



Experimental Study and Modeling of Methane Hydrate Formation Induction Time in the Presence of Ionic Liquids

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Abstract

Gas hydrate formation has been referred as unfavorable phenomenon since it leads to blockage of pipelines. To prevent formation of these compounds, several methods are normally pursued including system heating, depressurization, water removal, and use of gas hydrate formation inhibitors. The latter technique may be the most practical method for this purpose. Two types of inhibitors are generally used in the industry: thermodynamic inhibitors and kinetic ones. Thermodynamic inhibitors (such as ethylene glycol and methanol) shift the hydrate-liquid-vapor-(HLV) equilibrium curve to lower temperature and higher-pressure conditions. Kinetic inhibitors (such as PVP, PVCap) delay the hydrate nucleation and growth rates. There are some evidences that ionic liquids have dual inhibition effects. In this communication, we use three ionic liquids including (BMIM-BF₄), (BMIM-DCA), and (TEACL). Methane hydrate formation induction time in the presence of different concentrations of these three ionic liquids is kinetically investigated in this work. Consequently, the effects of initial pressure and ionic liquids concentration on the induction time can be evaluated. In addition, a three parameter semi-empirical model is developed on the basis of chemical kinetics theory. Finally, it is shown that the proposed semi-empirical model has a good accuracy in comparison with the experimental data.

Keywords: Methane hydrate, Kinetics, Ionic liquids, Induction time, Inhibitors

Research Highlights

- Measurement of methane hydrates induction time in the presence of ionic liquids.
- Proposing a three parameter semi-empirical model on the basis of chemical kinetics theory for representing experimental data.
- Optimization of model parameters by reported experimental data and prediction of all results by the model.

1. Introduction

Gas hydrates are belonging to the clathrates families, which are composed of water molecules and some guest molecules like methane, ethane, propane, etc. Under appropriate conditions which are high pressures and low temperatures conditions, some guest molecules which are gases with appropriate sizes and shapes are trapped in the cavities which are formed by water molecules that are connecting together by hydrogen bonding and gas hydrates are formed