



Assessment of Nucleation Kinetic Mechanisms in Gas Hydrate Crystallization Processes

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Abstract

Nucleation is one of the most important steps in the process of crystallization of gas hydrates. In the present work the nucleation mechanism of gas hydrate formation process using the propane as a sII gas hydrate former is investigated at isothermal operating conditions. Effects of variations of supersaturation and impeller speed on the kinetics of hydrate nucleation are also presented. Different expressions for dependence of induction time with degree of supersaturation are employed. The accuracy of the predicted induction times for the case of progressive nucleation are always much higher than those obtained through instantaneous nucleation assumption at all ranges of impeller speeds. It is found that the heterogeneous progressive nucleation is the most probable nucleation mechanism at the early stages of gas hydrate formation processes.

Keywords: gas hydrate, formation, nucleation, mechanism, crystallization, kinetics.

- Nucleation mechanisms of gas hydrate formation processes are investigated.
- Effects of variations of supersaturation and impeller speed on the kinetics of hydrate nucleation are presented.
- It is found that the heterogeneous progressive nucleation is the main nucleation mechanism at the early stages of gas hydrate formation processes.

1. Introduction

Studies on the kinetics of the process of gas hydrate crystallization are at a relatively early stage of development despite notable work of various authors in the last three decades [1-3]. Issues related to the nucleation and growth processes, including the supersaturation, the nucleation and growth rates and the induction time, have not been sufficiently clarified [4-6]. Recently, a mechanistic kinetic model for description of gas hydrate formation processes has also been presented by ZareNezhad et al. [7] and the secondary nucleation mechanisms due to crystal-crystal and crystal-impeller contacts are theoretically described for the first time.

Nucleation is one of the most challenging steps regarding the crystallization of gas hydrates. Depending on where and how nucleation occurs and how is schematic of clusters, there are