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Synthesis of High-Pressure Performance Adsorbent from Coconut Shells Polyetheretherketone for Methane Adsorption

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Abstract : Application of liquid base petroleum fuel (petrol and diesel) for transportation fuel causes emissions of greenhouse gases (GHGs), while natural gas (NG) reduces the emissions of greenhouse gases (GHGs). At present, compression and liquefaction are the most matured technology used for transportation system. For transportation use, compression requires high pressure (200–300 bar) while liquefaction is impractical. A relatively low pressure of 30-40 bar is achievable by adsorbed natural gas (ANG) to store nearly compressed natural gas (CNG). In this study, adsorbents for high-pressure adsorption of methane (CH4) was prepared from coconut shells and polyetheretherketone (PEEK) using potassium hydroxide (KOH) and microwave-assisted activation. Design expert software version 7.1.6 was used for optimization and prediction of preparation conditions of the adsorbents for CH_4 adsorption. Effects of microwave power, activation time and quantity of PEEK on the adsorbents performance toward CH_4 adsorption was investigated. The adsorbents were characterized by Fourier transform infrared spectroscopy (FTIR), thermogravimetric (TG) and derivative thermogravimetric (DTG) and scanning electron microscopy (SEM). The ideal CH4 adsorption capacities of adsorbents were determined using volumetric method at pressures of 5, 17, and 35 bar at an ambient temperature and 5 oC respectively. Isotherm and kinetics models were used to validate the experimental results. The optimum preparation conditions were found to be 15 wt% amount of PEEK, 3 minutes activation time and 300 W microwave power. The highest CH4 uptake of 9.7045 mmol CH4 adsorbed/g adsorbent was recorded by M33P15 (300 W of microwave power, 3 min activation time and 15 wt% amount of PEEK) among the sorbents at an ambient temperature and 35 bar. The CH4 equilibrium data is well correlated with Sips, Toth, Freundlich and Langmuir. Isotherms revealed that the Sips isotherm has the best fit, while the kinetics studies revealed that the pseudo-second-order kinetic model best describes the adsorption process. In all scenarios studied, a decrease in temperature led to an increase in adsorption of both gases. The adsorbent (M33P15) maintained its stability even after seven adsorption/desorption cycles. The findings revealed the potential of coconut shell-PEEK as CH_4 adsorbents.

Keywords : adsorption, desorption, activated carbon, coconut shells, polyetheretherketone
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