SINTESIS, KARAKTERISASI DAN UJI KINERJA *MIXED MATRIX MEMBRANES* PVDF/MIL-101(Cr)/GO UNTUK PEMISAHAN GAS CO_2

SKRIPSI

diajukan untuk memenuhi salah satu syarat memperoleh gelar Sarjana Sains
Program Studi Kimia

disusun oleh
Putri Amalia Zahrai
2000545

PROGRAM STUDI KIMIA
FAKULTAS PENDIDIKAN MATEMATIKA DAN
ILMU PENGETAHUAN ALAM
UNIVERSITAS PENDIDIKAN INDONESIA

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Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

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PERNYATAAN

Dengan ini saya menyatakan bahwa skripsi dengan judul **"Sintesis, Karakterisasi dan Uji Kinerja *Mixed Matrix Membranes* PVDF/MIL-101(Cr)/GO Untuk Pemisahan Gas CO_2"** ini beserta seluruh isinya adalah benar-benar karya saya sendiri. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika ilmu yang berlaku dalam masyarakat keilmuan. Atas pernyataan ini, saya siap menanggung risiko/sanksi apabila di kemudian hari ditemukan adanya pelanggaran etika keilmuan atau ada klaim dari pihak lain terhadap keaslian karya saya ini.

Bandung, 25 Agustus 2024

Yang membuat persetujuan

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KATA PENGANTAR

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Penulis berharap tesis ini dapat meningkatkan wawasan dan kontribusi bagi penulis sendiri, pembaca, dan peneliti selanjutnya dalam bidang kimia. Penulis menyadari bahwa masih terdapat kekurangan pada tesis ini. Oleh karena itu, kritik dan saran yang bersifat membangun dari berbagai pihak selalu diharapkan untuk perbaikan dan penyempurnaannya.

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ABSTRAK

Kadar CO_2 pada atmosfer meningkat dalam beberapa tahun terakhir dan mengakibatkan kenaikan suhu permukaan bumi. Peningkatan emisi CO_2 dalam jumlah besar dapat menjadi ancaman bagi keberlangsungan mahkluk hidup di bumi, seperti perubahan iklim, pelelehan es di kutub, dan bencana alam. Teknologi membran pemisahan gas dapat menjadi solusi dan inovasi terbarukan untuk mengurangi emisi CO_2 yang efektif karena luas permukaan yang tinggi, desain yang ringkas, kemudahan fabrikasi dan perawatan, dan efektivitas biaya. Teknologi membran pemisahan gas dapat menjadi solusi dan inovasi terbarukan untuk mengurangi emisi CO_2. Penelitian ini bertujuan untuk mengetahui kondisi optimum sintesis, karakteristik dan kinerja membran matriks campuran berbasis PVDF/MIL-101(Cr)/Graphene Oksida. Sintesis membran dilakukan melalui metode *casting* pada pelat kaca dan inversi fasa *Non-Solvent Induced Phase Separation* (NIPs) dengan komposisi optimum PVDF 15% : MIL-101(Cr) 0,2% : GO 0,1%. Hasil sintesis kemudian dikarakterisasi melalui FTIR, SEM-EDX, uji hidrofilisitas, uji porositas, *tensile strength*, *point of zero charge* (PZC) dan pengukuran ketebalan membran. Uji kinerja dilakukan dengan mengukur permeabilitas CO_2 serta selektivitasnya terhadap CO_2/N_2 dan CO_2/CH_4. Hasil penelitian menunjukkan bahwa MMMs memiliki ketebalan 0,075 mm dengan penampakkan fisik membran berwarna putih menjadi abu-abu seiring dengan penambahan konsentrasi GO. Keberhasilan penyisipan MIL-101(Cr) dan GO pada matriks PVDF ditunjukkan dengan pergeseran pada puncak serapan dan munculnya interaksi khas pada spektra FTIR untuk vibrasi Cr-O, C=O dan O-H. Selain itu, penambahan filler MIL-101(Cr)/GO juga meningkatkan hidrofilisitas (penurunan nilai sudut kontak dari 88^o hingga 83^o), persen porositas (37% hingga 51%), *tensile strength* (7,0 MPa menjadi 8,6 MPa), *point of zero charge* (pH 7,78 menjadi pH 8,16) dan ukuran pori rata-rata *cross-section* (1,447 μm menjadi 2,118 μm) serta *surface-area* (0,105 μm menjadi 0,217 μm). Uji kinerja menunjukkan bahwa permeabilitas CO_2 dan selektivitas MMMs terhadap CO_2/CH_4, dan CO_2/N_2 adalah 892,8 GPU (umpan *single gas*); 1,33; dan 1,77, secara berturut-turut. Lebih lanjut, permeabilitas dan selektivitas MMMs terhadap CO_2 dan CO_2/CH_4 adalah 745 GPU (umpan *mixture gases*) dan 1,05.

Kata kunci: *Mixed Matrix Membranes*, PVDF/MIL-101(Cr)/GO, karakteristik, permeabilitas, pemisahan CO_2/CH_4

Abstract

CO_2 levels in the atmosphere have increased in recent years and resulted in an increase in the Earth's surface temperature. Large increases in CO2 emissions can pose a threat to the survival of living things on earth, such as climate change, polar ice melting, and natural disasters. Gas separation membrane technology can be a renewable solution and innovation to reduce CO_2 emissions effectively due to its high surface area, compact design, ease of fabrication and maintenance, and cost-effectiveness. Gas separation membrane technology can be a renewable solution and innovation to reduce CO_2 emissions. This study aims to determine the optimum conditions of synthesis, characteristics and performance of PVDF/MIL-101(Cr)/Graphene Oxide-based mixed matrix membranes. Membrane synthesis was carried out through casting method on glass plate and Non-Solvent Induced Phase Separation (NIPs) phase inversion with optimum composition of PVDF 15%: MIL-101(Cr) 0.2%: Graphene Oxide 0.1%. The synthesis results were then characterized through FTIR, SEM-EDX, hydrophilicity test, porosity test, tensile strength, point of zero charge (PZC) and membrane thickness measurement. Performance tests were conducted by measuring CO_2 permeability and selectivity to CO_2/N_2 and CO_2/CH_4. The results showed that MMMs had a thickness of 0.075 mm with the physical appearance of the membrane being white to gray along with the addition of GO concentration. The successful insertion of MIL-101(Cr) and GO in the PVDF matrix is indicated by the shift in absorption peaks and the appearance of typical interactions in the FTIR spectra for Cr-O, C=O and O-H vibrations. In addition, the addition of MIL-101(Cr)/GO filler also increased the hydrophilicity (decreased contact angle value from 88^o to 83^o), porosity percent (37% to 51%), tensile strength (7.0 MPa to 8.6 MPa), point of zero charge (pH 7.78 to 8.16) and average pore size cross-section (1.447 μm to 2.118 μm) and surface-area (0.105 μm to 0.217 μm). Performance tests showed that the CO2 permeability and selectivity of MMMs to CO_2/CH_4, and CO_2/N_2 were 892.8 GPU (single gas feed); 1.33; and 1.77, respectively. Furthermore, the permeability and selectivity of MMMs to CO_2 and CO_2/CH_4 are 745 GPU (mixed gases feed) and 1.05, respectively.

Keywords: Mixed Matrix Membranes, PVDF/MIL-101(Cr)/GO, characteristics, permeability, CO_2/CH_4 separation

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