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Review

Viscosities, thermal conductivities and diffusion coefficients of CO_2 mixtures: Review of experimental data and theoretical models

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ABSTRACT

Accurate experimental data on the thermo-physical properties of CO_2-mixtures are pre-requisites for development of more accurate models and hence, more precise design of CO_2 capture and storage (CCS) processes. A literature survey was conducted on both the available experimental data and the theoretical models associated with the transport properties of CO_2-mixtures within the operation windows of CCS. Gaps were identified between the available knowledge and requirements of the system design and operation. For the experimental gas-phase measurements, there are no available data about any transport properties of CO_2/H_2S, CO_2/COS and CO_2/NH_3; and except for CO_2/H_2O(/NaCl) and CO_2/amine/H_2O mixtures, there are no available measurements regarding the transport properties of any liquid-phase mixtures. In the prediction of gas-phase viscosities using Chapman–Enskog theory, deviations are typically <2% at atmospheric pressure and moderate temperatures. The deviations increase with increasing temperatures and pressures. Using both the Rigorous Kinetic Theory (RKT) and empirical models in the prediction of gas-phase thermal conductivities, typical deviations are 2.2–9%. Comparison of popular empirical models for estimation of gas-phase diffusion coefficients with newer experimental data for CO_2/H_2O shows deviations of up to 20%. For many mixtures relevant for CCS, the diffusion coefficient models based on the RKT show predictions within the experimental uncertainty. Typical reported deviations of the CO_2/H_2O system using empirical models are below 3% for the viscosity and the thermal conductivity and between 5 and 20% for the diffusion coefficients. The research community knows little about the effect of other impurities in liquid CO_2 than water, and this is an important area to focus in future work.

Contents

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