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Study of different titanosilicate (TS-1 and ETS-10) as fillers for Mixed Matrix Membranes for CO_2/CH_4 gas separation applications.

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Abstract

Three titanosilicate zeolites were used as fillers for Mixed Matrix Membranes: (i) ETS-10, (ii) TS-1 having Si/Ti = 100 and (iii) TS-1 using Si/Ti = 25. Zeolite samples were characterized by X-Ray Diffraction, Scanning Electron Microscopy, Atomic Emission Spectroscopy, X-Ray Photoelectron Spectroscopy, and CO_2 and CH_4 adsorption isotherms. TS-1 particles showed a narrow size distribution ranging from 200 nm to 400 nm. In the case of ETS-10, the size distribution was broader ranging from 400 nm to 800 nm. Mixed Matrix Membranes were prepared using Matrimid® polyimide as continuous phase and filler loadings of 10, 20, and 30 wt.%. Membranes were characterized by Thermogravimetric Analysis, Differential Scanning Calorimetry, and Scanning Electron Microscopy. The performances was measured at 8 bars of transmembrane pressure for CO_2/CH_4 mixed gases system at 50/50 vol./vol. concentration.

Membranes using TS-1 (Si/Ti = 25) as filler showed a maximum increase of 89.1% of CO_2 permeability and 23.9% increase in separation factor. In the case of TS-1 (Si/Ti = 100) only permeability increased significantly, with a maximum increase of 90.1%. Regarding the ETS-10 membranes, both permeability and separation factor increased slightly with respect to the reference polymeric membrane (22.5% in CO_2 permeability and 7.8% in the separation factor). In conclusion, TS-1 (Si/Ti = 25) is the most suitable filler for the use in Mixed Matrix Membranes for gas separation applications among the titanosilicate studied in this work.

Keywords: Titanosilicate, Mixed Matrix Membrane, CO_2/CH_4 separation, TS-1, ETS-10