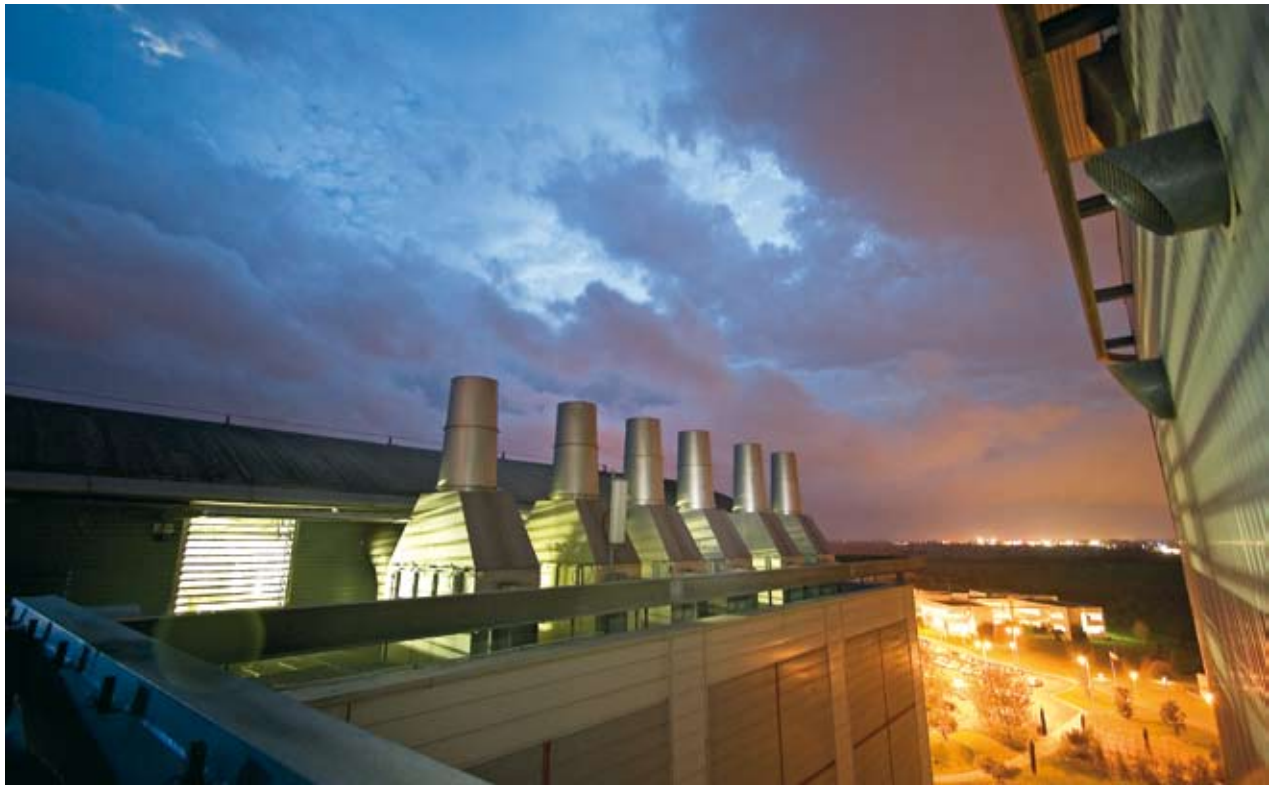
Odour control with Direct Cold Plasma



Six cold plasma units for 120,000 m³/h

Odour emission during the production or processing of food and feed is often an unwelcome side effect. However, by using cold plasma technology, the smell can be reduced up to 95%.

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Increasingly, feed manufacturers are being required to address the issue of emitting odour and harmful contaminants into the surrounding community. Local communities, special interest groups and government legislation all bring pressure to bear on factories to minimize real or perceived risks of contamination. There are no universally applied standards for odour or Volatile Organic Compounds (VOC) emissions, and to provide solutions that fit specific factory needs can be complex.

There is no single solution but understanding the feed manufacturers problems certainly helps a great deal. In recent years, there have been numerous changes regarding where production facilities are situated. Factory closures and relocation of manufacturing units has become commonplace. At the same time urban sprawl has resulted in residential areas being built closer to previously remote industrial areas. Another pressure that companies face is meeting local environmental needs.

So what does the industry need from its odour abatement equipment? This is a complex question and the answer needs to include:

- A compact design minimizing space requirements
- End of pipe solution
- Low running cost
- Minimal maintenance
- Ability to operate at normal feed manufacturing temperatures, to avoid cooling costs
- High odour removal efficiency
- No chemical additions and need to maintain chemistry
- No liquid effluent waste
- Instant on/off – no warm up time
- Modular construction, ease of relocation if change of production location and ease the ability to add on modules according to required capacity
- Competitive capital cost

In this example, five reaction chambers are installed in parallel, dimensioned to handle up to 100.000 m³/h. Untreated emission enters inlet stage of the reaction chambers from a lower duct and escapes vertically through the upper visible duct. Closing valves on the inlet- and outlet duct can isolate each reaction chamber.

Direct cold plasma

The above mentioned list is a long one, but there is a new technology that can answer most of these needs: direct cold plasma. In 2003 a global pet food manufacturer tested this new technology for odour removal, referred to as direct cold plasma, on drier and extruder flash-off exhausts.

The technology had obvious advantages over more conventional solutions. As a result, the pet food manufacturer looked for a suitable technology partner for collaboration on the application of cold plasma on pet food applications. In 2003 they formed such an agreement with APP (Applied Plasma Physics AS). APP is both a R&D and equipment supply company, specializing in the application of high voltage technology and non-thermal plasma systems for industrial processes. APP has now delivered more than 200 systems, most running on difficult applications. APP has experience on ultra high odour applications – where odour levels can be over 200.000 odour units per m³ - and the company achieved odour removal efficiencies of up to 97%. Another advantage that is unique for this specific technology is that both odour and dust are removed from the production emissions at the same time. The direct cold plasma has been adopted in the IPPC Bref-document as Best Available Technology (BAT).

The technology behind it

Odour bearing gases enter the cold plasma module, where it is distributed evenly as it enters the reaction chamber. The reaction chamber comprises a cluster of hexagonal cells. Running centrally through each cell is a corona wire, which is isolated from the rest of the chamber.

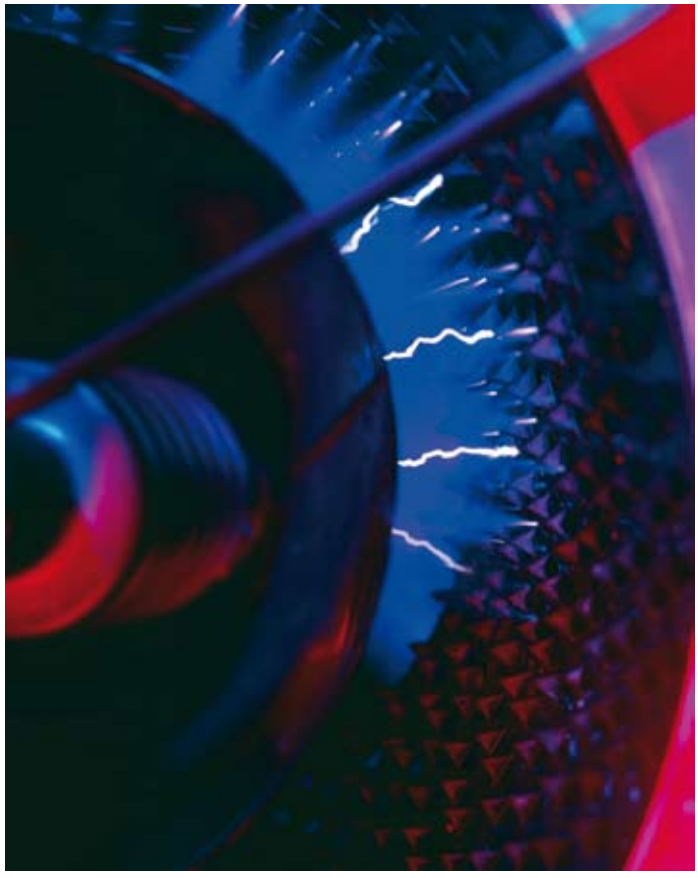
The high voltage generator distributes a modulating high voltage supply to each corona wire, and this process results in a discharge between the corona wire and the cell wall. The discharge promotes the emission with high-speed electrons, which collide with background gas molecules creating chemically active species known as radicals and charge carriers. This is actually identical to what happens with pollution in the atmosphere, only in this solution the process takes less than a second. Reactions occur with the odour bearing compounds in the gas to be treated. Ambient air may be injected just prior to the reaction chamber if conditioning is required. In essence the cold plasma process encourages “oxidation” of the odour bearing compounds at low temperature by creating discharge (cold plasma).

A proprietary control system monitors the high voltage passed to each of the corona wires in the reaction chamber, and controls the voltage modulation that generates the cold plasma.

The system also detects arcs between the corona wire and the cell wall, automatically shutting down electrical supply for a fraction of a second before power is reinstated.

The reaction chamber may be operated with the

Lower electrode frame inside the reaction chamber



The blue colour is the Non-Thermal Plasma condition created inside the APP reactor

gas flow passing upwards or downwards depending on site layout. The unit is capable of operating on emissions with relative humidity up to 100%.

The unit can be operated with emission temperatures up to 70°C. In most cases in the feed industry, the emission temperature from dryers will be less than this temperature limitation.

Maintenance and costs

Maintenance is minimal, if the unit is used as a dust collector as well as odour abatement system, then the unit would have a "wash-down" maybe once per week and an internal inspection once a month would be recommended. Operating costs are very low and mostly associated with the cost of electricity; 10-20kW for a standard 20.000 m³/h cold plasma unit.

A costing exercise produced by one of APP's customers, is shown in *Figure 1*. This is based on a 10-year period, including both investment and operating cost for a volume of 20,000 m³/h. The operating costs for the scrubber alone or scrubber biofilter do not include cost of water.

Testing

Since 2003, extensive testing with a pilot system both on extrusion flash-off, driers and coolers has been carried out. All possible variables have been reviewed to determine the optimum operating conditions for the cold plasma system. The variables that were tested included:

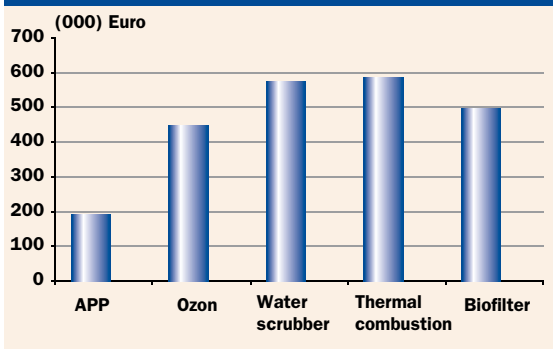
- Residence time (determines volume to be handled by a standard module);
- Effects of water scrubber at inlet or outlet of cold plasma;
- Cold plasma unit operating alone;
- Adding water to humidify inlet or outlet gas;
- Air infiltration volume (ion enrichment);
- Intensity of cold plasma generation;
- Geometry and arrangement of reaction cells.

The pilot plant (test unit) is designed to handle 1,600 m³/h and tests were repeated to check validity. Independent Olfactometry testing was used as a means of determining odour reduction efficiency.

Test results indicate that odour removal efficiencies of up to 90% are achievable within the food and feed industry and that the standard colds plasma module will handle around 20.000 Am³/h.

Higher efficiencies may be achieved by using a final polishing module. During testing, both high and low odour concentrations were experienced; nonetheless cold plasma achieved real odour reductions even on very low inlet concentrations, something that is not always the case on alternative technologies.

Figure 1 – Ten years life cycle cost



Effective reduction

Overall the tests indicated that the cold plasma unit operated most effectively without a scrubber either at the inlet or outlet. Dust removal was very effective (99% reduction).

As a result of these tests, several petfood sites have now installed cold plasma technology for their processes. As per today, 50 units are in operation in the petfood industry, a figure that will increase substantially in the years to come.

The experience of the environmental needs of the feed industry, and APP's approach to innovative design is combined to offer a competitive alternative solution to a problem that is of increasing significance to the food and feed industry. ●