

## **Catering for a Sustainable Future, Group**

### **Kitchen Ventilation ~ Energy Efficiency**

The kitchen ventilation system represents one of the largest uses of energy in the foodservice facility accounting for up to 45% of the HVAC load and represents between 10% & 15% of the total energy consumption.

Unlike a cooking appliance, which can be isolated for troubleshooting, the ventilation canopy is only one component of the ventilation system, and to further complicate things, the kitchen ventilation system is a subsystem of the overall building heating, ventilating and air-conditioning (HVAC) system. Fortunately, there is no magic to the relationship between the exhaust and its requirement for make-up air (MUA). The physics are simple, air that exits the building (through canopies and fans) must be replaced with outside air that enters the building (intentionally or otherwise).

Hot air rises! An exhaust fan in the ceiling could easily remove the heat produced by the equipment, but mix in smoke, volatile organic compounds, grease particles and vapour from the cooking operation, then a method to capture and contain the effluent is needed to avoid health and fire hazards. While a canopy serves that purpose, the key question is always, what is the optimum exhaust rate? The answer always depends on the type of appliance as this determines the volume of air to be extracted and the only method of calculation that should be used to obtain this information is the Thermal Convection Method as detailed in DW172 "HVCA Specification for Kitchen Ventilation Systems" which will also determine the make-up air supply rate.

The most exciting development in kitchen ventilation of the last 30 years is the introduction of the new technology that treats the contaminated air by using ultra-violet UV-C enhanced oxidation technology. The UV-C ventilation canopy takes filtration efficiency to entirely new levels as it incorporates removable stainless steel cartridge filters which are 98% efficient and ultra-violet cassettes. The use of the high efficiency filters reduce the volume of grease being extracted, the tried and tested ultra-violet UV-C technology is then used to destroy airborne grease and odours to leave carbon dioxide and water vapour as end products, this combination delivers the most efficient system yet developed. Airborne contamination is arrested at source and not conveyed by the ductwork system to atmosphere. Grease is prevented from entering the exhaust ductwork eliminating fire risk and costly cleaning operations.

Commercial kitchen ventilation systems are notoriously wasteful of heat, typically, 65% of the energy consumed by the cooking equipment is turned into convected heat and extracted, 15% is radiant heat, 10% is absorbed into the food and 10% is transferred into the kitchen. Is there a case for heat recovery?

- An island cooking suite with predominantly gas-fired cooking equipment, could consume 242 Kw of energy.
- 65% of this, ie. 157 Kw is (or should be!) drawn into the kitchen extract system and subsequently discharged to atmosphere.
- The average efficiency for most heat recovery systems is only 55% - but this still equates to 86 Kw.
- The above cooking island requires an extract flow rate of 3.5m<sup>3</sup>/sec and a make-up air flow rate of 3.0m<sup>3</sup>/sec (85% of extract)

- A make-up air system introducing 3.0m<sup>3</sup>/sec of fresh air in the UK, in say January needs 65 Kw of heat to raise it from -4°C outside to a fairly modest 14°C.
- Every day of the year this same facility requires 1400 litres of hot water per hour during the peak periods to operate the foodservice facility. To raise the temperature of this water from 10° to 65°C requires 90 Kw.

Conclusion – prior to UV-C whatever money was saved in recovering heat from the kitchen extract system, was doubled as a cost in cleaning off carry-over grease from the kitchen canopy. Because the UV-C system prevents grease from entering the ductwork and the heat recovery devices can be kept grease-free, we can a last look at heat recovery with realistic capital costs spread over 365 days per year, providing we remove the heat from the exhaust air and then transfer it to the domestic hot water supply.

The big problem that the foodservice industry has is that all commercial kitchens have significant amounts of idle cooking times when equipment is not fully utilized, however the extract system still pulls out enormous amounts of air as it is designed to operate at the maximum constant rate and requires large amounts of replacement air. There are two main reasons for this, firstly conventional baffle type grease filters need a minimum velocity to work efficiently and secondly BS 6173 states that an interlock of the ventilation system to the gas supply serving the cooking equipment shall be installed so in the event of air flow failure, the gas is switched off.

With reference to the first issue concerning the filters, this disappears when using a UV-C system with the high efficiency filters as the velocity is not such a critical issue, especially with the UV-C technology installed behind them. In fact it is true to say that a variable volume system would make the system more efficient as the lamps would not be working at full capacity throughout the period of time that the ventilation system is turned on.

When it comes to the second issue it seems wrong that the system has to run at full capacity to keep the gas supply connected. Why monitor the extract and make-up air to control the gas supply when the technology is available that would allow us to monitor and control the system by measuring heat rejection and carbon monoxide levels. Is it because at present in the UK dangerous carbon monoxide (CO) levels are measured in quantity discharged over time? If this matter can be resolved then it opens the door for the use of existing technology to provide major energy and emissions savings using variable volume controls.

Variable volume commercial kitchen ventilation systems are energy efficient because they control exhaust and make-up air fan speeds according to usage. The fan speeds are controlled by three sensors installed within the ventilation canopy or kitchen area, a carbon monoxide sensor, an optical sensor and temperature sensor. Upon detecting carbon monoxide, smoke, vapours or excessive heat the control signals are sent to a microprocessor to operate the fans at full speed until all contaminates or high heat conditions are removed. These controls operate the exhaust fans and make-up air unit automatically according to fluctuating usage, which results in up to 70% less energy consumption and emissions during slow cooking periods.

Based on a facility which operates within the public sector to provide three meals a day for two hundred people over a one hour service period for each meal will operate for 12 hours each day, for 300 days per year with one ventilation canopy which contains extract and make-up air. If we could use variable frequency drives the projected energy and emission savings are between 40% and 50% (average 45%).

To achieve the savings detailed below a minimum duct velocity of 2.54m/sec will need to be accommodated.

- Total electrical equipment load = 248,000 Kw per year
- Total electrical equipment usage @ 14% = 34,720 Kw
- Total natural gas equipment load = 622,800 Kw per year
- Total natural gas equipment usage @ 22% = 137,016 Kw
- Extract rate 3.5m<sup>3</sup>/sec
- Supply air rate 3.0m<sup>3</sup>/sec
- Total electrical load for fans = 5,700 Kw per year
- Total natural gas load for heater battery = 42,900 Kw per year
- Total electrical saving = 2,565 Kw per year
- Total gas saving = 19,305 Kw per year
- Total economic saving = £546.49
- Total environmental saving = 4,771 kgCO<sub>2</sub> (1,303 kg Carbon)

Option 1 ~ optimized the extract and make-up air supply for the equipment installed using the present HVAC systems and DW172.

Option 2 ~ install a UV-C ventilation system with an air to water heat recovery system.

Option 3 ~ carry out option 2 making provision for the retrofit of a properly implemented demand controlled ventilation system that will minimise the energy and emissions burden associated with commercial kitchen ventilation.

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