CO2 hydrates crystallization kinetic parametric study: effect of impeller type

Véronique Osswald, Pascal Clain, Didier Dalmazzone, Anthony Delahaye, L. Fournaison

ECGH 2024 – European Conference on Gas Hydrate – Trieste – June 11-14 2024

CO_2 hydrates crystallization kinetic parametric study: effect of impeller type

Véronique OSSWALD[1], Pascal CLAIN[1,2], Didier DALMAZZONE[3], Anthony DELAHAYE[1], Laurence FOURNAISON[1]

[1] *Université Paris-Saclay, INRAE, FRISE, Antony, 92761, France, veronique.osswald@inrae.fr*
[2] *Léonard de Vinci Pôle Universitaire, Research Center, Paris la Défense, 92916, France*
[3] *ENSTA-Paris, UCP, Palaiseau 91120, France*

CO_2 hydrate slurry is a promising phase change material for cold storage and distribution issues, due to its high latent heat (about 500 $kJ.kg^{-1}$ of water, higher than that of ice - 333 $kJ.kg^{-1}$) and wide melting temperature range suitable for air conditioning application. While the thermodynamic properties of CO_2 hydrates are now well established, knowledge of crystallization kinetics phenomena is still a challenge. Trying to understand and control the formation of gas hydrates is a key factor, since their discovery in pipeline plugs. The goal here, for cooling application, is to increase the rate of CO_2 hydrate formation. Most laboratory-scale hydrate reactors are equipped with pressure and temperature probes, and mass balance on CO_2 allows formation kinetic studies, but with assumptions on CO_2 concentration in the liquid phase and the hydration number.

The present work investigates the kinetics of CO_2 hydrate crystallization for two different types of stirrers, on one hand a three pitched blade stirrer and on the other hand a hollow shaft eight blade Rushton turbine. We use a jacketed stirred batch reactor, with a specially developed sensor (a thermopile) to determine experimentally heat balance on the cooling jacket. The mass fraction of crystallized hydrate during the time is determined directly from this heat balance. Those results are compared with mass balance approach. To highlight the effect of stirrer type on mass transfer, especially between vapour and liquid phases, an additional experimental study to determine vapour/liquid mass transfer coefficient, k_La, were achieved. We conclude about the global performance for heat and mass transfers of both stirrer, and give general recommendation for the choice of stirrer type and scale-up process.

☐ I am a student or a young researcher (thesis defended < 3 years)

☐ I am a student and I want to participate to a grant supported by CEI: www.cei.int

☐ I am a student and I want to participate to a grant supported by Dialogue 5+5: www.fiveplusfiverihe.org/about-us

☐ I am interested to deposit a full document for reviewing and publication