PRV) to direct the exhaust air away from the rooftop air handler's (RTU) outside air intake. Another solution is to use a high velocity stack discharge of about 2,000 fpm (10.1 m/s), which will direct the odors away from the inlets. Another chemical industry solution is to use dilution. The method is to introduce

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outside air into the exhaust stream just before the fan inlet and then also use the high velocity discharge. A 20% mixture of outside air is often sufficient for satisfactory dilution. Discharge velocities in the range of 2,500 fpm (12.7 m/s) are acceptable for discharge velocity noise. A discharge velocity above 3,000 fpm (15.2 m/s) creates noise complaints.

Utility Bills Are Too High

Slowing down the exhaust fan on an older hood system designed using the code exhaust rate formula is the first step in lowering utility bills. However, capture and containment must be maintained. Match the cfm per linear foot of hood face with the current industry standards noted in this article. Then slow the fan down to this new

exhaust rate. Visually test using the cooking heat and a smoke puffer test to verify that all is well in the areas of capture and containment. Be aware that by slowing the exhaust fan down the upblast fan discharge may cause recirculation of the exhaust into the nearby air intakes of rooftop air supply units. If you have a short-circuit hood, close off the short-circuit air supply to the hood, and direct this replacement air into the kitchen area. The new replacement air source should be heated and cooled to maintain kitchen staff comfort. The heated and cooled air outlet should be the new laminar flow type located in front of the hood face. After the exhaust system has been adjusted to a satisfactory solution of capture and containment, then the replacement air system's cfm rates also can be reduced. All these cfm reductions will result in lower utility bills.

Summary

A basic hood with a simple baffle filter, which has been tested by the manufacturers to ASTM F2519-05, should handle most cooking situations if the exhaust rate is based on Underwriters Laboratories, ASHRAE and manufacturers' recommendations based on cooking duty (temperature). Any exhaust system changes should try to match the exhaust rate relative to the latest industry and ASHRAE information. The next step is to remove any factors that are causing air-flow turbulence near the hood canopy. The addition of hood end panels is a low-cost addition to minimize some turbulence. Appliances should be pushed back under hoods to provide more front overhang. The final step is to appropriately handle the system discharge, which should be away from any outdoor air inlets. The topic of smoke and odor can be resolved by using the dilution solution in conjunction with the high velocity vertical discharge stack technology that is standard in industrial ventilation.

Staff comfort, at the cooking line, is best served by the addition of the laminar flow air source in front of the hood. With the reduction of exhaust air going out of the stack and less tempered replacement air need, utility bills will be reduced.

The solution to most kitchen ventilation problems is to observe/document what is installed and then update the systems to today's technology. ●

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