Quantifying Capture & Containment for Kitchen Exhaust Hoods

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Introduction

In 1998, a program was initiated to develop an innovative backshelf hood system that could achieve a much lower capture and containment (C&C) exhaust rate than traditional backshelf hoods. As part of this effort, an evaluation of the state-of-the-art tools in use in commercial kitchen ventilation in the United States was undertaken. This paper presents the new hood concept KVL, a description of the latest techniques available for determining C&C performance, and comparisons of the KVL new hood concept to other hoods.

A New Hood Concept

The developer wanted to capture a portion of the backshelf hood market in the United States and had not previously produced a backshelf hood. A backshelf hood has a couple of unique design criteria, including a mounting height of 18 inches (457 mm)above the appliance and a backset of 0 to 24 inches (610 mm). The developer's hood utilizes a typical backshelf hood shell but incorporates a unique technology to improve the C&C efficiency of the hood. In this approach, air jets are placed at the front of the hood and directed downward to form an air curtain in front of the hood as seen in Figure 1. This has the effect of forming a protective barrier that prevents heat, smoke, grease and other contaminants from spilling into the kitchen thereby reducing air-conditioning load and making for a more comfortable and safe environment for employees working in the kitchen.

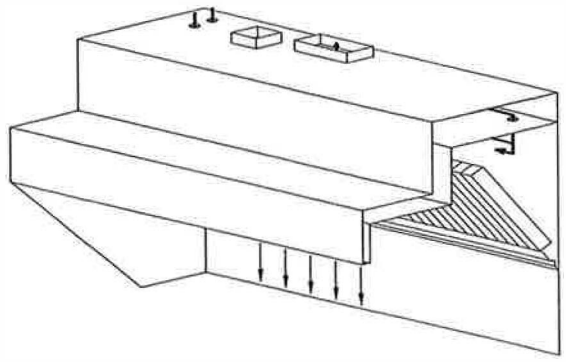

Figure 1. KVL Model Hood With Air Jets

Quantifying Capture and Containment

There are several means of determining the C&C performance of kitchen hoods. In Europe, the German-based Verein Deutscher Ingenieure (VDI) Standard 2052 is used to determine the C&C requirements for hoods based upon the convective airflows from

cooking appliances. In the United States, Standard F1704-96 by the American Society for Testing and Materials (ASTM) has provided a foundation for determining the C&C performance of kitchen hoods. A more recent innovation in the commercial kitchen arena, is the use of Schlieren technology to perform thermal imaging of the cooking plume to precisely measure the point at which C&C is obtained.

VDI Standard

The VDI Standard 2052 (1) calculates the sensible and latent thermal loads from an appliance line-up under the hood. During both cooking and idle, there is a free convection thermal flow (sensible load) above kitchen appliances due to differences in the air density. In addition, during cooking only there is a steam (or latent) load that is a function of the appliances and food under the extraction hoods. Additional factors account the physical size of the appliance, height between the appliance and extraction hood, and the location of the appliances relative to walls. These factors make the VDI 2052 a robust standard; however, there is still a significant amount of work to be done on some of the basic assumptions relating the heat from the appliances to it's nameplate rating. Work performed for ASHRAE in the United States has shown that the heat from appliances can vary significantly whether the appliance is idling or cooking (2). Additionally, the amount of heat from an appliance is not linearly related to it's nameplate rating. In fact, it's conceivable to have an appliance (such as a griddle or broiler) that has higher sensible heat gain during idling than cooking. Finally, different hood designs have different C&C efficiencies. The VDI standard currently has the same exhaust airflow calculated for different hood designs and does not encourage manufacturers to develop more efficient products.

ASTM F1704-96

ASTM F1704-96 (3) is a fairly rigorous standard that defines the test setup required to determine C&C in canopy and backshelf exhaust hoods. The basic requirement to perform this test is the construction of an air-tight room which has the ability to measure the air supplied to the room while a pressure differential of less than 0.05 in. Hg (0.17 kPa) is maintained between the laboratory and ambient conditions while the laboratory is sealed. The supply air to the room (along with the exhaust flow) are varied until the hood captures the cooking effluent. One current limitation of ASTM F1704-96 however, is that it is only designed to be used with exhaust-only style hoods operating in a laboratory with a mixing style air-conditioning system. Work needs to be performed to add displacement ventilation and various style hoods to the test standards.

Schlieren System

A Schlieren system is a thermal imaging technique to view changes in air density in real-time. Consequently, the use of Schlieren is a powerful tool when examining the C&C of hoods. Figures 2 and 3 show a photograph of the Schlieren system on both the KVL hood at C&C conditions, and an exhaust-only hood (without Capture-Jet technology) operating at the same airflow, respectively.

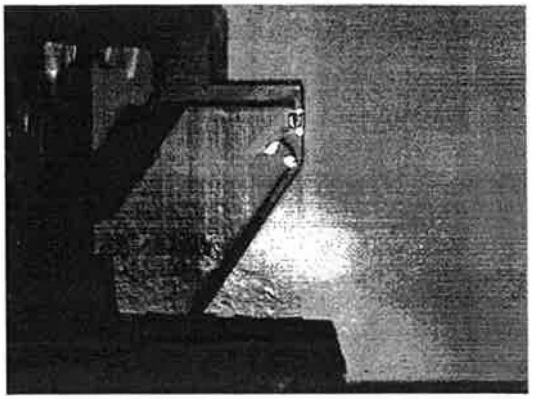

Figure 1. Schlieren Photo of KVL Hood With Air Jets

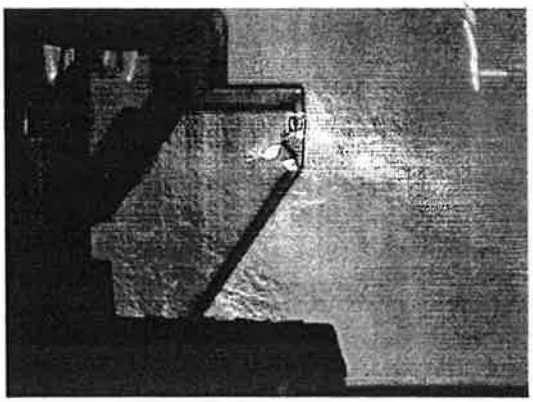

Figure 3. Schlieren Photo of Exhaust-Only Hood

Upon examining the figures, it is readily apparent that the exhaust-only hood is spilling significant amounts of heat to the kitchen space.

Comparisons to Other Hoods

In a series of independent tests conducted by Architectural Energy Corporation (AEC), the Halton KVL hood performed favorably against traditional style backshelf hoods. In fact, the exhaust-only hood required 100% greater exhaust air to capture than the KVL hood during idle conditions and 36% greater exhaust air during cooking conditions as shown in Table 1.

Table1. KVL and Exhaust-Only Hood Comparisons Using a 3 ft. (914 mm) Wide Griddle

Hood Style	Cooking C&C Airflow In Cfm/ft (L/s)	Idle C&C Airflow In Cfm/ft (L/s)
KVL with Air Jets	110 (51.9)	90 (42.5)
Exhaust-Only	150 (70.8)	180 (85.0)

Conclusions

Each of these standards and test methods have their strengths and weaknesses. By combining and utilizing all of these techniques, a robust hood design can be developed and introduced to the market. This hood is currently being marketed by Halton Group globally. In no small part, some of it's success is due to the use of state-of-the-art kitchen ventilation design tools by Halton Company. Halton Company is a division of Halton Group, a Finish-based company specializing in indoor air distribution and ventilation.

References

1. VDI 2052 Standard, June 1999.
2. Fisher, D. New Recommended heat gains for commercial cooking equipment. ASHRAE Transactions, 1998. Vol. 104, Pt. 2.
3. ASTM, F1704-96 Standard, 1996.