Interfacial phenomena and related thermophysical properties at elevated pressures

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The success of CCU techniques in EOR essentially depends on thermophysical properties of gas mixtures containing high amounts of carbon dioxide, especially when coming into contact with reservoir fluids and porous rocks. In the first place, interfacial properties such as wetting under conditions prevailing in aquifers and depleted oil reservoirs in presence of compressed carbon dioxide are studied. In general, drops of aqueous solutions show increased contact angles, i.e. worse wetting in CO2-atmosphere at rising pressure. In terms of capillarity, the changing wetting situation at elevated pressures has to be accounted for when performing carbon dioxide storage in aquifers.

At the same time, the interfacial tension decreases significantly with pressure for all relevant two and three phase systems comprising aqueous solutions, gases and hydrocarbon liquids. Among the gases considered in oil and gas industry, carbon dioxide is one of those that show the strongest molecular interactions with any other fluid. A systematic determination of the interfacial tension gives quantitative insight in the specific phase behavior, e.g. in terms of the minimum miscibility pressure: Carbon dioxide is known to mix with light hydrocarbons to a strong extent leading to a vanishing interfacial tension at moderate pressures, i.e. both adjacent fluid phase become completely miscible.

Recent developments show a promising behavior of foams at elevated pressures to combine various favorable effects, such as miscibility and displacing ability. Other efforts are made to increase the viscosity of carbon dioxide itself e.g. by adding CO2-soluble surfactants in order to inhibit fingering.
References