

Chapter 9

Development of Self–Organized Group Method of Data Handling (GMDH) Algorithm to Increase Permeate Flux (%) of Helical–Shaped Membrane

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ABSTRACT

The chapter focuses on enhancing the permeate flux of helical shaped membrane using group method of data handling (GMDH) algorithm. The variables such as operating pressure, pore size, and feed velocity were selected as input parameters, and permeate flux as model output. The uncertainty analysis evaluates the acceptability of the model, and it was found that values of Nash-Sutcliffe efficiency (NSE), the ratio of the root mean squared error to the standard deviation (RSR), percent bias (PBIAS) were close to the best value which shows the model acceptability. The effect of input parameters on model output is calibrated using sensitivity analysis. It shows that pore size is the most sensitive parameter followed by feed velocity. The optimum values of pore size, operating pressure, and feed velocity were calibrated and found to be 2.21 μ m, 1.31 $\times$ 10⁻³KPa, and 0.37m/sec, respectively. The errors in GMDH model were compared with multi linear regression (MLR) model. It shows that GMDH predicts results with minimum error. The predicted variable follows the actual variables with good accuracy.

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INTRODUCTION

Membrane separation process consist of a semi-permeable barriers generally used to separate particle of interest from feed stream. The process separates the feed stream in two parts known as permeate and reject. Portion of effluent that passes through the membrane is known as permeate and the portion that cannot passes through the membrane is known as reject or concentrate. The process is widely used in treating effluent due to its ability to produce high quality of permeate flux. The process is considered as green technology as it doesn't include any addition of chemicals. De Souza et al studied the performance of two nano-filtration membranes in removing norfloxacin from synthetic pharmaceutical wastewater. Different parameters like solution concentration, pH and trans-membrane pressure are considered for evaluation. The study shows high norfloxacin rejection rate which was reported between 87 to 99.5%. The study also highlights the effect of pH on membrane selectivity and permeability (De Souza et al., 2018). Banik et al developed computational fluid dynamics model of disc membrane to evaluate the effect of membrane for improving the rubber industrial effluent. The study compares the ability of stationary and rotational membranes to enhance permeate flux. The Study shows superior ability of rotational membrane over stationary membrane (Banik, Bandyopadhyay, & Biswal, 2017). The chapter focuses on enhancing the permeate flux of helical shaped membrane implemented to treat the effluent generated from rubber industry.

Motivation, Background and Discussion

The membrane was known since eighteen century and was used to treat water. The separation ability of membrane depends on pore size. Based on pore size membrane can be divided into following categories like micro-filtration, ultra-filtration, nano-filtration and reverse osmosis (KUO & CHERYAN, 1983). Moreover membrane can also be classified based on membrane thickness, particle of transport, and charge of the membrane etc. Due to its ability to produce good quality of permeate flux, membrane is widely used in rubber industry, food industry, water and wastewater treatment, and paper industry(Mokhtar, Lau, Ismail, & Veerasamy, 2015)(Zhou, Zhao, Bai, Zhang, & Tang, 2012). Membrane separation still finds limited application due to its rapid fouling tendency. The deposition and accumulation of solutes and other constituents present in the feed stream on membrane bed is termed as fouling. Fouling of the membrane is due to partial and complete pore blocking. The fouling the membrane also leads to lowers the permeate flux thus reducing the membrane acceptability(Guo et al., 2019). So, GMDH algorithm was implemented to enhance the permeate flux and antifouling property of the membrane.

Choudhury et al prepared ceramic ultra-filtration membrane implementing CuO nano particles to remove chromium (VI). The study also used response surface methodology (RSM) to optimize the membrane process. The ceramic membrane illustrates high chromium (VI) ions rejection of 88.08% (Choudhury, Mondal, Majumdar, Saha, & Sahoo, 2018). Li et al used PAFSSB as pre treatment technique for RO membrane to treat pulp and paper wastewater. The paper illustrates PAFSSB increase the membrane efficiency and COD removal rate(Li & Zhang, 2011). Ejraei et al implemented a hybrid system combined of adsorption, photocatalytic degradation, and membrane separation process to treat wastewater generated from paper and pulp industry of Iran. The study highlights the best performance of membrane separation process among other tested method but superior separation performance is achieved when hybrid system combined of photocatalytic degradation, adsorption, and membrane separation process used in series(Ejraei, Aroon, & Ziarati Saravani, 2019). Zhao et al used flat sheet ceramic membrane

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