Gas Drying with Ionic Liquids

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Abstract

In gas separation industry, crystalline hydrate substances are often formed when water is presented in the gases. The hydrates formation may choke or completely block the gas pipelines during the transportation, and also cause damage to the equipments and operating system. It is known that gas drying is the most economical and efficient means to prevent the hydrate formation and unwanted corrosion in the gas pipeline. However, the study on gas drying with ionic liquids (ILs) as absorbents is still preliminary and under progress. The ILs are selected as separating agents, due to their advantages of significant energy saving and pollution reduction.

The gas drying technology with ILs was systematically studied ranging from the molecular level to industrial scale. The COSMO-RS model was first used to screen the suitable IL and provide theoretical insights at the molecular level. Towards CO\textsubscript{2} gas dehydration, we measured the CO\textsubscript{2} solubility in single [EMIM][Tf\textsubscript{2}N] and in the [EMIM][Tf\textsubscript{2}N] + H\textsubscript{2}O mixture, as well as the vapor-liquid equilibrium (VLE) of [EMIM][Tf\textsubscript{2}N] + H\textsubscript{2}O system, to justify the applicability of UNIFAC-Lei model. The UNIFAC-Lei model developed by us has been widely applied by many authors for the systems containing ILs. Based on the thermodynamic study, the rigorous equilibrium (EQ) stage mathematical model was established for process simulation. The gas drying experiment with IL was also carried out, and the water content in gas product can be reduced to 375 ppm (see Figure 1). It was confirmed that for the gas drying process with the IL [EMIM][Tf\textsubscript{2}N], the total heating and cooling duties can decrease by as high as 75.27\% and 73.04\%, respectively, when compared with the conventional triethylene glycol (TEG).

It is worth noting that the results presented in this work on experiment, calculation and theoretical analysis may be directly extended to other gas drying processes with different ILs.