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Prediction of permeation flux decline during MF of oily wastewater using genetic programming

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ABSTRACT

Genetic programming is an orderly method for getting computers to regularly solve a problem. The genetic programming creates a computer program from an obtained data and solves the problem. In this work, treatment of oily wastewaters with synthesized mullite ceramic microfiltration membranes was studied and a new approach for modeling of the membrane flux is presented. The model used input parameters for operating conditions (flux and filtration time) and feed oily wastewater quality (oil concentration, temperature, trans-membrane pressure and cross-flow velocity). The genetic programming utilized here delivers a mathematical function for the membrane flux as a function of the independent variables stated above. Parameters for controlling and termination criterion for a run are provided by the user. Result is provided as a tree of functions and terminals. The results thus obtained from the genetic programming model demonstrated good representation of the experimental data with an average error of less than 5%.

Keywords: Modeling; Microfiltration; Oily wastewater; Genetic programming

1. Introduction

Oils, fuels, solvents, detergents, rusts and paints a wide variety of other substances are typical contaminants. Oily wastewaters are mostly generated in oil refining processes. Petroleum refineries are trying to reduce oil content in water discharged into the sea (Peng and Tremblay, 2008; Salahi et al., 2010; Muller and Robert, 1985). Wastewater oil content appears in three shapes of free, dispersed and emulsified. Free oil is defined as having particle sizes greater than 150 μm, with dispersed oil particle size ranging from 20 to 150 μm and emulsified oil droplets being characterized with particles sizes of less than 20 μm (Cheryana and Rajagopalan, 1998). Mean particle size of oil droplets in this paper is set at 1.09 μm. As membrane technology has been applied for wastewater treatment, it has been growing rapidly due to the need for high quality water requirements. Membrane technology in wastewater treatment has significant progress in recent years. Microfiltration (MF) membrane as a key technology in the treatment of oily wastewaters is significant (Peng and Tremblay, 2008).

Despite their expensive investment and construction costs, membrane processes are widely employed due to their success in reducing effluent concentrations to as low as 5 mg/L (Mulder, 2002). Fouling is generally a problem in membrane filtration, especially in the filtration of wastewater. This phenomenon is a damaging appearance in the membrane process that can make permeation flux (PF) decline as a result of the degeneration of feed water quality. Techniques for fouling prevention are needed (Huotari and Huisman, 1999; Grenier et al., 2008).

Cleaning methods are used to minimize gel wastes formed in the membrane surface. Flux values in a cross-flow membrane filtration are intensely dependant on different process variables such as temperature (T), oil concentration (C_{oil}), trans-membrane pressure (TMP), cross-flow velocity (CFV), filtration time (t) and membrane type (Aydiner et al., 2005). Modeling of permeation flux decline during MF of oily wastewater in membrane with experimental results is thus important when evaluating membrane fouling. These models have predicted flux for various process variables.

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