Int. J. Environ. Sci. Technol.
DOI 10.1007/s13762-016-1156-3

ORIGINAL PAPER

Separation of H_2S from CH_4 by polymeric membranes at different H_2S concentrations

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Received: 3 July 2016 / Revised: 13 October 2016 / Accepted: 7 November 2016

Abstract In this work, permeation of mixed gases H_2S/CH_4 through commercial polyphenylene oxide (PPO) hollow fiber and poly (ester urethane) urea (PEUU) flat membranes was studied at pressures of 345–689 kPa, at ambient temperature and at 313.15 K. Various H_2S concentrations of about 100–5000 ppm in CH_4 binary synthetic gas mixtures as well as a real natural gas sample obtained from a gas refinery containing 0.3360 mol.% H_2S (equivalent to 3360 ppm) were tested. It was observed that the permeance of components was affected by the balance between competitive sorption and plasticization effects. Separation factors of H_2S/CH_4 were in the range of 1.3–2.9, 1.8–3.1 and 2.2–4.3 at pressures of 345, 517 and 689 kPa, respectively. In the range of 101–5008 ppm of H_2S in CH_4, the effect of temperature on the separation factor was nearly negligible; however, permeances of both components of the mixtures increased with temperature. Additionally, the results obtained by PEUU membrane indicated that it was a better choice for hydrogen sulfide separation from H_2S/CH_4 mixtures than PPO. For PPO membrane, removal of hydrogen sulfide from high-concentration (up to 5008 ppm) binary mixtures of H_2S/CH_4 was compared with that of low concentration (as low as 101 ppm) through PPO. At concentrations of 101–968 ppm, plasticization was dominant compared with the competitive sorption, while for the H_2S feed concentrations of 3048 ppm, the competitive sorption effect was dominant. For H_2S concentration of 5008 ppm, the balance between these two effects played an important role for explanation of its trend.

Keywords PPO and PEUU membranes · Mixed gas permeation · Acid gas · Plasticization · Competitive sorption

Editorial responsibility: B.V. Thomas.

Experimental results of binary mixtures separation of CH_4 at various H_2S concentrations from low ($\sim$100 ppm) to more than 5000 ppm by PPO and PEUU membranes were presented. Also, tests with a real gas sample containing high concentration of H_2S and other impurities have been reported. To our knowledge, very few studies have reported investigations on high concentration of acid gas and real gas separation with these membranes and different configurations.

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Introduction

Hydrogen sulfide exists naturally in the environment (e.g., in natural gas, volcanic gases, sulfur springs). It is also produced by living organisms and as a byproduct of many industrial processes such as paper manufacturing and sewage treatment. Natural gas contains various amounts of hydrogen sulfide from a few parts per million (ppm) to as high as 28 wt%. Natural gas with high levels of hydrogen sulfide is considered as sour gas. H_2S is a dangerous air pollutant in natural gas processing, petroleum refineries and geothermal energy production, which is of a significant public health concern when released to the atmosphere. The Iranian raw natural gas has H_2S content from 66.2 to 32700 ppm (3.27 mol.%) in different gas fields. Removal

Published online: 28 November 2016