

## Abstract

The present research uses the pervaporation technique to remove sulfur and nitrogen compounds from model gasoline. Here, polydimethylsiloxane (PDMS) is used as the base polymer material, whose selectivity towards sulfur and nitrogen compounds present in model gasoline is improved by adding suitable fillers as application demands. The research was performed in three different ways: desulfurization (model fuel: thiophene/ isooctane), denitrogenation (model fuel: pyridine/ isooctane), and simultaneous desulfurization and denitrogenation (model fuel: thiophene/ pyridine/ isooctane) by pervaporation using composite membrane, comprised of PDMS-filler. Desulfurization was performed using the fabricated PDMS-modified alumina composite membrane. Alumina nanoparticles of average size 8.54 nm were prepared from the aluminum metal plate through hydrolysis. Alumina is further treated with a coupling agent, triethoxy (octyl) silane, to enhance its compatibility in the PDMS matrix. A plausible mechanism of surface modification is also suggested based on the change in the characteristics of alumina after modification, as observed from XPS and FTIR analyses. Denitrogenation was performed using a PDMS-MIL-100 (Fe) composite membrane, where MIL-100 (Fe) was synthesized by a hydrothermal HF-free method. MIL-100 (Fe) of an average particle size of 125 nm helped in improving the PMDS membrane properties by enhancing flux and selectivity towards pyridine for removing it from the pyridine/isooctane mixture. Simultaneous desulfurization-denitrogenation of model gasoline was performed using PDMS-MIL-100 (Fe) composite membrane to understand the competitiveness between thiophene and pyridine during removal by pervaporation as well as the effect of changing their concentration in model oil on the process. Alumina, modified alumina, and MIL-100 (Fe) were characterized by FESEM, EDS, XRD, FTIR, and BET analysis. However, TEM and XPS analyses were performed to analyze the effect of surface modification of alumina nanoparticles in depth. Characteristics of composite membranes were analyzed by FESEM, EDS, XRD, contact angle, AFM, FTIR, XPS, and Ultimate tensile strength analyses. All pervaporation experiments using particular types of composite membranes were performed by varying filler percentage and operating parameters (such as temperature, feed flow rate, and feed concentration). The performance of membranes was verified by total flux, enrichment factor, permeability, and selectivity. As confirmed by long-term stability analysis, all prepared membranes were stable in the feed environment.

**Keywords:** Pervaporation; alumina nanoparticle; PDMS-modified alumina composite membrane; PDMS-MIL-100 (Fe) composite membrane; desulfurization; denitrogenation; thiophene; pyridine; isooctane