Welcome to our June Newsletter. In this issue we have included a detail overview of the Air Emissions Abatement Technology options generally considered for Pharma API plants. For more information on our current projects and to sign up to our email newsletter, please go onto our website www.bpe.ie or contact us directly on info@biopharma.ie. We do hope you enjoy this newsletter and thank you for your continued support. Any feedback or comments you may have would be highly appreciated.

THE PRINCIPLES OF BAT FOR VOC ABATEMENT SYSTEMS IN API PLANTS

Biopharma have supported a number of clients in the assessment of VOC (Volatile Organic Compound) Abatement systems for the treatment of site emission streams to meet their legislative requirements (current & future) while maintaining low lifecycle costs and operational flexibility. This article gives a brief overview of the most commonly used VOC Abatement technologies and their pro's and con's.

GUIDANCE & LEGISLATIVE REQUIREMENTS

The principle of BAT (Best Available Technology) is applied in the selection of suitable VOC Abatement technology. EPA and EU guidelines* describe suitable technologies and the allowable emission limit for specific substances under an IPPC license (i.e. TA Luft Classes).

* The IED (Directive on industrial emissions 2010/75/EU) replaces the IPPC directive and was transposed into Irish national legislation in the S.I. No. 565 of 2012 "Installations and Activities using Organic Solvents". Under this directive, the implementation of a reduced total VOC emission limit of 20 mg Carbon /Nm^3 is expected to be implemented by 2016.

TECHNOLOGY ASSESSMENT

The following technologies are the most commonly used Primary Abatement Systems in the API processing industry:

- Carbon Adsorption
- Cryogenic Condensation
- Thermal Oxidation (TO)

Pre-treatment scrubbing systems are typically used as part of an overall abatement system to remove incompatible corrosive gases or specific compounds to meet emission limits prior to the primary treatment technology.

CARBON ADSORPTION

Uses activated carbon to adsorb the VOC's from the vent stream onto the carbon bed. Dual beds are used, with one bed online for adsorption with the other bed off line for regeneration when saturated with VOC. Regeneration is usually done using steam which removes and collects the VOC's for disposal. Carbon beds are more restricted in what solvent streams can be used than TOs. Pre-treatment/Scrubbing is required to remove acidic gases. Carbon does also have to be periodically replaced. Certain compounds which have high exothermic heat of adsorption (Ketone & Aldehyde solvents) can cause potential hotspots resulting in bed fires, particularly during periods of start-up and shutdown.

Pros	• Relatively Low Operating Cost. • Handles intermittent venting well. • Can handle relatively lean VOC streams. • Handles both chlorinated and non-chlorinated streams.
Cons	• Requires steam for regeneration. • Periodic replacement of beds required. • Issues with older carbon beds cracking. • Captured VOC's require subsequent disposal.

CRYOGENIC CONDENSATION

Uses liquid nitrogen to condense VOC's out of the vapour stream by cooling the gas stream to below the saturation point of each VOC component. Recovered VOC's can be disposed of or reused if suitably pure. This technology is most effective where the VOC stream is a highly concentrated low volumetric load due to the high cost of liquid nitrogen. It is also possible to recover vaporised nitrogen for use in blanketing and inerting applications where the demand profile suits.

Pros	• Recovers solvent cleanly by direct condensation. • Potential to recover nitrogen for other uses where indirect condensation used. • Can treat both non chlorinated and chlorinated streams.
Cons	• High Operating Costs. Liquid Nitrogen is expensive if a significant proportion cannot be recovered for reuse. • Not suitable for larger scales. • Dilute streams and high flowrates will not be treated as effectively. • Most suitable for VOC's with boiling point above 38^{o}C • Needs dual equipment for duty/regeneration

THERMAL OXIDATION (TO)

Is considered a relatively robust technology with the capability of meeting BAT limits for multiproduct streams. Abatement is achieved by the complete thermal combustion/oxidation of the VOC's in the vent stream. The main types of thermal oxidation variations include Direct Fired Thermal Oxidation (DFTO), Regenerative Thermal Oxidation (RTO) and Catalytic Thermal Oxidation (CTO) and are described on the next page.

Selection of the most suitable TO technology is dependent on the vent stream conditions (VOC contents, concentration and volumetric loading) and vent header design.

DIRECT FIRED THERMAL OXIDATION (DFTO)

Can treat complex mixtures of compounds and provide high levels of control and reliability. The systems can treat low (<1g/m^3) to high (100g/m^3) inlet VOC concentrations, however with low VOC inlet streams, more supplementary fuel will be required to maintain combustion temperature. DFTO systems can be sized for a range of flow rates (150-800,000Nm^3/hr) and the systems can be designed for either induced or forced draft operation depending on the vent header arrangements. It can also be considered for chlorinated/halogenated streams but costs will be higher due to additional measures such as increased temperatures and scrubbing to eliminate dioxin formation. Additional monitoring and limits related to dioxins will also form part of an IPPC license.

REGENERATIVE THERMAL OXIDATION (RTO)

Uses a packed bed (ceramic) to recover the flue gas heat and pre-heat the inlet VOC stream thereby reducing the fuel requirement. The Gas streams are intermittently re-directed to maintain the heat recovery process. The systems require a lean vent header (<25% of LEL) operation and are not suited to the treatment of halogenated VOC.

Pros	• Robust solution for multi component solvent streams capable of meeting very low emission limit values. • Minimal waste streams for disposal • DFTO are best for VOC Rich streams with inert closed processing. • DFTO can work with co-incineration of liquid solvent wastes for heat recovery from waste solvent. • RTO systems (ceramic bed used for preheating gas stream) can be used for heat recovery on lean streams.
Cons	• DFTO are costly for high volume/lean streams as this will result in high natural gas consumption to maintain a combustible mixture. • Intermittent venting – TO needs to be kept online with natural gas if periods where no VOC's in operation • Plant/Process venting modifications are often required to optimise TO design/size and for safety reasons. • Expensive and more complex due to additional measure required for acid gas and dioxins formation prevention or removal if handling chlorinated solvents.

CATALYTIC THERMAL OXIDATION (CTO)

Uses a catalyst to significantly reduce the required temperature for oxidation required for thermal oxidation. It therefore needs less supplementary fuel than a thermal oxidiser. It is not technically suitable for all venting combinations due to the risk of catalyst poisoning and may not be suitable for chlorinated solvents. From a BAT hierarchy /criterion, it is favoured over thermal oxidation from an energy use aspect if technically suitable.

Pros	• Robust and capable of achieving similar emission limit values to a TO where VOC streams are compatible. • Lower operating costs than DFTO / RTO. • Lower capital cost than TO at smaller scales. • Minimal Waste Streams for Disposal. • Less NOx production than TO.
Cons	• Not suitable for all VOC stream combinations including chlorinated solvents. • A risk of catalyst poisoning in multiproduct plants. • Not as common in Pharma API plants due to complex vent stream compositions.

VENT HEADER DESIGN

The vent header systems must be designed to prevent and/or contain any ignition of flammable mixtures. The German TRBf100 code is normally used for design of vent header systems. This code detail the requirements for protective devices and measures to prevent ignition propagation (flame arrestors, inertion, LEL/O_2 monitoring). The degree of protection depends on the zoning of the header. The most cost effective header system is for headers designed to be inert (Zone 2), where inert processing conditions are maintained. A header can be designed to be Zone 0 (continuously flammable) but this is relatively costly due to the levels of protection required. A lean header can also be considered where the VOC content is always less than 25% of the LEL (e.g. Fume Extracts). Defining the vent header philosophy for the plant is usually a key design issue when installing a TO system. Some larger API plants segregate venting operations into chlorinated and non-chlorinated streams. The non-chlorinated being treated by a TO with the chlorinated stream being treated by an alternative technology (e.g. carbon adsorption or cryogenic condensation). This is typically where the chlorinated stream is a relatively low proportion of the overall VOC streams. This also allows the possibility of switching to the secondary abatement system in the event of an unplanned shutdown/trip of the TO. For more information on this article, please contact Tom O'Dwyer on todwyer@biopharma.ie.

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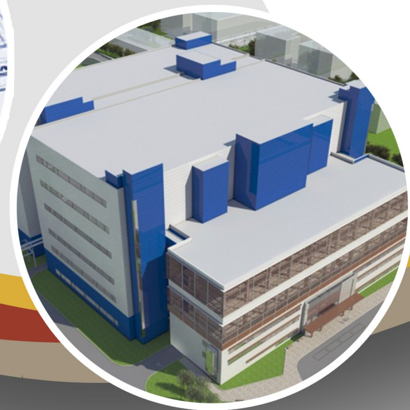

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