Emission Control for Commercial Kitchen Ventilation

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Enabling Wellbeing
Topics of Discussion

- Emissions from cooking process
- Mechanical filtration at hood level
  - Filter efficiency as function of particle size ASTM 2519-05
  - Filter efficiency as function of cooking process
- Electrostatic precipitators
- Pollution control systems (multistage filtration systems)
- UV oxidation systems
Air Pollution has been with us since the very first fire was lit...
Pollution is one of the biggest global killers, affecting over 100 million people....

That’s comparable to global diseases such as Malaria and HIV.
In December 1952, air pollution in London created fatal smog that immediately killed 4,000 people in the first week and then 8,000 more over the next few months.

Burning of coal was the main cause.
People who live in places with high levels of air pollutants have a 20% higher risk of death from lung cancer than those who live in less polluted areas.
• According to the World Health Organization, ambient air pollution contributes to 6.7% of all deaths worldwide…

• …shameful!
Why do we need emissions control?

to turn something like this

into something like this
Enabling Wellbeing

or something like this

into something like this

or something like this

into something like this
EMISSIONS FROM COOKING PROCESS
Emissions from cooking process

Emissions lb/1000lb of product cooked

ASHRAE RP-745
Emissions from cooking process
grease composition

ASHRAE RP-745
Mechanical filters

- Grease filters (single and double stage), cartridges and extractors are most common and often the only source of emission control for exhaust air stream.
- They are close to the source of emissions and their grease removal effectiveness is very important.
Test Methods

• EPA Method 202 can be used to determine overall efficiency (particulate + vapor) of an emission control device.
• ASTM 2519-05 method of test that rates filter efficiency as function of particulate size.
• UL 1046, 710 are safety standards and can not be used to rate filter efficiency.
Filter efficiency as function of the airflow (cyclonic filter)
Filter Efficiency @ 270 cfm/ft

Cyclonic Filter
Baffle I
Baffle II
Filter efficiency as a function of cooking process

• Determine emissions for a cooking process (vapor and particulate) including particle distribution for particulate emissions.

• Determine filter efficiency as function of particle size and air flow range through the filter.

• Calculate filter efficiency for the cooking process by overlaying the filter efficiency curve with the particle distribution curve for the cooking process at the design (for this cooking operation) airflow through the filter.
Mechanical filter selection

- Chose optimum filter for given cooking operation, consider:
  - filter efficiency
  - pressure drop at specified airflow
Secondary filtration systems

- Electrostatic precipitators
- Pollution control systems (multistage filtration systems)
- UV oxidation systems
Electrostatic precipitators ESP

• Pros
  ➢ Low pressure drop
  ➢ High particulate removal efficiency when plates are clean

• Cons
  o Doesn’t remove grease vapor
  o Efficiency drops if plates are covered with grease
  o Water usage and contamination
  o High energy consumption during automatic wash & dry cycle
  o High first costs
Electronic Air Cleaning

Halton’s Ecology-E is a new generation electrostatic precipitator used to extract cooking effluents and odors from commercial kitchen exhaust. Ecology-E is a reliable solution for minimizing the restaurants impact on the surrounding environment. It’s available in side access units for use with central air handlers or as a stand alone fan powered unit.

Dependable high frequency electronics, safe/no-short charging system, rugged ionizer electrodes and improved automatic cleaning are just a few of the innovations developed to make Ecology-E the most reliable ESP ever. High efficiency particle collection is delivered instantly and continuously. The extremely low resistance to airflow means less fan horsepower is needed, compared to conventional media filtration, and since resistance to airflow is constant, the system air volume is always maintained. Optional bonded activated carbon can be added for odor control, making Ecology-E the IDEAL SOLUTION for ventilation or exhaust air quality problems.

Reliability, high performance and low operating cost make Ecology-E an excellent choice for indoor air cleaning or exhaust air pollution control.
Key Features

- New Generation ESP designed for dependable operation
- Reliable high frequency electronics do not use fragile ionizing wires or insulators
- Specified efficiency is instant and constant
- Pressure drop is a constant 0.25" w.g., resulting in reduced fan horsepowern
- Constant resistance to airflow prevents fluctuations in system air volume
- Permanent aluminum collector cells never need replacing
- Built-in automatic cleaning and PLC controls
- Optional bonded carbon for gas/odor control
- Optional custom blower/motor package
- Optional safety filter

Ventilation is the critical factor to consider when investigating the feasibility of a new commercial kitchen site. New projects, new designs to existing buildings, and non-traditional sites often require uncommon solutions for kitchen ventilation problems. Ecology-E may be your solution to:

- Code requirements
- Environmental standards
- Multi-story structures
- High installation costs
- Limited roof top space
- Historical/Architectural sites
- Multi-restaurant applications

Halton has the equipment, design flexibility and experience to solve the problems of each site.
System Description

Ecology-E Side Access Model (HE) is a factory packaged system including side access housing with upstream and downstream flanges, integral wash system, pre and post mist eliminators, electronic collectors, system control, detergent dispenser, and accessories. The factory assembled system is designed for mating to air handlers and ventilation systems or as a stand alone unit factory furnished blower/motor package.

The System PLC Control is programmed to start and stop the system according to customer requirements. At a predetermined schedule, the Control also initiates a water/detergent wash cycle to clean away collected contaminants. Spent wash water is drained from the bottom drain pan, Ecology-E is forced dried and ready to continue operations. Start, stop and wash functions can also be initiated by manual push button.

Each Ecology-E Side Access system is ETL listed, conforming to ANSI/UL STD 867 & UL STD 710.
Pollution control systems (Multi Stage Filtration)

- **Pros**
  - High particulate removal efficiency
  - No water contamination
  - Guaranteed performance
    - As filters get clogged, efficiency improves

- **Cons**
  - High pressure drop resulting in high electrical energy consumption (compared to ESP).
  - High maintenance costs when filters need frequent replacement
    (high efficiency filtration within the hood is important to reduce the frequency of filters replacement).
- Maintaining constant airflow regardless of filter loading
- Filter loading monitor
Control Panel
The EcoloAir Control Panel features a standard 120 volt control system, touch screen and is constructed of stainless steel. The control can be surface mounted, remote mounted or recessed in the wall.

ECOSystem
Halton’s ECOSystem is standard with the EcoloAir system. The ECOSystem “Exhaust Control Optimizer” maintains the design exhaust air flow during filter loading. This feature provides an average of 20% reduction in exhaust over filter life and reduces tonnage required on HVAC design. A green benefit by reducing overall energy use and minimizing operating cost.

Halton’s ECOSystem is proactive in identifying filter replacement requirements by providing the end user with a clear visual indicator. The indicator shows filter life as a percentage filter loaded for each filtration stage or if filters are missing so operations can plan regular maintenance. With an optional web link, the system will send an email or text message to a designated service provider to schedule filter change during routine maintenance. This prevents any downtime during critical operating periods. Halton also offers the ECOSystem to be retrofitted to provide all the above mentioned benefits for already installed EcoloAir Systems.

- Pressure Transducers – Monitor the pressure drop across each filter as well as pressure in the main duct. Also, providing the status of each filter as a % loaded as well as notify the operator with an early warning of when the filters need to be replaced.
- On start up, the main pressure transducer is calibrated with the Capture Jet Testing and Balancing Ports to design airflow. This setting is stored in the system memory and acts as the reference point for design exhaust.
- Microprocessor – Reads signal from the pressure transducer and controls the VFD to maintain constant airflow in the system regardless of the filter conditions.
- V.F.D. (Variable Frequency Drive) – Controls the RPM of the fan module based on the signal received from the microprocessor to maintain the constant pressure in the system regardless of the filters condition.
Filter Module

The cooking effluent is exhausted from the hood and is ducted to the Filter Module, which consists of a series of 3 filters designed to achieve 95% (ASHRAE) particulate free air for excellent grease and smoke control.

3 Filter Stages:
PRE-FILTER - The 30/30 UL Class 1 disposable pleated Pre-Filter is MERV 8 (Minimum Efficiency Reporting Value).

MEDIUM FILTER - The Hi-Flo 95 Class 1 disposable pocket filter is a MERV 14 (Minimum Efficiency Reporting Value).

ABSOLUTE FILTER - The Micretain UL Class 1 smoke filter is a MERV 16 (Minimum Efficiency Reporting Value).

A UL/ULC classified fire damper is located downstream in the Filter Module with a fusible link to close the spring-loaded damper.
PCU with UV module

- Fan section
- Activated carbon filters section
- Disposable panel filters section
- UV lamps section
- Disposable bag filters section
- Absolute [HEPA] filters section
UV Oxidation Systems

- **Pros**
  - Works on vapor
  - Low pressure drop
  - Minimal impact on the environment if ozone removed
- **Cons**
  - Requires regular maintenance to keep lamps clean from deposit
  - Potential hazard (UV radiation and ozone) if not properly maintained and does not have proper safety features.
UV Technology
UV light and cooking emissions

UV oxidation is a two-step process

1. Photolysis
   Occurs within hood exhaust plenum with cooking emissions directly exposed to UV-C light

2. Ozonolysis
   Occurs in exhaust ductwork with O3 and hydroxyl radical interacting with cooking emissions in exhaust ductwork
Photolysis

- The cooking effluent including air, water and VOC is exposed to UV light.
- Long chain molecules are broken down into shorter chains.
- Double bonds are destroyed in long-chain VOC molecules.
- Oxygen molecules are broken into single atoms of oxygen that react with other oxygen molecules forming ozone.

This process called “PHOTOLYSIS” adds energy to the molecular chains, which breaks bonds and creates radicals.
Ozonolysis

- Exposure to UV-C (< 200 nm) creates ozone ($O_3$).

- Ozone and hydroxyl radicals interact with long-chain molecules breaking them to shorter chains and some are oxidized down to $CO_2$ and $H_2O$
Study at Western Kentucky University To Analyze Emissions

Filter samples from EPA Method 5 test
Cooking hamburgers without and with UV light
Condition Of The Duct

Immediately after the Hood

Further downstream
Crew Galley Duct From Deck 6, No UV-System
Main Galley Duct 2K From Deck 6, UV-System
Questions?

For further information please visit our web site
www.halton.com
or email at
sales.ae@halton.com

THANK YOU