PHASE BEHAVIOR OF CO_2-RICH MIXTURES INVOLVING GAS HYDRATES AND ICES AS A CHALLENGE FOR THE DESIGN OF CCS/U TECHNOLOGIES

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Design of new technologies for carbon capture, transport, storage, and utilization heavily relies on the knowledge of thermophysical properties, thermodynamics, transport, and phase change processes in CO_2-rich systems. Unlike other technologically relevant and in general well-described fluids such as aqueous mixtures, natural gas or refrigerants, carbon dioxide and its mixtures exhibit complex phase behavior involving vapor, supercritical fluid, CO_2-rich liquid, water-rich liquid, and even solid phases such as dry ice and gas hydrates. As a result, the properties and phase behavior of CO_2 systems can dramatically change even with a tiny variation of temperature, pressure or the mixture composition. Inappropriate design together with inaccurate detection of the system performance can result in serious failure of the CCS/U technologies such as pipeline blockage. Since carbon dioxide will not be in a pure state in any of the CCS/U technologies, the accurate description of thermophysical properties and phase behavior of its mixtures with components such as carbon monoxide, water, methane, argon, or hydrogen sulfide are of high demand [1]. The water + carbon dioxide mixture is of special interest as it may form solids similar to water ice called clathrates or gas hydrates [2]. The clathrates consist of water molecules arranged in a form of crystal structure and the gas molecules engaged inside the cavities of the crystal. The presence of gas molecules thermodynamically stabilizes the water crystal. The CO_2 hydrates can form under CCS/U relevant conditions at temperatures below 20 °C and pressures above 10 bar. Our team has developed an accurate model of the CO_2 hydrates that is being successfully used in the research and development of CCS/U technologies [3].

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