Wet air oxidation as an option for industrial membrane concentrate remediation

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Abstract:

Membrane processes are often an alternative over conventional treatments for industrial effluents because of permeate's outstanding quality. Whilst membranes are highly effective for pollution removal, generated concentrates require additional treatment before environmental discharge as membranes are not destructive processes. A hybrid process coupling membrane processes (microfiltration-ultrafiltration, reverse osmosis) and wet air oxidation (WAO) was developed. The purpose is to obtain a great volume of high-quality permeate and a residue coming from the retentate of WAO. The mixture of these two fluxes can be rejected to the environment according to the standards.

The aim of this study is to treat industrial membrane concentrates containing organic pollutants (especially bio-refractory compounds) with WAO. WAO is typically autothermic in the range of chemical oxygen demands (CODs) between 10 – 100 $gO_2 \cdot L^{-1}$. Therefore, the hybrid process benefits of filtration's concentration step to perform a low-energy WAO.

WAO was performed in a lab-scale autoclave with 5 industrial membrane concentrates: landfill leachates, a complex industrial effluent, bilge, dairy and pharmaceutical wastewaters. Temperature's effect was studied at 200, 250 and 300 °C at 18 MPa during 6 h. Pressure's effect was studied at 300 °C-(18 and 21 MPa). COD and total organic carbon (TOC) were measured at the beginning and 4 times throughout oxidation to follow process efficiency.

Experiments highlighted temperature's role (300 °C) in the degradation of organic compounds through reaction rates and overall COD and TOC removals. For bilge wastewater and leachates, COD removal after 6 h reached 87% with respective CODs of 121 and 1154 $mgO_2 \cdot L^{-1}$. For pharmaceutical and dairy wastewaters, COD removal reached 94% and 96% with respective CODs of 1330 and 2813 $mgO_2 \cdot L^{-1}$. For the complex effluent, 97% of COD was removed with a final COD of 1060 $mgO_2 \cdot L^{-1}$.

Experiments in a bubble column reactor working in continuous are foreseen to confirm process efficiency.

Keywords: membrane concentrates, treatment, hybrid process, industrial effluents, wet air oxidation

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