#04

EPOS TECHNOLOGY FOCUS

Technologies for industrial processes

March 2018

FLUE AND PROCESS GASES

Recovery and abatement of volatile organic and inorganic compounds (part 1)

EPOS

SYMBIOSIS IN INDUSTRY

About the EPOS Technology Focus

Within the scope of the EPOS project, extensive literature and market research reviews were performed in order to identify different technological, organisational, service and management solutions that could be applied to different industrial sites and clusters. The collected information will aid in establishing on-site and/or cross-sectorial industrial symbiosis opportunities; additionally, to enhance overall sustainability, performance and resource efficiency of different process industry sectors. Through the cooperation of project partners, a longlist of different technological options was created. Resource material for this list included: scientific articles, project reports, manufacturer's documentation and datasheets.

FLUE AND PROCESS GASES

The emission of flue gas is one of the most significant issues that process industries must deal with. Flue gas is a result of combustion, taking place in ovens, furnaces, boilers, etc. The composition of the flue gas relates to the type of source that is burned; mainly consisting of water vapour, carbon monoxide, carbon dioxide, particulates, nitrogen oxides and sulphur oxides.

Flue gas emissions have a significant impact on the environment, as such, there were many incentives in recent decades from regulatory bodies and national governments in order to reduce emissions and enhance sustainability of the critical industry sectors. Numerous measures and environmental standards were established. Industries were encouraged to invest and develop new technologies for emissions reduction and utilise the remaining emissions for other activities on industrial sites (e.g. lime production from desulphurisation, liquefaction of CO_2, etc.). This resulted in the establishment of several IS options that are now commonly used.

Treatment of flue gas and utilisation of the opportunities that are offered by different technological options contributes not only to reduced emissions and consequently, reduced costs from penalisation fees, but also offers new options for industries to generate additional revenue, i.e. from re-using or selling products obtained from flue and process gases (lime, liquid CO_2, etc.).

RECOVERY AND ABATEMENT OF VOLATILE ORGANIC AND INORGANIC COMPOUNDS

The techniques identified here are for the treatment of flue and process gases. The focus is on recovery and abatement of volatile organic and inorganic compounds; recovery and abatement of particulates; carbon capture, storage and utilisation techniques; utilisation of waste fuel/methane and flue gas monitoring.

- Membrane separation
- Condensation and cryogenic condensation
- Adsorption
- Wet gas scrubber
- Bio-filtration
- Bio-scrubbing

TECHNOLOGIES FOR THE RECOVERY AND ABATEMENT OF VOLATILE ORGANIC AND INORGANIC COMPOUNDS

Technology 1: Membrane separation

Processes that retain certain substances contained in the waste stream on one side of a membrane. The fluid that permeates through the membrane is referred to as the permeate. The fluid that is retained is referred to as the concentrate. The pressure difference across the membrane drives the process. The waste gas stream is compressed; it then passes through the selectively permeable membrane for organic vapours. [1]

Frequently used as a concentration step to facilitate further recovery or treatment, examples include [1]:

- Enrichment of VOCs in the gas phase, which increases the dew point of the waste gas stream, so the subsequent condensation occurs more readily
- Incineration of an enriched waste gas stream, reducing the need for additional fuel

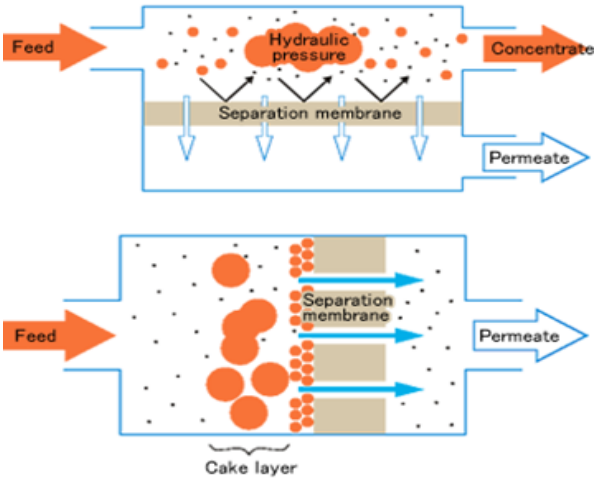

Figure 1 Membrane separation [2]

Applicability
Membrane separation is widely used in the chemical and petrochemical industries to recover solvent vapours from the waste gas or exhaust air.

Maturity
Commercial.

Hydrogen separation with membrane technologies.

Technology 2: Condensation and cryogenic condensation

Meant for the elimination of solvent vapours from a waste gas stream by reducing its temperature below its dew point. It is applied to the relatively saturated gas streams (i.e. high dew point) of volatile compounds and odorous substances. [1]

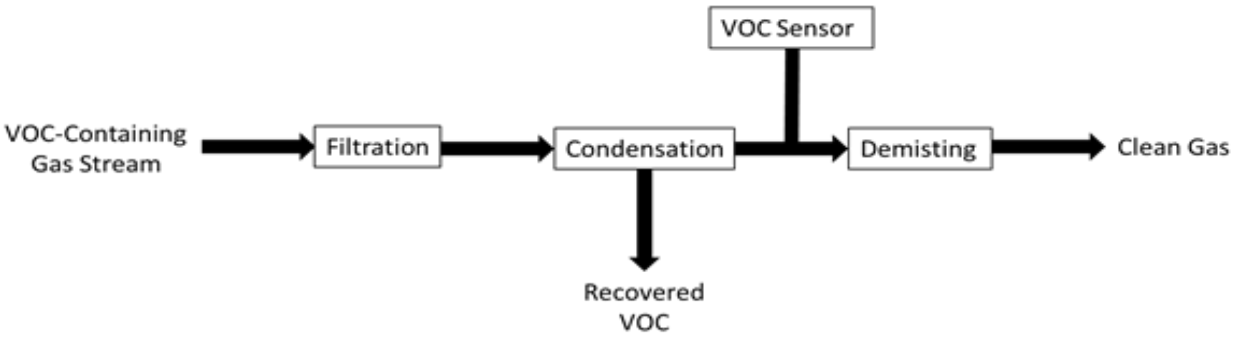

Figure 2 Condensation and cryogenic condensation [3]

Applicability
For the treatment of waste gases in gas treatment facilities, especially in the chemical industry. See also the basic description.

Maturity
Commercial.

Project/product reference
Active VOC recovery: offshore loading, Norwegian Continental Shelf.

Technology 3: Adsorption

A heterogeneous reaction in which gas molecules are retained on a solid or liquid surface that prefers specific compounds to others and thus removes them from the effluent stream. [1]

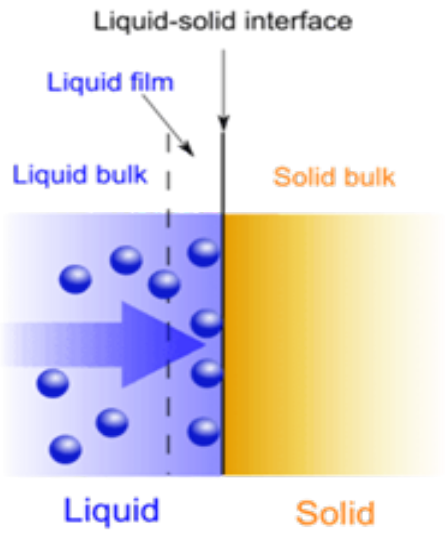

Figure 3 Adsorption [4]

Applicability
Adsorption is mainly used to abate, recover, recycle and prepare the inorganic compounds, VOCs and other organic hazardous air pollutant emissions in the chemical industry, iron and steel production, waste incineration and waste treatment.

Maturity
Commercial.

Project/product reference
Capturing Organic Vapours from Non-Condensable Gases Using Activated Carbon.

Technology 4: Wet gas scrubber

Wet scrubbing or absorption is a mass transfer between a soluble gas and a solvent in contact with each other. [5]

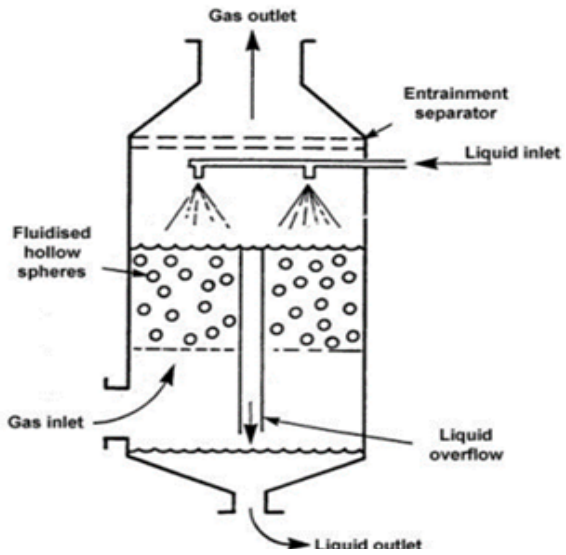

Figure 4 Wet gas scrubber [1]

Applicability

For separation and purification of gaseous streams containing high concentrations of VOCs and the abatement of inorganic compounds. Widely used as a raw material and/or product recovery technique in the chemical industry, waste incineration, sludge processing installations, sewerage water pumping stations and wastewater treatment plants.

Maturity

Commercial.

Project/product reference

Power boiler air emission compliance with new scrubber technology: a case study.

Technology 5: Bio-filtration

A waste gas stream passes through a bed of organic material, where it is biologically oxidised by naturally occurring microorganisms into carbon dioxide, water, inorganic salts and biomass. It is suitable for low concentrations of pollutants that are easily soluble in water. It is not suitable for waste gases containing many different and/or changing pollutants. [1]

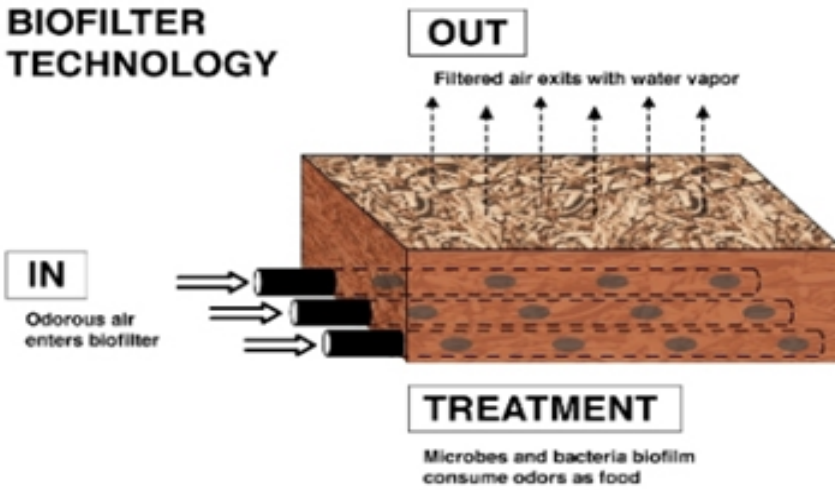

Figure 5 Bio-filtration [6]

Applicability
The abatement of readily biodegradable components at relatively low concentrations in waste gases in the chemical industry and wastewater treatment plants.

Maturity
Commercial.

Project/product reference
ESSUK's solution.

Technology 6: Bio-scrubbing

Consisting of a gas scrubber and a biological reactor. In the gas scrubber, to-be-removed components are absorbed from the gas stream by the wash water that contains a population of microorganisms, which are suitable to oxidise the noxious gas components. In the biological reactor, the pollutants that have been absorbed by the wash water are biologically degraded. The purified scrubbing liquid circulates to the scrubber, where it is able to reabsorb the pollutants. [5]

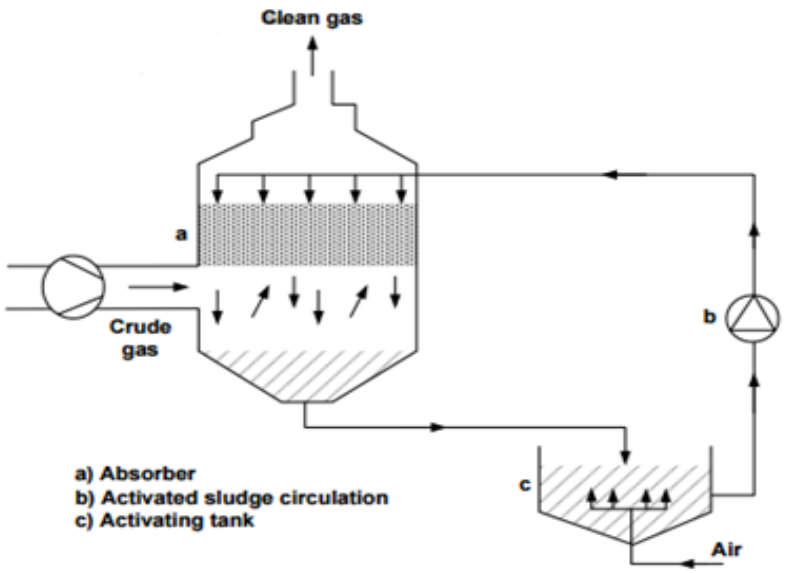

Figure 6 Bio scrubber [1]

Applicability
Used to abate readily biodegradable components, such as ammonia, amines, hydrocarbons, etc. It is well suited to low concentrations of pollutants that are easily soluble in water. They are used in the chemical and petrochemical industries, in sewerage treatment plants and for the removal of odours arising from polymer production.

Maturity
Commercial.

Project/product reference
Bionomic industries bio-scrubber.

REFERENCES

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4. "Absorption vs. Adsorption," [Online].
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All the EPOS TECHNOLOGY FOCUS Acts could be found on www.spire2030.eu/epos (Section Outcomes/Publications)

CREDITS

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