Ecology Units and Kitchen Exhaust Applications
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   - Electrostatic Precipitation
   - Carbon Filtration
   - UV-C Technology
   - The Odour Neutraliser

3. Ecology Units
Introduction

- Kitchen is a source of
  - Heat
  - Volatile organic compounds (VOC)
  - Grease particles
  - Vapor

- Exhaust fan & Exhaust Hood

- The key questions: What is the appropriate exhaust rate? & Which hood? & How to balance the air?
Introduction

Elimination of odour and contaminants

Efficient elimination of dirty air from kitchen

Key to figure
(a) cooking area
(b) cooker hood/canopy
(c) grease filters
(d) coarse pre-filter
(e) fine pre-filter
(f) activated carbon filters
(g) Fan/motor unit
(h) Lagging
(i) anti-vibration mounting
(j) noise attenuator (best located within the building)
(k) exhaust flue/stack
Selecting & Sizing Exhaust Hoods

1. The cooking factor
2. The hood factor
3. The make up air factor
1. The cooking factor

- What is the category of cooking appliances?
  (Categorized acc to thermal plume, the quantity of grease, smoke, water vapor, combustion products they produce.)
  - Light (Gas and electric ovens, kettles etc)
  - Medium (Gas and electric griddles/fryers etc)
  - Heavy (Gas and electric broilers etc)
  - Extra heavy (Appliances with solid fuels like a broiler with wood)
2. The hood factor

- Type of the hood
- UL Listed or not?
- Side panels and overhang
- Cross Drafts
Single Island Canopy
Double Island Canopy
Wall Mounted Canopy
Back Shelf

For same capacity (Exhaust volume)
Single-island canopy hood > Wall-mounted canopy hood > Proximity (backshelf) hood
Safety Factor: Typically recommended increasing the exhaust rate by 5% to 25% over the minimum listing.

### IMC Minimum Exhaust Flow Rate for Unlisted Hoods (cfm per linear foot of hood)

<table>
<thead>
<tr>
<th>Type of Hood</th>
<th>Light Duty Equipment</th>
<th>Medium Duty Equipment</th>
<th>Heavy Duty Equipment</th>
<th>Extra-Heavy Duty Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted Canopy</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>550</td>
</tr>
<tr>
<td>Single Island Canopy</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>Double Island Canopy</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>550</td>
</tr>
<tr>
<td>Eye Brow</td>
<td>250</td>
<td>250</td>
<td>not allowed</td>
<td>not allowed</td>
</tr>
<tr>
<td>Backshelf</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>not allowed</td>
</tr>
<tr>
<td>Passover</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>not allowed</td>
</tr>
</tbody>
</table>

### Minimum Exhaust Flow Rate for Listed Hoods (cfm per linear foot of hood)

<table>
<thead>
<tr>
<th>Type of Hood</th>
<th>Light Duty Equipment</th>
<th>Medium Duty Equipment</th>
<th>Heavy Duty Equipment</th>
<th>Extra-Heavy Duty Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted Canopy</td>
<td>150-200</td>
<td>200-300</td>
<td>200-400</td>
<td>350+</td>
</tr>
<tr>
<td>Single Island Canopy</td>
<td>250-300</td>
<td>300-400</td>
<td>300-600</td>
<td>550+</td>
</tr>
<tr>
<td>Double Island Canopy</td>
<td>150-200</td>
<td>200-300</td>
<td>250-400</td>
<td>500+</td>
</tr>
<tr>
<td>Eye Brow</td>
<td>150-250</td>
<td>150-250</td>
<td>not recommended</td>
<td>not recommended</td>
</tr>
<tr>
<td>Backshelf/Passover</td>
<td>100-200</td>
<td>200-300</td>
<td>300-400</td>
<td>not recommended</td>
</tr>
</tbody>
</table>

Source: ASHRAE 2003 Applications Handbook, Chapter 31, Kitchen Ventilation
3. The make up air factor

Air that is removed from the kitchen through an exhaust hood must be replaced with an equal volume of outside replacement (makeup) air through one or more of the following pathways:

- Transfer air,
- Diffusers
- Integrated hood plenum
Integrated Hood Plenum Types

- **Short Circuit**
- **Air Curtain**
- **Front Face**
- **Perforated Perimeter**
- **Rear Discharge**
The Design Process

1. Establish location and “duty” classifications of appliances (Light, Medium, Heavy, Extra Heavy)
2. Select hood type, style, and features.
3. Size exhaust airflow rate.
4. Select makeup air strategy; size airflow and layout diffusers.
Selecting & Sizing Exhaust Hoods

- Design Example A - **Quick Service Restaurant**
- Summary of Cases

**Table A-6. Summary of Exhaust Rates**

<table>
<thead>
<tr>
<th>Hood Type and Arrangement</th>
<th>Exhaust (cfm)</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Unlisted Canopy Hood</td>
<td>3375</td>
<td></td>
</tr>
<tr>
<td>Single Listed Canopy Hood</td>
<td>2375</td>
<td>30%</td>
</tr>
<tr>
<td>Custom-Engineered Backshelf/Canopy Hood Combination</td>
<td>1350</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Bar Chart**

- Single Unlisted Canopy Hood: 3375 cfm
- Single Listed Canopy Hood: 2375 cfm
- Custom-Engineered Backshelf/Canopy Hood Combination: 1350 cfm

- 1000 cfm savings
- 2025 cfm savings
Filtration Systems
Agenda

What is needed between the extraction hood and the fan?

• What can be in a commercial kitchen exhaust
• How best to filter / control it by;
  • Electrostatic Precipitation
  • Carbon Filtration
  • UV-C Technology
  • The Odour Neutraliser
DEFRA Guide Odour Arrestment

Low to medium level odour control may include:

1. Fine filtration or ESP followed by carbon filtration (carbon filters rated with a 0.1 second residence time).
2. Fine filtration followed by counteractant/neutralizing system to achieve the same level of control as 1.

High level odour control may include:

1. Fine filtration or ESP followed by carbon filtration (carbon filters rated with a 0.2 – 0.4 second residence time).
2. Fine filtration or ESP followed by UV ozone system to achieve the same level of control as 1.

Very high level odour control may include:

1. Fine filtration or ESP followed by carbon filtration (carbon filters rated with a 0.4 – 0.8 second residence time).
2. Fine filtration or ESP followed by carbon filtration and counteractant/neutralising system to achieve the same level of control as 1.
3. Fine filtration or ESP followed by UV ozone system to achieve the same level of control as 1.
It’s all about ODOUR CONTROL!
The Pollutants

PARTICULATE
- Smoke
- Grease

GASEOUS
- Combusted Gases
- Food Flavourings
Requirements for a Good Control System

- LOW CAPITAL COST
- LOW MAINTENANCE AND REPAIR COST
- HIGH OPERATION EFFICIENCY
- MAINTAINED EFFICIENCY DURING SERVICE CYCLES
- LOW AND CONSTANT PRESSURE LOSS
- LOW ENERGY CONSUMPTION
The Pollutants

- **Particulate**
  - Smoke
  - Grease

- **Gaseous**
  - Combusted Gases
  - Food Flavourings
Particulate Sizes

- 150 Microns
  - Human hair
- 25 Microns
  - Just visible
- 10 Microns
- 5 - 10 Microns
- 1 - 5 Microns
- 0.3 - 1 Microns
- 0.001-0.01 Microns
  - Almost molecular
These devices have been used since the late 19th C.

The Electrostatic Precipitator is used to remove the particulate phase of the contaminant.

The process electrically charges pollutants to one potential then collects them on a surface with the opposite electrical potential.
### Particles Removed by Electrostatic Air Filters

<table>
<thead>
<tr>
<th>METHOD OF ANALYSIS</th>
<th>VISIBLE WITH ELECTRON MICROSCOPE</th>
<th>VISIBLE WITH MICROSCOPE</th>
<th>VISIBLE WITH NAKED EYE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILTER TYPE</td>
<td>Electronic Air Cleaner</td>
<td>Mechanical Filter</td>
<td></td>
</tr>
<tr>
<td>TYPICAL POLLUTANTS</td>
<td>Oil Smoke</td>
<td>Metal Fumes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tobacco Smoke</td>
<td>Cement Dust</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon Black</td>
<td>Atmospheric Dust</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atmospheric Dust</td>
<td>Aerosols</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tobacco Smoke</td>
<td>Paint Particles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbon Black</td>
<td>Bacteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atmospheric Dust</td>
<td>Human Hair</td>
<td></td>
</tr>
</tbody>
</table>

- **Particle Size (Microns):**
  - 0.001
  - 0.01
  - 0.1
  - 1.0
  - 10
  - 100
  - 1000

- **Electrostatic Air Filters**

- **Mechanical Filter**

- **Visible with Electron Microscope**

- **Visible with Microscope**

- **Visible with Naked Eye**
The Pollutants

**PARTICULATE**
- Smoke
- Grease

**GASEOUS**
- Combusted Gases
- Food Flavourings
The Pollutants

PARTICULATE
- Smoke
- Grease

GASEOUS
- Combusted Gases
- Food Flavourings
Activated carbon has been used for many years to reduce fumes and gases from the air.

Ideal for use in light cooking environments

OR

For odour control after pre-filtration i.e. an ESP.

If a carbon filter is not adequately protected it will quickly fail and can off gas, adding to odours.
Adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. This process differs from absorption, in which a fluid (the absorbate) is dissolved by or permeates a liquid or solid (the absorbent), respectively. Adsorption is a surface-based process while absorption involves the whole volume of the material. The term sorption encompasses both processes, while desorption is the reverse of it. Adsorption is a surface phenomenon.
Activated carbon, also called activated charcoal, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions.\(^1\) Activated is sometimes substituted with active.

Due to its high degree of microporosity, just one gram of activated carbon has a surface area in excess of 3,000 m\(^2\) (32,000 sq ft),\(^2\) as determined by gas adsorption.\(^3\) An
Based on the synergy, which occurs when oxygen and ultra-violet light at 185nm are combined to produce ozone.

The ozone then acts on the odorous gases in the airstream changing their molecular structures so neutralising their odours.

UV rays break up oxygen molecules, O₂, into separate oxygen atoms, O.

Separate oxygen atoms combine with oxygen molecules to produce ozone, O₃.
Odour Control Using UV-C Technology

Ozone can be delivered into the extract ducting in various ways.

**INLINE DELIVERY**
Placing the unit directly inline with the extract ducting.

**EXTERNAL DELIVERY**
Placing the unit outside of the exact ducting and drawing the ozone into the duct via a spigot.
**Inline UV-C Delivery:**
*How It Works*

As you can see below we recommend that the UV-C unit is placed directly after an ESP filtration unit or similar, this will ensure that there is a minimum amount of oil and grease particulates in the airflow to coat the surface of the lamps thus reducing their output. As well as there being the maximum length of duct run available for the ozone generated by the unit to work in.
Key Facts About Inline Delivery of UV-C Technology

LOW UNIFORM AIR RESISTANCE

MODULAR SYSTEM CAPABLE OF DEALING WITH ALL AIRFLOW LEVELS

EASY TO MAINTAIN
Lamps need periodical cleaning and replacement

DESIGNED TO COMPLEMENT ESP SYSTEM
External UV-C Delivery: How It Works

UV units are located outside of the extract ducting. It draws ambient air into the housing past racks of UV-C lamps and delivers ozone into the extract ducting via a spigot. As the ambient air is free of oil and grease particulates the condition of the lamps is controlled providing a consistent output.
Key Facts About External Delivery of UV-C Technology

- Virtually no pressure loss
- No monthly maintenance needed
- Easy to install
- Can be retro-fitted into an existing duct
UV-C lamps are sometimes placed into the extraction hood itself to deliver ozone at the point of extract entry, before any other form of filtration has taken place.

We feel that this approach is flawed as UV-C light cannot function properly once the lamp is obscured by oil, grease and carbon particulates.

It is also claimed that ozone completely destroys airborne oil and grease particulates – it does not.

This is why we introduce the ozone into the duct after pre-filtration via an ESP to ensure that the airborne particulates that can coat a lamps surface have been virtually all removed.
Above are pictures of a lamp that was not cleaned for about six weeks.

As you can see the UV lamp has been completely obscured by the build-up of grease, oil and smoke particulate that has come up from the cooking range below the hood.

With lamps in this state very little if any UV-C band width light will be mixing with the exhaust fumes so very little if any Ozone will be generated.

This is one of the major reasons that this type of odour control just does not work.
Odour Neutraliser: How It Works
USES PATENTED TECHNOLOGY TO SCIENTIFICALLY TREAT COOKING ODOURS

CAN REDUCE ODOURS BY UP TO 75%

EASY TO INSTALL AND MAINTAIN
Ecology Units
Ecology Unit

Ecology units are ventilation equipment which have been used for commercial kitchens’ exhaust systems.

Kitchen exhaust steam contains too much grease and odour in itself.

This grease and odor content in the steam has many adverse effects on people’s lives and well being.
Ecology Unit

It’s sometimes confused that Ecology Units are purposed keep industrial kitchens free of odour. It’s not totally correct!

Ecology Units are purposed to keep environment free of odour and smoke!
Grease Content

Grease content in the exhausted steam is being accumulated in ventilation equipments and ducts.

This accumulation cause:

- Fire hazard
- Unhealthy conditions, bacterial growth
- Increased pressure drop, efficiency losses
Grease Content

Some practical examples of kitchen exhaust ducts
Odors contribute to a reduced quality of life for people. Besides having a disturbing effect on human, odors also have several health effects such as:

- nausea,
- headaches,
- difficulty breathing,
- Comfort loss
- etc.
What is Ecology Unit?

Ecology units are the ventilation equipment which has the duty removing these grease and odor in the kitchen exhaust air to provide a safer and healthier environment.

In the guidance; problems associated with nuisance odor emissions from commercial kitchen exhausts and information on best practice techniques for the minimization of odor nuisance form kitchen exhaust systems were discussed.
One of the most interesting parts in the guidance is related with the kitchen types.

It is mentioned that the precautions should be taken for certain foods can be different from each other due to different odor and grease concentration of the food type.
# Kitchen Types – Cooking Principals

<table>
<thead>
<tr>
<th>Catering establishment</th>
<th>Description</th>
<th>Odour concentration</th>
<th>Grease content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Tea shop</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pizza restaurant</td>
<td>Herb</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Steakhouses</td>
<td>Fat</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>French</td>
<td>Herbs/garlic</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Italian</td>
<td>Herbs/garlic</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Most pubs</td>
<td>Fat</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>Ginger, spices, oil</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Japanese</td>
<td>Spices, oil</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Cantonese</td>
<td>Spices, oil</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Indian</td>
<td>Spices, oil</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Thai</td>
<td>Spices, oil</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Vietnamese</td>
<td>Spices, oil</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Kebab houses</td>
<td>Fat, cooking meat</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fried chicken</td>
<td>Oil, cooking meat</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pubs (large turnover of deep-fried food)</td>
<td>Oil, cooking meat</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fish and chips</td>
<td>Oil, cooking meat</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fast food/burger</td>
<td>Oil, cooking meat</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
There is one more odor risk assessment classification, an extensive version, including also effects of dispersion, proximity of receptors and size of kitchen.

<table>
<thead>
<tr>
<th>Dispersion</th>
<th>Very poor</th>
<th>20</th>
<th>Low level discharge, discharge into courtyard or restriction on stack.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poor</td>
<td>15</td>
<td>Not low level but below eaves, or discharge at below 10 m/s.</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>10</td>
<td>Discharging 1m above eaves at 10-15 m/s.</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>5</td>
<td>Discharging 1m above ridge at 15 m/s.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proximity of receptors</th>
<th>Close</th>
<th>10</th>
<th>Closest sensitive receptor less than 20m from kitchen discharge.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium</td>
<td>5</td>
<td>Closest sensitive receptor between 20 and 100m from kitchen discharge.</td>
</tr>
<tr>
<td></td>
<td>Fair</td>
<td>1</td>
<td>Closest sensitive receptor more than 100m from kitchen discharge.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size of kitchen</th>
<th>Large</th>
<th>5</th>
<th>More than 100 covers or large sized take away</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium</td>
<td>3</td>
<td>Between 30 and 100 covers or medium sized take away.</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>1</td>
<td>Less than 30 covers or small take away.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooking type (odour and grease loading)</th>
<th>Very high</th>
<th>10</th>
<th>Pub (high level of fried food), fried chicken, burgers or fish &amp; chips.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>7</td>
<td>Kebab, Vietnamese, Thai or Indian.</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>4</td>
<td>Cantonese, Japanese or Chinese.</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>1</td>
<td>Most pubs, Italian, French, Pizza or steakhouse.</td>
</tr>
</tbody>
</table>
Overall score from the previous table is being used to determine the odor risk assessment as:

- **Low level odor control**: Less than 20, VOClean M
- **High level odor control**: 20 to 35, VOClean H
- **Very high level odor control**: More than 35, VOClean EH

In order to determine the precaution level for kitchen at least one of these guidances must be applied.
Electrostatic Precipitation

One of these precautions, probably the most important one, also mentioned in DEFRA Guidance is Electrostatic Precipitation.

By electrostatic precipitation, grease particles are being extracted from the exhaust steam.
Electrostatic Precipitation

Electrostatic precipitator are composed of two main parts:

- Ionizer section,
- Collector section.
Diagram shows, in a basic visual, how an electrostatic precipitator works. As air passes into the combined ionizer / collector cell, the particulates in the air stream are polarized to a negative potential. As they continue through the ionizer and between the collector cell plates, the polarized particulates are repelled away from the negatively charged plates and attracted to the earthed plates where they stick and so are filtered out of the air flow.
Filter Stages

- **Pre Mesh Filter**
  - High Efficient Electrostatic Precipitator
  - Removing grease, moisture, and other particles from the exhaust air by ionizing the particles.

- **Post Mesh Filter**

- **Activated Carbon Filter**
  - Removing odour from the exhaust. High dwelling time.

- **Bag Filter**
  - In order to provide a longer life for the Activated Carbon filter.

**PMF – ESP – PMF – F7 BF – AC – FAN**
Filter Stages

PMF: Pre & Post Metallic mesh filter

Main Purpose:
Pre grease filter

ESP: Electrostatic precipitator

Main Purpose:
Grease and VOC Elimination
Cleaning ESPs periodically is one of the crucial factors that lead to a high level of performance. At least ESPs must be cleaned once a month, but this value can vary from once a week to once every 2 months also. It depends on the kitchen.

ESPs can be ordered by an autowash system, but this option changes the dimensions and prices also.
ESP Maintenance
F7 Bag Filter

**Main Purpose:**
Extend AC filter’s lifetime

**Change frequency:** 6-12 months
Filter Stages

AC: Activated Carbon Filter

Main Purpose: Odor Absorption
Filter Stages
**Filter Stages**

**AC: Activated Carbon Filter**

AC Cartridges should be changed when their weight is increased by 15% of the initial weight. After gaining this 15% AC cartridges loses their ability to hold the odor in the airstream.

Activated carbon dwelling time is also a subject which is marked in DEFRA Guidance. Minimum acceptable dwelling times are:

- Low level odor control: 0.1 sec dwelling
- Medium level odor control: 0.2 sec dwelling
- High level odor control: 0.4 sec dwelling or 0.2 sec dwelling with UV-C
Filter Stages
Automation Features

Ecology units are being manufactured with factory mounted control panel. A frequency inverter is ready to supply optimum exhaust airflow. Airflow can be reduced by a potentiometer connected to the automation panel for basic control or advanced control unit choice.

Devices are set to a maximum and a minimum airflow rates at installation. Between these working points user can reduce the airflow by the potentiometer when the need is low in the kitchen. This leads device to use less power. Reducing airflow also increase the efficiency of ESPs.

When kitchen does not work with the full load, reducing airflow may lead the unit work with higher efficiency both fan motor and ESP.
Demand controlled kitchen ventilation can be done with sensors that recue the fan speed when necessity is low at the kitchen. Thus, power consumption and heat losses can be minimized.

- **Temperature sensor**: measures temperature of exhaust air at the kitchen hood (measuring cooktop temperature with infrared sensors is also possible).

- **Optical sensor**: measures amount of smoke and humidity of exhaust air at kitchen hood.
Options

- **Motor outside airstream**

  The air sucked from the kitchen does not exceed a temperature level of 50°C. If it exceeds this temperature, ESPs and activated carbons can not operate well but in case of customers’ request, motor can be coupled to a fan outside the airstream.

- **Odor neutralizer**

  Odor neutralizers can be used for odor masking. This method actually does not get rid of the source of odor but can make it imperceptible by other odors which have better scents.

- **Separate unit without fan**

  In some cases, placement of the unit may have some limitations. For these cases, unit can be produced by separate sections also.
Big Chef’s Restaurant had been closed by the municipality, because of the odour disposal related claims.
Case Study / Reference Project

<table>
<thead>
<tr>
<th>No.</th>
<th>Location Details</th>
<th>Sample Time</th>
<th>Odor Unit KB/m³</th>
<th>Average Odor Unit KB/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Opera Gayrimenkul Geliştirme A.Ş, Mavi Bahçe AVM - Big Chefs İşletmesi</td>
<td>03.01.17/12:05</td>
<td>7600</td>
<td>8924</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>03.01.17/12:07</td>
<td>8500</td>
<td>8924</td>
</tr>
<tr>
<td>3</td>
<td>Koku Giderim Sistemi Çıkışı</td>
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(*) Average value, it is the geometric average of measurement results.
Case Study / Reference Project
After VOclean…

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<th>Ölçüm Noktasi</th>
<th>Örnekleme Tarih/Saati</th>
<th>Koku Konsantrasyonu KB/m³</th>
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<td>1</td>
<td>Opera Gayrimenkul Geliştirme A.Ş, Mavi Bahçe AVM - Big Chefs İşletmesi Koku Giderim Sistemi Çıkışı</td>
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(*) Ortalama değer, ölçüm sonuçlarının geometrik ortalamasıdır.
Thanks for your listening!