Waste water oxidation using a catalytic contactor

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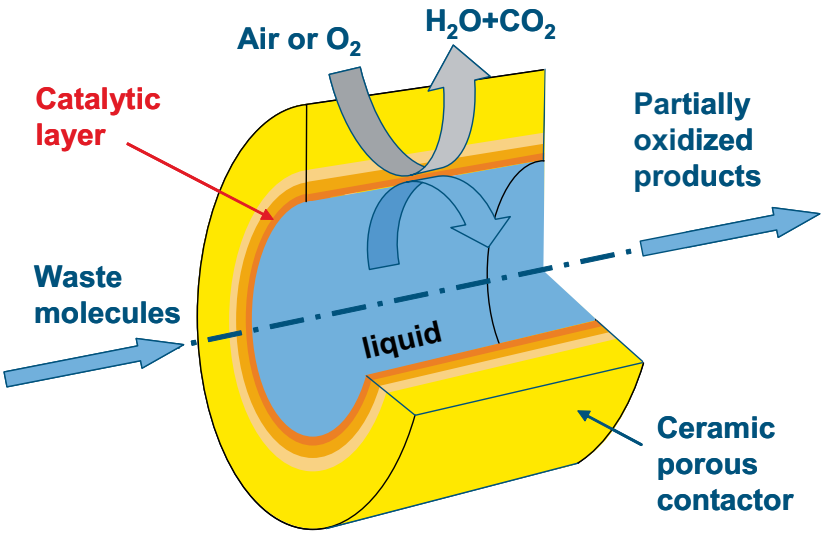
- A revolutionary catalytic membrane reactor for waste water treatment

A new and innovative method for oxidation of dissolved compounds in water – the "Watercatox" process – has been developed by SINTEF, the Norwegian company Due Miljø AS and partners. The new process is particularly suited for waste water treatment. It can operate at low temperatures and pressures compared to conventional wet air oxidation and incineration technology, and it has very small space requirements compared to biological treatment plants. The method is particularly interesting for treatment of toxic but dilute waste water. Today, such effluents are expensive to treat since they have low energy content and can not be treated biologically due to toxicity.



Principle of operation of the Watercatox process. The porous contactor tube has a layer on the inside wall containing catalytic nanoparticles where the oxidation takes place.

Mild conditions

We have demonstrated industrially competitive conversion rates for real industrial effluents at remarkably mild conditions; 20-80° C, ambient pressure on the liquid side, 5-15 bar on the gas side. The low temperature and pressure leads to reduced energy consumption and less corrosion problems. The Watercatox process is expected to be quite robust, since the contactor is made of ceramics that can withstand high temperatures and pressures and tough chemical environment. It has been shown that the efficiency of the process is maintained even in a chloride-rich environment.

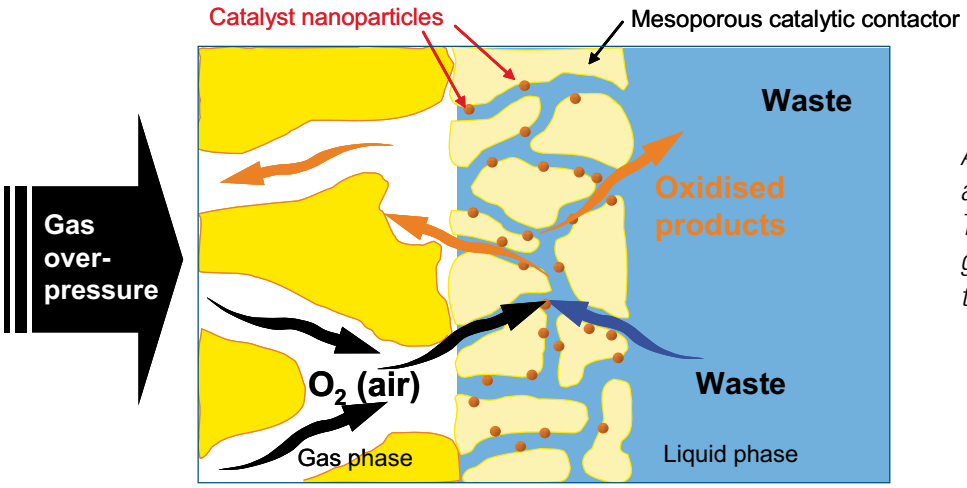
Compact units

A Watercatox plant can be made modular, so that the capacity of the plant can be varied in accordance with demand. The process is suitable for SMEs, since small units can be cost effective and only small space is required. It is even possible to install a unit in a vehicle to treat occasional discharges on-site. The low weight is ideal for installation on offshore platforms and in ships.

A first application could be treatment of effluents containing high concentrations of phenols and formiates. Such effluents are quite abundant in industry, and they are difficult to treat biologically. An application with a large potential in Norway is treatment of produced water from oil and gas wells. In the longer term, the process could be applied to other industrial liquid oxidation processes and reclaim of valuable substances.

Principle of operation

The principle of operation of the Watercatox process is to oxidise the dissolved molecules using the oxygen of air with the aid of a catalytic porous contactor. The contactor may have the shape of a tube with one or several channels, and the water is pumped along the contactor on one side, while air or oxygen flows along the other side of the contactor. The liquid and the gas phase meet at the catalytic particles in the porous network of the contactor, and the waste molecules oxidise spontaneously to water, CO_2 or partly oxidised components depending on conditions.



An overpressure of air or oxygen is applied to the outside wall of the tube. The overpressure (5-15 bar) forces the gas-liquid interface to a position close to the catalytic layer.

European development

The method has been developed through a European project supported by the European Commission [1] and is protected through a patent [2]. The Norwegian company Due Miljø AS has built a pilot unit for the process with 0.3 m^2 contactor area and ›300 L/h capacity.

References:

1. WATERCATOX, Waste Water Treatment by Catalytic Oxidation Contactor, EU 5th FP Contract no. EVK1-CT-2000-00073, 2001-2004. Partners: SINTEF (NO), CNRS-IRC (FR), National Institute of Chemistry (SI), TREDI (FR), Monsanto (BE), LEK (SI), Due Miljø AS (NO), Pall-Exekia (FR), Inocermic (DE) and MAST Carbon (UK).

2. Int. Patent Publ. No. WO02074701 (Application No. PCT/NO02001), Eur. Patent Publ. No. 1368278, Norwegian Patent No. 313994 (2003), Wet oxidation with the aid of a porous catalytic contactor. Inventors: R. Bredesen, H. Ræder, J.-A. Dalmon and S. Miachon

Relevant literature

H. Raeder, R. Bredesen, E. Iojoiu, S. Miachon, J.-A.Dalmon, A. Pintar, Bercic, G. and J. Levec, Wet air oxidation of waste waters in a catalytic membrane reactor, Proceedings of the 8th Int. Conf. on Inorganic Membranes (ICIM8), Cincinnati, USA, July 18-22, 2004, p. 394-397.

M. Vospernik, A. Pintar, G. Bercic, J. Levec, J. Walmsley, H. Raeder, E. Iojoiu, S. Miachon and J.-A. Dalmon, Performance of catalytic membrane reactors in multiphase reactions, Chemical Engineering Science 59 (2004) 5363-5372.

H. Raeder, R. Bredesen, G. Crehan, S. Miachon, J.-A. Dalmon, A. Pintar, J. Levec and E. G. Torp, A wet air oxidation process using a catalytic membrane contactor, Separation and Purification Technology 32 (2003) 349-355.

Left: Pilot unit for application testing of the Watercatox process. The unit has 0.3 m^2 contactor area and >300 L/h capacity.

Right: End section of a multichannel tube impregnated with catalytic nanoparticles. The hexagon-shaped tube has a diameter of 31 mm and is 1020 mm long. The greyish colour is due to the platinum deposition.

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