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Low Transition Temperature Mixtures as Innovative and Sustainable CO_2 Capture Solvents

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Emission of carbon dioxide (CO_2), a major anthropogenic greenhouse gas, should be reduced. Conventionally, an aqueous solution of monoethanolamine (30% MEA) is used as chemical sorbent. The major disadvantage of using MEA is the parasitic energy consumption during the solvent regeneration in the stripper. Other disadvantages include the high toxicity, the high vapor pressure, the high corrosiveness and the low chemical and thermal stability.

Over the last two decades ionic liquids (ILs) were proposed as serious contender for CO_2 capture, capable of overcoming the drawbacks of the MEA process. Since ILs can be tailor-made, they would also be able to replace physical absorbents like Selexol and Rectisol for source streams with high CO_2 partial pressures.

Currently, we are exploring the potential of a new type of solvents, so-called low transition temperature mixtures (LTTMs), as sustainable substituents for the traditional CO_2 absorbents. LTTMs are mixtures of solid compounds that form liquids upon mixing and have very low melting points, far below that of the individual compounds. In most cases, an LTTM exists of a mixture of a natural organic salt (acting as hydrogen bond acceptor) and a natural organic acid (acting as hydrogen bond donor). While their physicochemical properties are similar to those of ILs, LTTMs are non-flammable, less toxic, biocompatible, much cheaper and easy to prepare, hence bypassing complex purification steps and waste disposal encountered with ILs.

The thermal operating window (e.g., glass transition and decomposition temperature) and physicochemical properties (e.g., density, viscosity and surface tension) of several novel developed LTTMs for CO_2 capture have been determined. A thermogravimetric technique based on a magnetic suspension balance operating in static mode was applied to study the thermodynamics (i.e., absorptive capacity and Henry's law coefficient) and kinetics (i.e., diffusion coefficient) at several temperatures and pressures up to 150 bars. The influence of LTTM composition and water content on the CO_2 solubilities and diffusivities was established. It will be shown at the conference that LTTMs are promising sorbents for pre-combustion CO_2 capture due to their high capacity (at high pressures) and their low regeneration energy consumption (low heat of absorption).