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Review

Property impacts on Carbon Capture and Storage (CCS) processes: A review

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ABSTRACT

The knowledge of thermodynamic and transport properties of CO_2-mixtures is important for designing and operating different processes in carbon capture and storage systems. A literature survey was conducted to review the impact of uncertainty in thermos-physical properties on the design and operation of components and processes involved in CO_2 capture, conditioning, transport and storage. According to the existing studies on property impacts, liquid phase viscosity and diffusivity as well as gas phase diffusivity significantly impact the process simulation and absorber design for chemical absorption. Moreover, the phase equilibrium is important for regenerating energy estimation. For CO_2 compression and pumping processes, thermos-physical properties have more obvious impacts on pumps than on compressors. Heat capacity, density, enthalpy and entropy are the most important properties in the pumping process, whereas the compression process is more sensitive to heat capacity and compressibility. In the condensation and liquefaction process, the impacts of density, enthalpy and entropy are low on heat exchangers. For the transport process, existing studies mainly focused on property impacts on the performance of pipeline steady flow processes. Among the properties, density and heat capacity are most important. In the storage process, density and viscosity have received the most attention in property impact studies and were regarded as the most important properties in terms of storage capacity and enhanced oil recovery rate. However, for physical absorption, physical adsorption and membrane separation, there has been a knowledge gap about the property impact. In addition, due to the lack of experimental data and process complexity, little information is available about the influence of liquid phase properties on the design of the absorber and desorber for chemical absorption process. In the CO_2 conditioning process, knowledge of the impacts of properties beyond density and enthalpy is insufficient. In the transport process, greater attention should focus on property impacts on transient transport processes and ship transport systems. In the storage process, additional research is required on the dispersion process in enhanced oil recovery and the dissolution process in ocean and saline aquifer storage.

Contents

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Nomenclature

Symbol

Q_{sen}	sensible heat for solvent heating
Q_{latent}	latent heat for water evaporation
Q_{rxn}	heat of reaction for the desorption of CO_2
Υ	specific heat ratio
ρ	density

Abbreviation

3P1T	three-parameter cubic equation of state with one parameter temperature-dependent
BWRS	Benedict–Webb–Rubin–Starling
CCS	Carbon Capture and Storage
e-NRTL	Electrolyte Nonrandom Two-liquid
EOR	enhanced oil recovery
EOS	equation of state
GDPC	generalized pressure drop correlation
GHG	greenhouse gas
IFT	interfacial tension
ISRK	Improved Soave–Redlich–Kwong
KSMHV2	Kwong–Soave with modified Huron–Vidal mixing rules
LK	Lee–Kesler
LKP	Lee–Kesler Plöcker
MEA	monoethanolamine
MMP	Minimum Miscible Pressure
MPR	Modified Peng–Robinson
MSRK	Modified Soave–Redlich–Kwong
P	pressure
PC-SAFT	Perturbed-Chain Statistical Associating Fluid Theory
PR	Peng–Robinson
PRMHV2	Peng–Robinson with modified Huron–Vidal mixing rules
PROPATH	PROgram PAckage on the THermo-physical properties of fluid
PRSV	Peng–Robinson–Stryjek–Vera
PRWS	Peng–Robinson with Wong–Sandler mixing rules
PSA	Pressure Swing Adsorption
PSRK	Predictive Soave–Redlich–Kwong
PT	Patel–Teja
REFPROP	REFerence fluid PROperties
RK	Redlich–Kwong
RK-ASPEN	Redlich–Kwong-ASPEN
RKS	Redlich–Kwong–Soave
RKSWS	Redlich–Kwong–Soave with Wong–Sandler mixing rules
SRK	Soave–Redlich–Kwong
SR-POLAR	Schwartzentruber–Renon
SW	Span–Wagner
T	temperature
TSA	temperature swing adsorption
UNIQUAC	Universal Quasi Chemical
VSA	vacuum swing adsorption