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Intensification of Wet Air Oxidation of Landfill Leachate Reverse Osmosis Concentrates

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Abstract : Water is a precious resource. Treating industrial wastewater remains a considerable technical challenge of our century. The effluent considered for this study is landfill leachate treated by reverse osmosis (RO). Nowadays, in most developed countries, sanitary landfilling is the main method to deal with municipal solid waste. Rainwater percolates through solid waste, generating leachates mostly comprised of organic and inorganic matter. Whilst leachate ages, its composition varies, becoming more and more bio-refractory. RO is already used for landfill leachates as it generates good quality permeate. However, its mains drawback is the production of highly polluted concentrates that cannot be discharged in the environment or reused, which is an important industrial issue. It is against this background that the study of coupling RO with wet air oxidation (WAO) was set to intensify and optimize processes to meet current regulations for water discharge in the environment. WAO is widely studied for effluents containing bio-refractory compounds. Oxidation consists of a destruction reaction capable of mineralizing the recalcitrant organic fraction of pollution into carbon dioxide and water when complete. WAO process in subcritical conditions requires a high-energy consumption, but it can be autothermic in a certain range of chemical oxygen demand (COD) concentrations (10-100 $g.L^{-1}$). Appropriate COD concentrations are reached in landfill leachate RO concentrates. Therefore, the purpose of this work is to report the performances of mineralization during WAO on RO concentrates. The coupling of RO/WAO has shown promising results in previous works on both synthetic and real effluents in terms of organic carbon (TOC) reduction by WAO and retention by RO. Non-catalytic WAO with air as oxidizer was performed in a lab-scale stirred autoclave (1 L) on landfill leachates RO concentrates collected in different seasons in a sanitary landfill in southern France. The yield of WAO depends on operating parameters such as total pressure, temperature, and time. Compositions of the effluent are also important aspects for process intensification. An experimental design methodology was used to minimize the number of experiments whilst finding the operating conditions achieving the best pollution reduction. The simulation led to a set of 18 experiments, and the responses to highlight process efficiency are pH, conductivity, turbidity, COD, TOC, and inorganic carbon. A 70% oxygen excess was chosen for all the experiments. First experiments showed that COD and TOC abatements of at least 70% were obtained after 90 min at 300°C and 20 MPa, which attested the possibility to treat RO leachate concentrates with WAO. In order to meet French regulations and validate process intensification with industrial effluents, some continuous experiments in a bubble column are foreseen, and some further analyses will be performed, such as biological oxygen demand and study of gas composition. Meanwhile, other industrial effluents are treated to compare RO-WAO performances. These effluents, coming from pharmaceutical, petrochemical, and tertiary wastewater industries, present different specific pollutants that will provide a better comprehension of the hybrid process and prove the intensification and feasibility of the process at an industrial scale. Acknowledgments: This work has been supported by the French National Research Agency (ANR) for the Project TEMPO under the reference number ANR-19-CE04-0002-01.

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