

**PENGARUH PENAMBAHAN Fe₃O₄ TERHADAP KINERJA
MEMBRAN NANOFILTRASI POLIVINILIDIN FLUORIDA UNTUK
PEMISAHAN ION GARAM**



Diajukan untuk memenuhi salah satu syarat memperoleh gelar Magister
Sains pada Program Studi Kimia

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FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM

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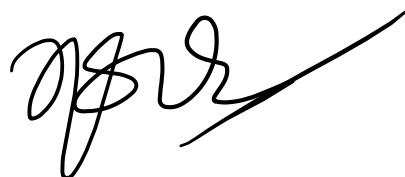
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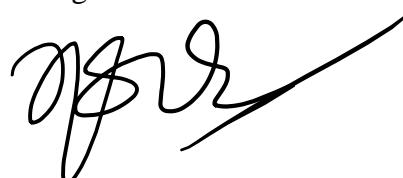
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ABSTRAK

Teknologi membran nanofiltrasi sebagai proses *pre-treatment* desalinasi menjadi salah satu solusi alternatif untuk mengatasi masalah ketersediaan air bersih melalui desalinasi air. Penelitian ini bertujuan untuk mengetahui karakteristik, uji kinerja, dan kondisi optimum sintesis membran nanokomposit PVDF/MWCNT/Fe₃O₄. Membran disintesis melalui metode inversi fasa dengan komposisi PVDF (18%), MWCNT (0.001%), Fe₃O₄ NPs (0.001-0.005%). Karakteristik membran nanokomposit PVDF/MWCNT/Fe₃O₄ dianalisis menggunakan teknik dan instrumentasi antara lain, FTIR, XRD, SEM-EDX, sifat mekanik, hidrofilisitas, porositas, dan *point zero of charge* (PZC). Selain itu, kinerja membran diuji dengan sistem filtrasi *dead-end* (DE) dan *cross-flow* (CF) melalui permeabilitas, permselektivitas, MWCO, dan *antifouling*. Keberhasilan sintesis membran ditunjukkan dengan adanya interaksi khas pada spektrum FTIR 532 cm⁻¹ (Fe-O) dan difraktogram XRD pada puncak 2θ 20.16° [110], 26.39° [002], dan 43.02° [400] serta peningkatan %kristalinitas dari 33.10% menjadi 51.71%. Fotografi SEM menunjukkan bahwa penambahan MWCNT dan Fe₃O₄ NPs menyebabkan perubahan struktur morfologi dan ukuran pori dari 130 nm menjadi 100 nm. Penambahan Fe₃O₄ NPs juga meningkatkan hidrofilisitas dari 74.58° menjadi 59.60°, porositas dari 49.31% menjadi 70.49%, dan range nilai PZC berkisar antara 6.62-7.51. Uji kinerja membran dengan sistem DE dan CF menunjukkan bahwa penambahan Fe₃O₄ NPs meningkatkan permeabilitas air menjadi 35,16 dan 28,80 L/m²·h·bar, selektivitas ion garam NaCl (65,62% dan 79,86%), CaCl₂ (70,03% dan 73,69%), dan FeCl₃ (83,06% dan 88,68%) serta meningkatkan flux recovery ratio (FRR) dari 66.25% menjadi 87.46%. Hasil uji MWCO menggunakan zat warna (RB, MO, dan MB) menunjukkan bahwa membran nanokomposit PVDF/MWCNT/Fe₃O₄ memiliki nilai MWCO sekitar 320 Da yang mengindikasikan membran termasuk dalam kategori *tight* nanofiltrasi.

Kata kunci: membran nanofiltrasi, PVDF/MWCNT/Fe₃O₄, sintesis, karakteristik, uji kinerja

ABSTRACT

Nanofiltration membrane technology as a process *pre-treatment* desalination is an alternative solution to overcome the problem of clean water availability through water desalination. This research aims to determine the characteristics, performance tests, and optimum conditions for the synthesis of PVDF/MWCNT/Fe₃O₄ nanocomposite membranes. The membrane was synthesized via the phase inversion method with the composition PVDF (18%), MWCNT (0.001%), Fe₃O₄ NPs (0.001-0.004%). The characteristics of PVDF/MWCNT/Fe₃O₄ nanocomposite membranes were analyzed using techniques and instrumentation including, FTIR, XRD, SEM-EDX, mechanical properties, hydrophilicity, porosity, and *point zero of charge* (PZC). Additionally, the membrane performance was tested with the filtration system *dead-end* (DE) then *cross-flow* (CF) through permeability, permselectivity, MWCO, and *antifouling*. The success of membrane synthesis is demonstrated by the presence of typical interactions FTIR spectrum in the 532 cm⁻¹ (Fe-O) and XRD diffractogram at 2θ peak 20.16° [110], 26.39° [002], and 43.02° [400] as well as an increase in %crystallinity from 33.10% to 51.71%. SEM photography shows that the addition of MWCNT and Fe₃O₄ NPs caused changes in morphological structure and pore size from 130 nm to 100 nm. The addition of Fe₃O₄ NPs also increased the hydrophilicity of 74.58° to 59.60°, porosity from 49.31% to 70.49%, and the PZC value range is between 6.62-7.51. Membrane performance tests with DE and CF systems showed that the addition of Fe₃O₄ NPs increased water permeability to 35.16 and 28.80 L/m²·h·bar, NaCl salt ion selectivity (65.62% and 79.86%), CaCl₂ (70.03% and 73.69%), and FeCl₃ (83.06% and 88.68%) and increasing the flux recovery ratio (FRR) from 66.25% to 87.46%. MWCO test results using dyes (RB, MO, and MB) show that the PVDF/MWCNT/Fe₃O₄ nanocomposite membrane has an MWCO value of around 320 Da which indicates the membrane is included in the category *tight* nanofiltration.

Keyword: nanofiltration membrane, PVDF/MWCNT/Fe₃O₄, synthesis, characteristics, performances

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