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Analysis and optimization of operating conditions on ultrafiltration of landfill leachate using a response surface methodological approach

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ABSTRACT

The term "leachate" or "landfill juice" refers to the water that has percolated through the waste and has become highly polluted. The pollution indicators total suspended solids (TSS), chemical oxygen demand (COD), biological oxygen demand and salinity of this effluent far exceed the discharge standards. In addition, the increasing requirements of the standards and the stabilization of leachates over time, new techniques have emerged to remedy this problem. Among the technologies used, we find reverse osmosis which has developed in many European countries. In Morocco, at the Oum Azza plant, leachates are treated by reverse osmosis because of their very high salinity. To avoid repeated fouling of the membranes, the pre-treatment must be efficient to meet the requirements of this process. This paper discusses the efficiency of ultrafiltration (UF) as a pretreatment of reverse osmosis in leachate treatment using three ceramic membranes. The response surface method (RS which is an analytical tool and an efficient approach to build predictive models and optimize the UF process was used. Influence of transmembrane pressure (TMP) and circulation velocity (CV) on the performance of three ceramic UF membranes of different pore sizes (UF20, UF50, UF100) for landfill leachate (LFL) treatment is studied. The response surface methodology based central composite design is applied to optimize the operational variables: TMP and CV. Quadratic models developed for the three responses permeate flux, COD and TSS indicate that rejection of COD and TSS obtained are respectively 85%, 66.8% for UF20, 76% and 62.6% for UF50 and finally 70.6% and 50.5% for UF100. Analysis of variance is used to study the variables and the interaction between them. A coefficient of determination found ($R^2 > 0.8$) for all three membranes shows a good correlation between experimental and predicted response values. In addition, response surface plots are drawn for spatial presentation with the regression equations. These results provide a new information on the effects of porosity and operating parameters on the performance of UFs membranes.

Keywords: Ultrafiltration; Response surface methodology; Central composite design; Optimization; Transmembrane pressure; Circulation velocity

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