

# NOVEL WASTE GAS TREATMENT PROCESS: ABLE TO COPE WITH FLUCTUATING LOADS, POORLY WATER SOLUBLE VOC AND BIOMASS ACCUMULATION

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Biological waste gas treatment processes show major challenges, which are not yet solved:

- volatile organic compound (VOC) load fluctuations in the waste gas stream
- highly and poorly water soluble compounds
- excessive accumulation of biomass

The overall objective of this project is to solve the mentioned challenges, by developing a novel waste gas treatment process. The novel system is separated in two process steps: the removal of the VOC from the gas and the microbial degradation.

The VOCs are removed from the contaminated waste gas by a membrane-based absorption. The VOCs together with oxygen diffuse through the membrane and are buffered in the absorbent. This buffering is introduced to remove most of the VOCs from waste air independently of load fluctuations and of microbial performance at present.

In the second process step the VOCs are degraded in a membrane based biofilm reactor. This second membrane separates the absorbent from the mineral medium. A biofilm grows on the mineral medium side of the membrane and degrades the buffered VOCs. The nutrient solution overflows the biofilm, introducing shear stress on the biofilm surface and thereby removing excessive biomass to prevent clogging of the reactor [1].

The necessary oxygen for the aerobic microbial degradation also stems from the absorbent. VOCs and oxygen reach the biofilm by diffusing through the membrane. This creates an inverse biofilm – the most active layer of the biofilm (the highest oxygen concentration) is located close to the membrane and not to the nutrient medium as usual. This profile is advantageous due to the fact that the top part of the biofilm surface is removed by the shear stress. This fact enables to discharge the inactive part of the biomass and with that to keep the microbial activity high.

Membranes are used in the novel system due to the superior performance in the treatment of poorly water-soluble compounds. VOCs do not have to be solved directly in the aqueous phase to be removed from the gas phase and to be degraded.

The model VOC is toluene, the absorbent a silicone oil. A novel ultra thin (45µm thick) dense polydimethylsiloxan membrane, with an integrated wire-cloth for mechanical strength is used as the absorption membrane and as growth substratum for the biofilm. The absorption and the biofilm area amount to 0.2 and 0.25m<sup>2</sup> respectively. The reactor is inoculated with two bacterial strains *Pseudomonas putida F1* and *Rhodococcus erythropolis PWD1*.

[1] Vinage, I., *Biological waste gas treatment using a modified Rotating Biological Contactor*. 2002, Diss. ETH Nr. 14702, Swiss Federal Institute of Technology Zurich, Switzerland.