Stack Odor Control at Pet Food Plants

White Paper
March 10, 2017

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Please visit us at Pet Food Forum: - Kansas City (MO) April 4+5, 2017. Booth 316.
- Cologne (Germany) June 13+14. 2017 booth Z-10

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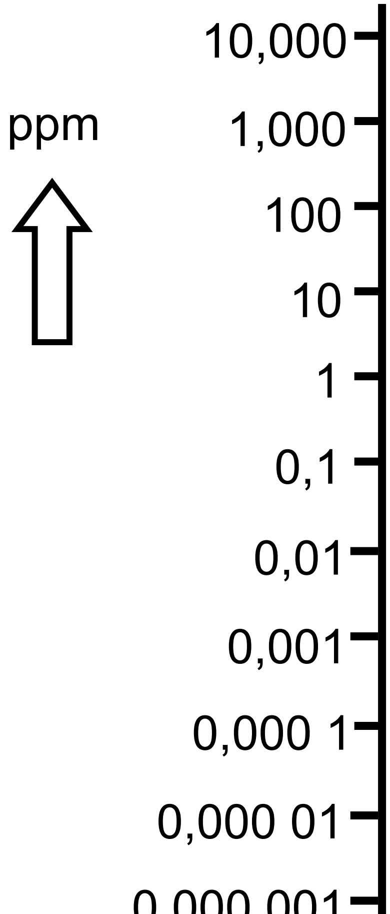
WHAT MAKES PET FOOD ODOR COMPLICATED?

- It is a cocktail of hundreds different organic components.
- The weight concentration (ppm) is mostly very low < 20ppm, but the odor-concentration (ou/m3 or DT = number of required dilutions with clean air to detection threshold) can be very high.
- The odor-components with the lowest concentrations (sub-ppb-range) cannot all be detected analytically (GC or GCMS, etc) but the human nose may very well. With analytic testing it is impossible to make accurate calculations or predictions on odor-emission.
- Each odor-component can mask or amplify another component within the cocktail.
- Odor is dynamic, since the components and their concentrations will vary in time due to differences in process conditions, raw material quality, weather conditions, oxidation, etc.
- Particles can generate odor once they are released in atmosphere, especially particles below 1 or 0.1 micron have an extremely large total surface area per unit of weight compared to 10 micron.
- It is impossible to determine odor reduction efficiencies without olfactometric measurements, because of the above-mentioned reasons. But a +/- 50% tolerance on the results are not unusual.

ODOR THRESHOLDS:

PPM is only a measure for odor if there is only 1 contaminant. Pet food odors are cocktails and many components have extreme low detection thresholds and change in time with recipes and process conditions.



Propane = 1500 ppm

Acetone = 42 ppm

Ammonia = 1.5 ppm

Phenol = 0.056 ppm

Styrene = 0.035 ppm

H2S = 0.41 ppb
Indole = 0.30 ppb
Methyl Mercaptane = 0.070 ppb
P-Cresol = 0.054 ppb
EthlylMercaptane = 0.0087 ppb
Skatole = 0.0056 ppb
IsoAmylMercaptane = 0.00077 ppb

Cocktails are complicated:
Olfactometric analyzes required

VERY HIGH
REMOVAL
EFFICIENCY
REQUIRED AT
LOW PPB and PPT CONC.

Measuring odor: olfactometer

A human nose can detect odor at concentrations well below the sensitivity levels of chemical analytical methods.

A much diluted odorous mixture (above detection) and an odor-free gas (as a reference) are presented separately.

The panellists are asked to report the presence of odor together with a confidence level such as guessing, inkling or certainty.

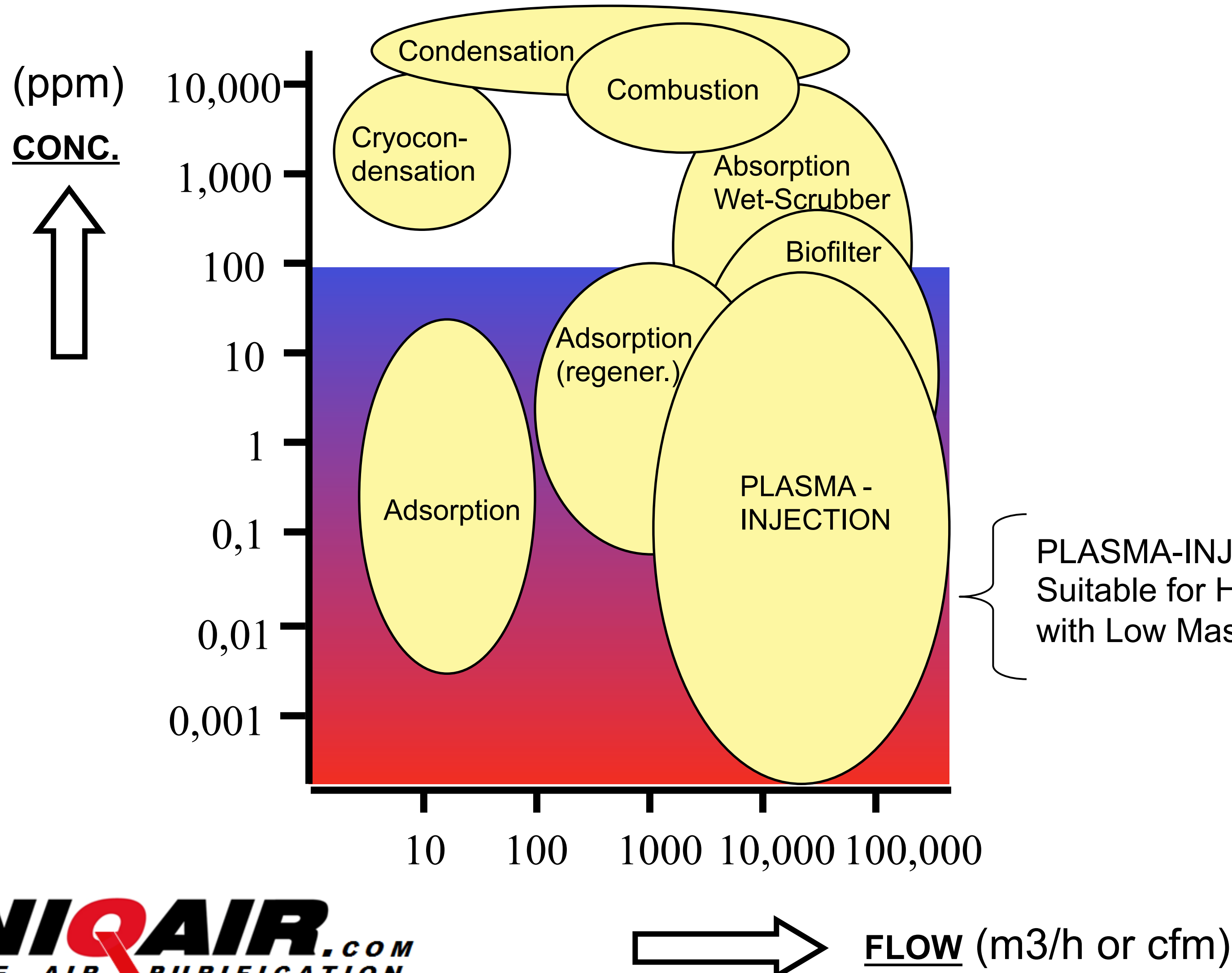
The gas-diluting ratio is then decreased.
The port from which the odorous air is presented is chosen randomly.

An air sample may need 100,000 dilutions when half of the panellists can detect; concentration = 100,000 odor units/m3 or DT

<u>Recommendations testing humid samples:</u>

- Dilution with dry N2 to prevent condensation and preserving the sample in a Tedlar or Nalophan sample bag material,
- Odor lab that complies to the performance requirements of EN13725 re. Accuracy and Repeatability, including annual interlab. ring test.

ODOR CONTROL: low VOC ppm mass concentration in pet food stack odor emissions with high odor concentrations.



PLASMA-INJECTOR:
Suitable for High Airflows
with Low Mass Concentration

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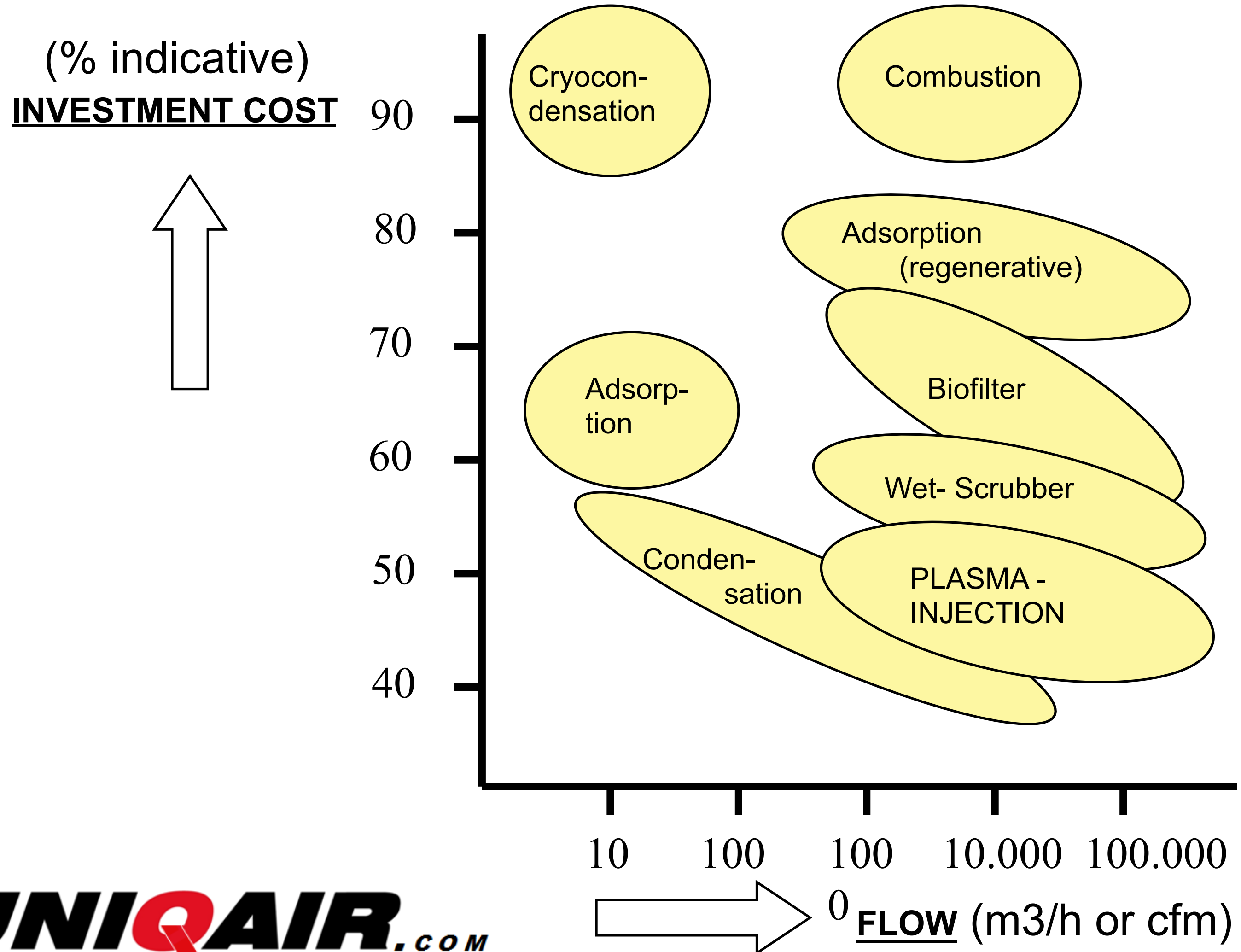
ODOR CONTROL TECHNOLOGIES:

Condensating the moisture may have the lowest investment cost but the odor reduction efficiency is limited at app. max. 50% . Combustion or RTO may have the highest effficiency at 90% but energy cost is very high. Plasma injection odor reduction is between 70% (low odor conc.) and 90% (high odor conc.)



COMPARING CRITERIA: dryers, air conveyors and coolers

Validation of criteria: plasma injection is second best in odor reduction and best overall.

0 = poor 10 = excellent	Waste-flow	Area	Energy	Invest. cost	Operat. cost	Life	Easy to operate	**Odor reduction**	TOTAL
Carbon adsorption	4	4	4	4	2	4	6	**1**	**29**
Combustion	1	5	1	3	1	6	4	**10**	**31**
Bio filtration	8	1	7	7	8	9	7	**6**	**54**
Wet-scrubber (chem)	1	4	7	4	2	7	2	**7**	**34**
Wet-scrubber (water)	5	4	7	7	8	8	8	**4**	**47**
PLASMA -INJECTION	9	10	7	8	8	9	9	**9**	**69**

Remarks:
- Carbon adsorption: temperature and humidity too high, carbon will be clogged with water.
- Bio systems: not suitable for changing recipes with changing contaminants and low solubility, bacteria need more constant process conditions and can be difficult to control.
- Wet scrubbers: has a low odor reduction efficiency as it is only suitable for odors with good solubility, which is not the case with feed/petfood odors (fat/proteine with low ppm but high odors)

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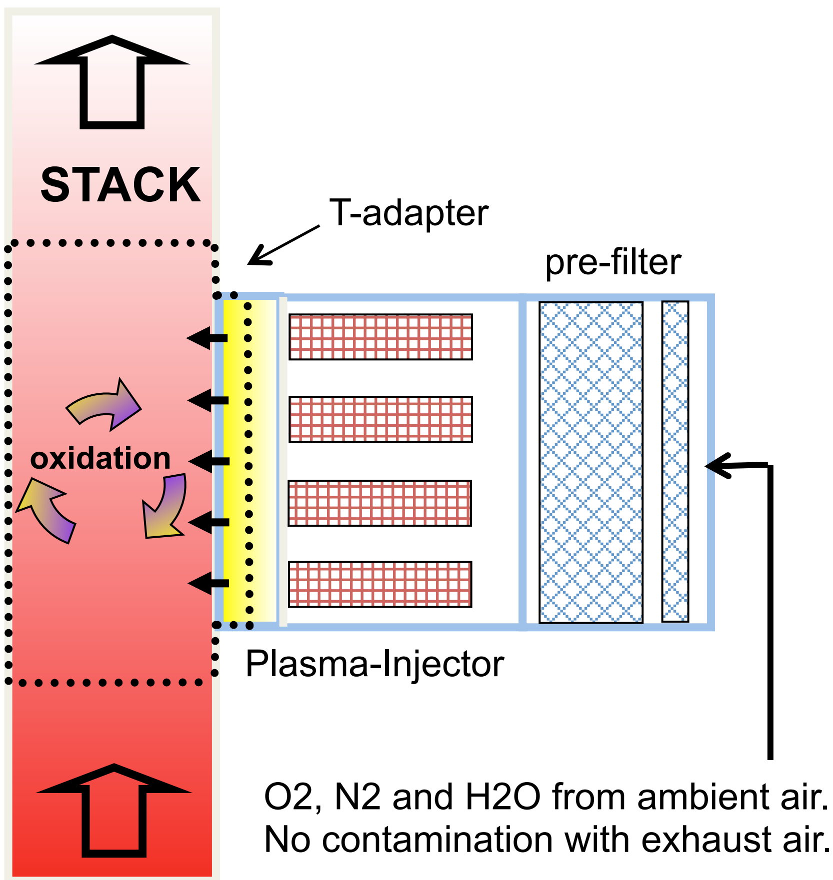
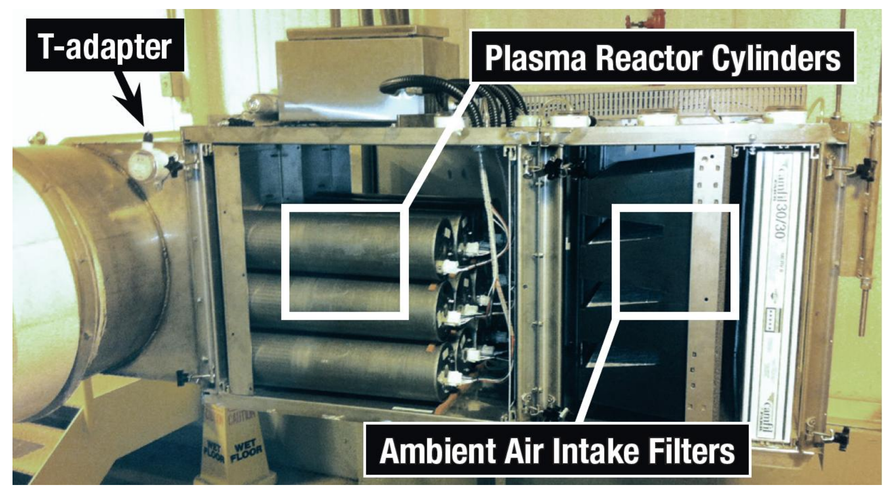
PLASMA-INJECTOR: with T-adapter connection

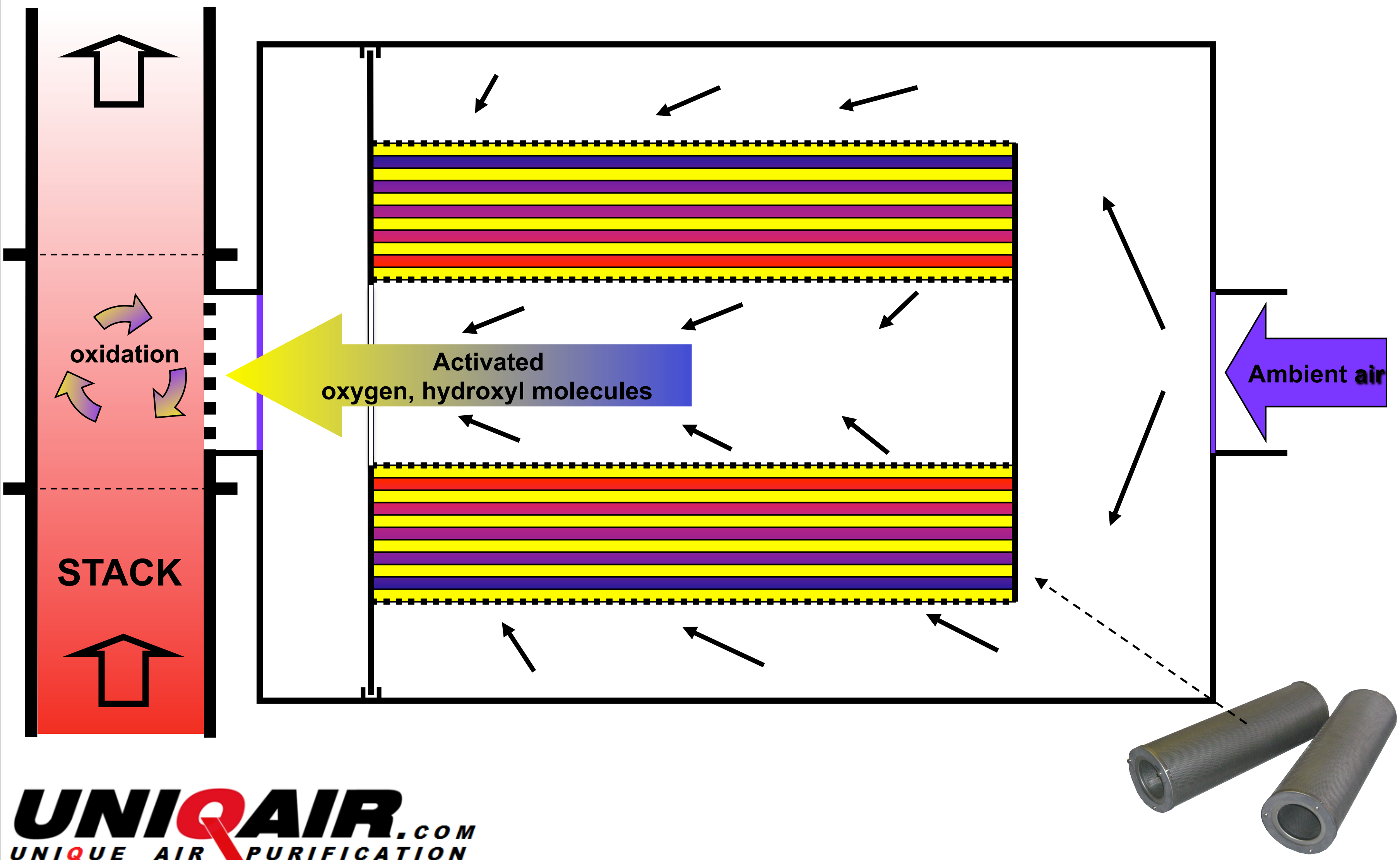


<u>Plasma Reactor Cylinders:</u>

- Modular 1kW cold plasma reactor cylinders
- Quick bayonet coupling: 15 second disconnect
- Annual regeneration/exchange.
- Reactors rental program for lifetime warrantee



Modular Plasma Reactors: schematic airflow



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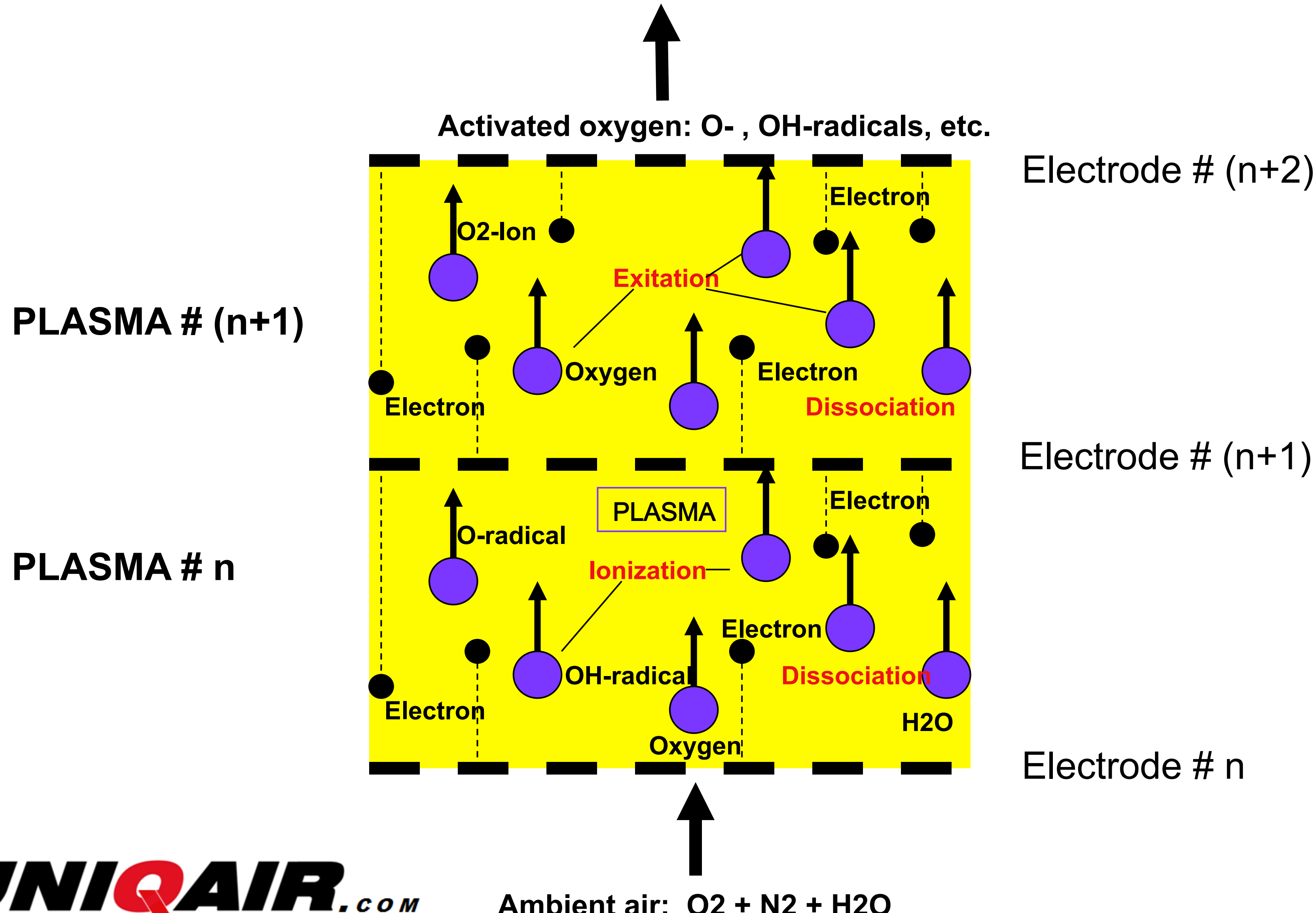
PLASMA REACTOR: Converting ambient air into activated oxygen.



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Working principle:

- Oxidation of odor molecules (just like nature only faster) to various levels.
- Ionisation/Polarisation of odor molecules and small particles
- Agglomeration of small particles

COLD (NON THERMAL) HIGH FREQUENCY PLASMA:

- Photo dissociation $O2 + hv \rightarrow O + O\ (1D)$ $\lambda < 190$ nm
  $O3 + hv \rightarrow O2\ (1\Delta g) + O\ (1D)$ $\lambda < 310$ nm
- Ion-electron recombination $O2+\ e \rightarrow O + O\ (1D)$
- Electron impact $O + e\text{-fast} \rightarrow O\ (1D) + e\text{-slow}$
- Photo dissociation $O2 + hv \rightarrow O + O\ (1S)$ $\lambda < 133$ nm
- O-atom recombination $3O \rightarrow O2+ + O\ (1S)$
- Etc.

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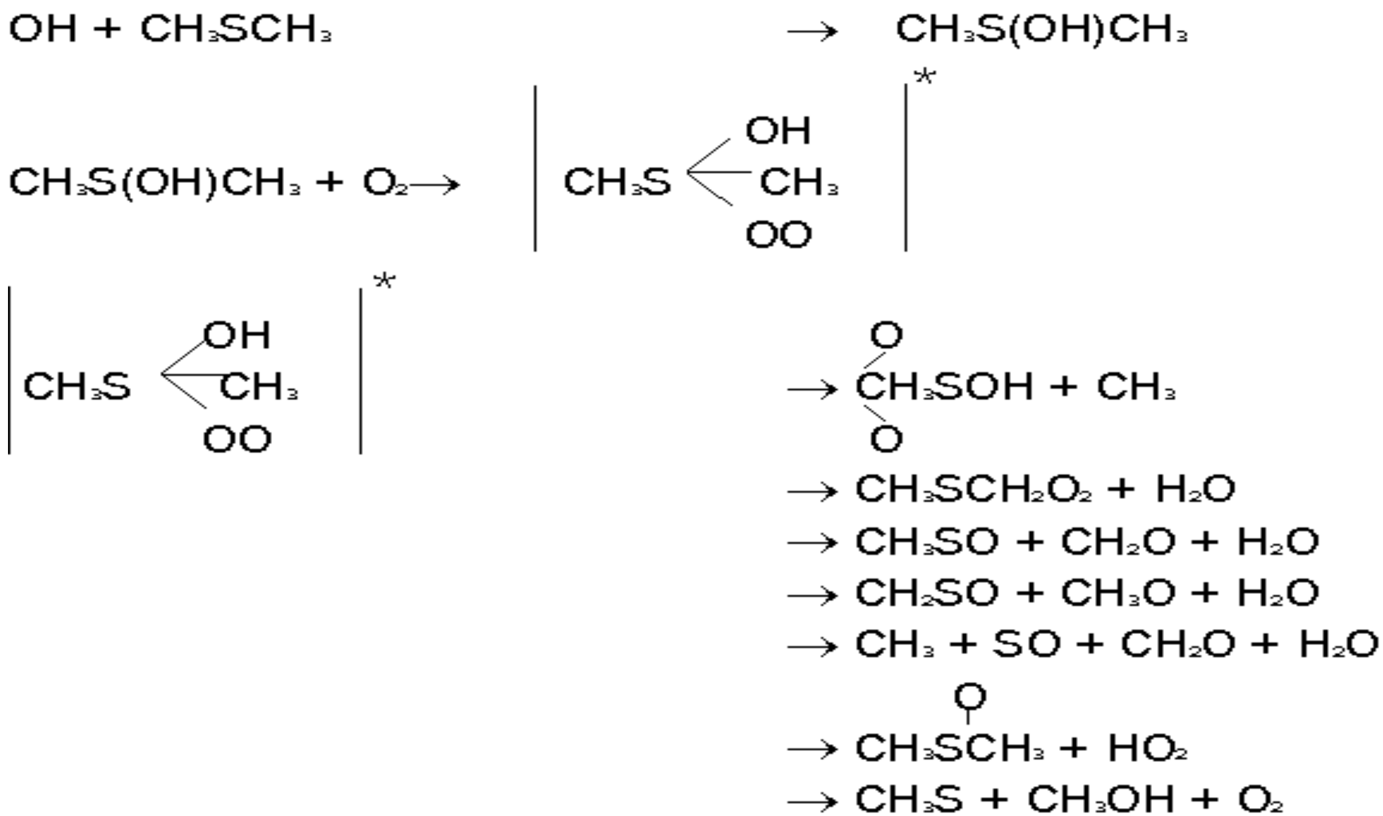
Example: Dimethyl Sulfide oxidation process

Oxygen and hydroxyl radicals are oxidizing and breaking down odors



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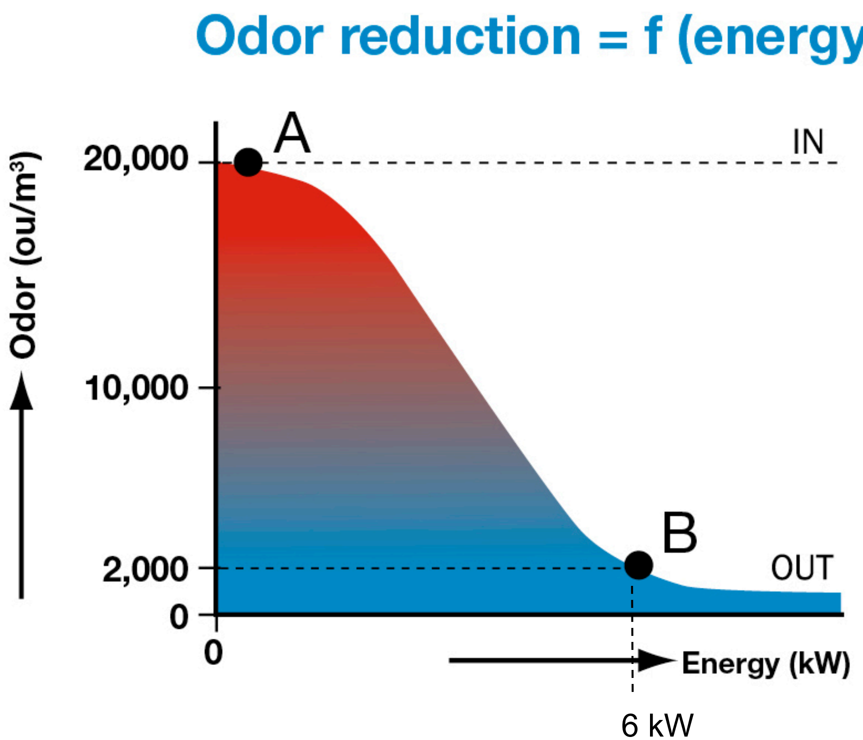
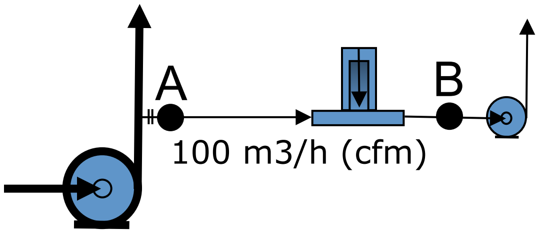
Odor reduction = function (energy)

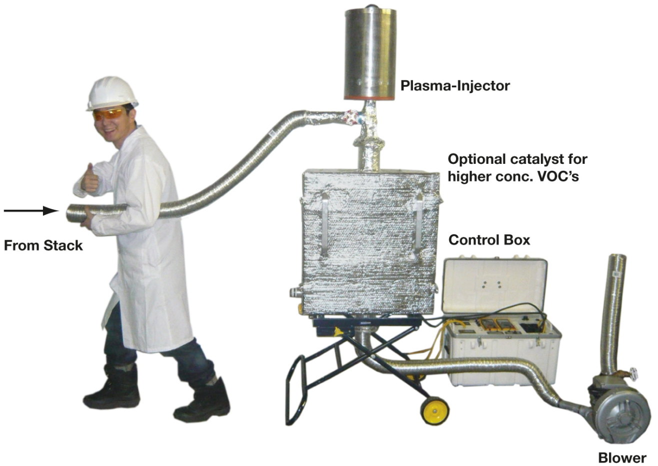
More energy input will increase odor reduction until this levels off.
Usually the optimal energy level (see example point B) will be set
as a minimum for all recipes. Testing to be done with highest odor recipes.



Example pet food dryer: 17,000 m3/h (10,000 cfm) with 6 kW



Pilot test units determine required energy



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PLASMA-INJECTOR: palatant pork/fish/chicken flash dryer

- Model PI-300 (30kW)
- Simple start/stop control.
- 30,000 cfm (50,000 m3/h)
- No water or chemicals
- No operator training
- Virtually maintenance free.
- High odor 40,000 ou/m3
- Reduction 90% at 30kW
- No waste
- Plasma-Injector Video

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6 Stacks from pet food dryers and dryer-coolers: 120,000 cfm

Plasma-Injector per stack under canope

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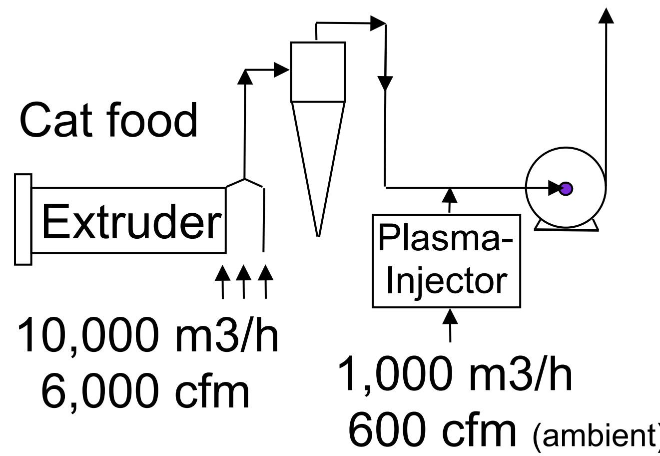
PLASMA-INJECTOR: treating 6,000 cfm (10,000 m3/h)



Plasma-Injector PI-30: 3kW

PLASMA-INJECTOR: sustainable cold plasma oxidation

- High odor removal efficiency
- No supply of chemicals, water, fuel, etc.
- No waste at all
- No moving parts and only clean air processing
- Low cost, long lifetime > 25 yr
- Plasma reactor rental with lifetime guarantee
- No impacts from process fluctuations like dust, temperature, humidity etc.

- Injection principle: no impact on pressure and production process.
- Almost no maintenance: one 15 minute plasma reactor exchange per year, 1 dust filter per quarter.
- Low energy consumption
- Simple & safe operation (only on/off, no kV-wires inside/outside)
- Safe: all high voltage parts are inside the plasma reactors with annual exchange/regeneration.
- Compact and easy to install