A COMPARISON OF CO₂ AND CO₂ MIXTURE EQUATIONS-OF-STATE IN FITTING P-ρ-T EXPERIMENTAL DATA

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The transport is an important feature of the CCS process, indeed sometime indicated as CCS&T (Carbon Capture, Storage and Transportation). In fact, normally the power and industrial production plants that are large sources of CO₂ are located a long distance away from storage locations and the captured CO₂ has to be transported from the point of capture to the storage site. The transport may influence the choice of the capture technology and the limit performance requirements on the basis of the CO₂ quality necessary for the specific transport system, for example in terms of concentration, impurity or pressure and temperature conditions.

Different transport solutions are available, in particular the main ones are pipelines and ships. In any case high density and purity are recommended, while for a safe final storage a CO₂ concentration > 95.5% is required (De Visser et al., 2008).

In this work the attention is focused on pipelines, where CO₂ will most likely be transported at T > 273.15 K and in the pressure range of 80–130 bar: above the critical pressure (73.74 bar), but not too much high in order to avoid the pipeline stress. In these conditions CO₂ is in the “dense” phase and exhibits very low viscosity and a density similar to a liquid allowing smaller pipeline diameter than in the gas phase that presents a very low density.

Moreover, in order to avoid two-phase flow, it is necessary to repump the CO₂ whenever the pressure falls below 80 bar.

Therefore the knowledge of the thermodynamic properties of CO₂ and CO₂-mixtures and the interactions between the CO₂ and other components that it is possible to find (i.e. nitrogen, hydrogen, hydrogen sulphide, methane) could be of great of interest.

For this goal, the study of the Equations of State (EOS) becomes extremely important allowing the thermodynamic property calculations for different mixture compositions in the homogeneous gas, liquid and supercritical region and for vapour-liquid equilibrium (VLE) states.

In addition the EOS are useful to determine, on the basis of operating condition and composition, when a phase change occurs and thus, for example, where it needs a pumping station in order to avoid an excessive pressure decrease. Moreover the EOS can give some information about what can occur as consequence of a pipeline failure.

Therefore, finding a proper Equation of State could be of great of importance in the CCS&T process.

In literature many references are available about CO₂ and CO₂ mixture EOS (Span and Wagner, 1996; Kunz et al., 2007; Li and Yan, 2008; Li and Yan, 2009), nevertheless a suitable equation of state for mixtures in the appropriate conditions for pipeline transport, in particular with a high CO₂ concentration, has not been clearly defined yet.
This paper analyses in detail different EOS (i.e. PR, SRK, RK, BWRS, GERG-2004) in order to evaluate their reliabilities for predicting densities of CO$_2$ and binary CO$_2$ mixtures based on the comparisons with experimental data found in literature or obtained by laboratory p-p-T measurements. The comparison among the aforementioned equations of state has been made by means of commercial simulation software such as, for example, Aspen Plus, Aspen Properties, Aspen Hysys and Olga. In this paper the results are shown and discussed in detail. The aim of this work is to optimize the thermodynamics properties description of CO$_2$ mixtures, in particular in the crucial working conditions using for the transport.

**References**


