

## **Thermophysical Properties of Systems with Gas Clathrate Hydrates and of Systems with Ionic Liquids**

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More than ever, there is a strong societal demand to solve a number of major problems, among them problems related to energy, water and environment. In order to achieve these goals, thermo-physical research needs to come up with new ideas, insights and basic information, e.g., thermodynamics and phase behavior of complex systems. In this contribution, a couple of examples will be presented that may offer new possibilities in energy storage, carbon-capturing and storage (CCS) and processes with enhanced chemical waste reduction, using ionic liquids. First of all, it will be shown that gas clathrate hydrates may offer opportunities for energy storage and for CO<sub>2</sub> sequestration (CCS) as well. New results in hydrogen storage in clathrate hydrates, obtained by experiment, molecular modeling and molecular simulation, will be presented. Furthermore, the phase behavior and thermodynamics of gas clathrate hydrates with CO<sub>2</sub> and certain salts dissolved in the aqueous phase will be discussed. It was found that in these systems retrograde behavior of the solid hydrate phase may occur. Ionic liquids have a great potential to develop new and atom-efficient processes with significant chemical waste reductions. First of all, the peculiar phase behavior phenomenon behind this kind of processes will be highlighted. For some model reactions it will be demonstrated that in particular for the pharmaceutical industry this approach is attractive. Finally, it will be shown that the characteristic thermo-physical properties of ionic liquids may play an important role in developing new and more efficient separation processes.