Solubility of N2, O2 and CH4 in Ionic Liquids for CH4 Purification from Low-Concentration Coal-Bed Gas

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Coal-bed gas is natural gas stored in underground coal seams, and large quantities of low-concentration coal-bed gas are generated in the coal mining process, which has not yet been effectively utilized. These coal-bed gases are generally discharged directly into the atmosphere during the mining process, which not only wastes energy but also causes serious greenhouse effects. Ionic liquids are a new type of green solvent. Based on the difference in solubility of gases in them, it realizes the separation and purification of specific gases. Therefore, ionic liquid can be used to purify CH4 from low-concentration coal-bed gas. N_2, O_2 and CH_4 are the most dominant components of low-concentration coal-bed gas. In this work, we select three kinds of ionic liquid as a purification solvent ([EMIM][TF_2N], [HMIM][TF_2N], and [DMIM][TF_2N]) and measure the solubility of N_2, O_2 and CH_4 in them using the saturation volumetric method in the pressure range of 0.2–3.0 MPa and the temperature range of 293.15–353.15 K. The experimental data are correlated by a modified Krichevsky-Kasarnovsky equation. Based on the solubility and other thermodynamic properties, we designed an ionic-liquid based CH_4 purification system and performed a comprehensive thermodynamic analysis. The energy required to purify a certain concentration of CH_4 per unit mass was evaluated with the variation of operational parameters, which is of great significance for advancing the practical application of CH_4 purification from low-concentration coal-bed gas.

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