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Investigation of separation properties of membrane materials based on polyphenylene oxide or diphthalic anhydride and diamine for biogas separation processes

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Publication title:	Investigation of separation properties of membrane materials based on polyphenylene oxide or diphthalic anhydride and diamine for biogas separation processes
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Summary: Decarbonization, minimizing greenhouse gas emissions, circular economy and the waste-to-energy trend lead to increased demand for gas and green energy. The European Biogas Association shows that biomethane gas can cover 30-40% of EU gas demand by 2050. There is a steady increase in the number of biomethane installations in Europe. The application of membrane processes to biogas upgrading has been intensively researched. It is practically used in large installations with several hundred m^3/ h of biogas, operating at pressures higher than 1 MPa [3-5].The problem arises when dealing with small farms, such as in Poland. Despite the estimated energy potential of the Polish agro-food sector for biogas production being over 7.8 bcm per year, there is a lack of small-scale biogas upgrading technologies suitable to Polish conditions. A good energy efficiency and overall profitability of the investment may be more difficult to achieve in this case. The proper design of a membrane separation process should be based on a thorough knowledge of the membrane characteristics, i.e. the permeability coefficients and selectivity on it, under conditions as close as possible to the actual operating conditions of the plant [6]. The

aim of the work was to develop a methodology leading to a non-invasive estimation of the actual values of the permeability coefficients of the main biogas components CH_4 and CO_2. The laboratory tests were carried out on two kinds of flat polymer membranes (PPO 70 and AE 55) prepared by the Center for Polymer and Carbon Materials of the Polish Academy of Sciences in Zabrze. Both membranes had an active surface of 58 cm2 and a thickness of 85 µm. The pure gases CH_4, CO_2 and mixtures CO_2/CH_4 were examined separately. Permeation studies of pure gases were carried out at a feed gas flow rate of approximately 40 ml/min, a transmembrane pressure drop in the range of 1.7-7.5 bar (abs) at temperatures 19-21°C. However, the tests on the separation process of CO2/CH4 mixtures were carried out for feed gas flow rates of 60, 100, and 130 ml/min, with a constant transmembrane pressure drop of approximately 7 bar (abs), at a temperature of 20-22°C where methane concentration in carbon dioxide was 40, 50 and 60 vol.%. It was found that carbon dioxide was a component that permeated more quickly through both of the membranes. Moreover, it was observed that in each case the permeability coefficients are not constant, but change with the change in the feed gas pressure. The data from experimental research allowed to determine permeability coefficients and ideal CO_2/CH_4 separation factors which were respectively: P_{CO2} = 150 barrer P_{CH4} = 61 barrer, $\alpha^*_{CO2/CH4}$ = 2.46 for the PPO 70 membrane, and P_{CO2} = 162.6 barrer, P_{CH4} = 25.8 barrer and $\alpha^*_{CO2/CH4}$ = 6.3 in case of the AE 55 membrane.

Attachments:

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