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Ionic liquid-amine blends and CO_2BOLs: Prospective solvents for natural gas sweetening and CO_2 capture technology—A review

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ABSTRACT

Reduction of greenhouse gas emissions has become one of the most impending global issues. Innovative technological development for removing acid gases such as CO_2 and H_2S from natural gas (NG) and other sources is indispensable for clean energy production. The presence of these gases in NG deteriorates its quality (heating value) as well as liquefaction process performance. Thus, removal of acid gases up to an acceptable specification is mandatory prior to its transportation for domestic and commercial use.

Currently, majority of natural gas sweetening and post combustion CO_2 capture technologies are amine-based; however, amine based technologies have a couple of disadvantages such as: solvent loss, corrosive nature and high heat of solution. In contrast, ionic liquids (ILs) based separations are less energy intensive and have gain popularity over amines as CO_2 scrubbing agents, especially due to their exceptional physicochemical properties. However, ILs also have few disadvantages such as hygroscopic nature, high viscosity and high cost. Thus, coupling of the advantages of both ILs and amines may provide a better route for effective capture of CO_2. The main target of the coupling is to take advantage of good aspects of parent solvents. Recently, a new class of solvents called binding organic liquids (BOLs) or switchable solvents has also been discovered. BOLs have tunable physicochemical properties like ILs.

In this context, recent state-of-the-art of comprehensive applications of aqueous amines, ILs, IL-amine blends and BOLs for natural gas sweetening and health/environmental impacts of amine, ILs and BOLs are reviewed, together with a set of critical conclusions and future directions. It has been noticed that the combination of room temperature ILs with secondary, tertiary and sterically hindered amine are highly efficient in CO_2 capture and may be a boon for natural gas sweetening and post combustion CO_2 capture technologies. It is also observed that the stripping of CO_2 from CO_2BOLs is less energy consuming process as in most of the cases CO_2 can be separated from BOLs by modest heating or simple inert gas bubbling. Overall, CO_2BOLs have enormous potential as energy-efficient organic CO_2 scrubbers.

Nevertheless, to accelerate technology transfer to industrialization, advances in the area of systematic platform technologies need to be synchronized to current technologies: molecular simulation of solvents; solvent properties and thermodynamic models; process engineering studies through process design, simulation, optimization and scale-up; multi-scale modeling for optimal solvent selection. In particular, the integration of physicochemical property and thermodynamic model packages to a set of commercial process engineering simulators is one of the impending research areas.

Contents

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