OPTIMASI MEMBRAN KOMPOSIT *POLYETHERSULFONE*/ POLIMER ADITIF/NANOPARTIKEL MENGGUNAKAN *MACHINE LEARNING* UNTUK APLIKASI PENGOLAHAN AIR

SKRIPSI

diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar Sarjana Sains pada Program Studi Kimia

Oleh:

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2008291

PROGRAM STUDI KIMIA

FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM

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Skripsi ini diajukan untuk memenuhi salah satu syarat memperoleh gelar Magister Sains pada Program Studi Kimia Departemen Pendidikan Kimia Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

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PERNYATAAN

Saya menegaskan bahwa skripsi dengan judul "OPTIMASI MEMBRAN KOMPOSIT *POLYETHERSULFON*E/ POLIMER ADITIF/NANOPARTIKEL MENGGUNAKAN *MACHINE LEARNING* UNTUK APLIKASI PENGOLAHAN AIR" dan semua kontennya adalah hasil karya asli saya. Saya tidak melakukan tindakan penyalinan atau pengutipan dengan metode yang tidak sejalan dengan etika pengetahuan yang berlaku dalam komunitas ilmiah. Dengan pernyataan ini, saya siap untuk menerima konsekuensi atau sanksi jika di masa mendatang ditemukan pelanggaran etika ilmiah atau ada tuntutan dari pihak lain mengenai otentisitas karya saya ini.

Bandung, Agustus 2024

Yang membuat persetujuan

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KATA PENGANTAR

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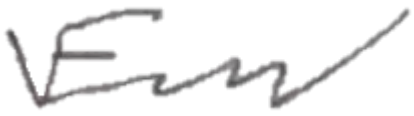
Saya berharap skripsi ini dapat memberikan manfaat dan kontribusi, baik bagi saya sendiri, pembaca, maupun para peneliti berikutnya di bidang kimia. Saya menyadari bahwa skripsi ini masih memiliki kekurangan. Oleh karena itu, saya sangat menghargai kritik dan saran yang membangun dari berbagai pihak untuk perbaikan dan penyempurnaan skripsi ini. Bandung, Agustus 2024.

Penulis,



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ABSTRAK

Teknologi membran filter air merupakan solusi serbaguna untuk mengatasi masalah sanitasi air. salah satu material yang telah banyak digunakan dalam teknologi membran adalah *Polyethersulfone* (PES) karena memiliki sifat termal dan mekaniknya yang unggul, sehingga menawarkan solusi untuk menyaring kontaminan dari air. Namun, sifat hidrofobik PES meningkatkan risiko *biofouling*, sehingga diperlukan modifikasi dengan polimer aditif dan nanopartikel untuk meningkatkan sifat hidrofiliknya. Dalam penelitian ini, *machine learning* (ML) digunakan untuk membuat model prediksi performa membran dengan waktu dan biaya yang efisien. *Artificial neural network* (ANN) digunakan sebagai algoritma yang bertujuan untuk memprediksi dan mengoptimalkan formulasi serta karakteristik membran komposit PES/aditif/nanopartikel. Model prediksi ANN dilatih menggunakan basis data dengan tiga parameter utama terkait formulasi, karakteristik, dan performa membran komposit. Variabel output yang menjadi performa membran komposit terdiri atas fluks air dan rejeksi yang masing masing akan dibuatkan model prediksi secara terpisah. Hasil evaluasi akhir model prediksi ANN menunjukkan nilai R = 0.85552, dan RMSE = 0.83091 untuk performa fluks air, serta R =0.85560 dan RMSE = 0.74161 untuk performa rejeksi. Membran komposit PES/PEG/CuO dengan pelarut DMF menunjukkan hasil optimal dalam kedua parameter performa,. Fluks air yang optimum dicapai menggunakan membran dengan karakteristik sudut kontak 32-71.74°, ukuran pori 77.55-3.72 nm, dan porositas 70.68-84.24%. Untuk rejeksi, karakteristik optimum meliputi sudut kontak 78.14-90°, ukuran pori 1.41-25.48 nm, dan porositas 17-45.56%. Kondisi formulasi optimum untuk fluks air adalah komposisi PES 15-15.31%, PEG 3.72-5.04%, dan nanopartikel CuO 0.33-0.63%. Sedangkan untuk rejeksi, kondisi optimum adalah komposisi PES 20.38-21%, PEG 5.09-5.32%, dan nanopartikel CuO 0.9-1%.

Kata Kunci: Membran, *Polyethersulfone*, Polimer Aditif, Nanopartikel, *Machine Learning*, *Artificial Neural Network*

ABSTRACT

Membrane filter water technology is a versatile solution to overcome water sanitation problems. One material that has been widely used in membrane technology is Polyethersulfone (PES) because it has superior thermal and mechanical properties, thus offering a solution for filtering contaminants from water. However, the hydrophobic nature of PES increases the risk of biofouling, so modification with polymer additives and nanoparticles is required to increase its hydrophilic properties. In this research, machine learning (ML) is used to create a membrane performance prediction model in a time and cost efficient manner. Artificial neural network (ANN) is used as an algorithm that aims to predict and optimize the formulation and characteristics of PES/additive/nanoparticle composite membranes. The ANN prediction model was trained using a database with three main parameters related to the formulation, characteristics and performance of composite membranes. The output variables for the performance of the composite membrane consist of water flux and rejection, each of which will be made into a separate prediction model. The final evaluation results of the ANN prediction model show a value of R = 0.85552, and RMSE = 0.83091 for water flux performance, and R = 0.85560 and RMSE = 0.74161 for rejection performance. The PES/PEG/CuO composite membrane with DMF solvent showed optimal results in various performance parameters. Optimum water flux was achieved using a membrane with contact angle characteristics of 32-71.74°, pore size of 77.55-3.72 nm, and porosity of 70.68-84.24%. For rejection, optimum characteristics include a contact angle of 78.14-90°, pore size of 1.41-25.48 nm, and porosity of 17-45.56%. The optimum formulation conditions for water flux are the composition of PES 15-15.31%, PEG 3.72-5.04%, and CuO nanoparticles 0.33-0.63%. Meanwhile, for rejection, the optimum conditions are the composition of PES 20.38-21%, PEG 5.09-5.32%, and CuO nanoparticles 0.9-1%.

Keywords: Membrane, Polyethersulfone, Additive Polymer, Nanoparticles, Machine Learning, Artificial Neural Network

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