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## CYCLOPENTANE HYDRATE COHESION MEASUREMENTS AND PHASE EQUILIBRIUM PREDICTIONS

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### Abstract

Clathrate hydrates can form in oil and gas flowlines at high pressures and low temperatures. These solids frequently form under flowing conditions, where they can encounter other hydrate particles due to turbulent mixing. Hydrates may also form in locations where they can anneal significantly before coming in contact with other hydrate particles, such as during transient shut-in conditions in a flow line. Understanding the effect of different shut-in/annealing time periods on hydrate cohesive forces can be important in providing further insight into effective strategies to prevent hydrate plug formation.

Cyclopentane hydrates were tested using a micromechanical force (MMF) apparatus to investigate the effect of annealing time on the cohesive forces between hydrate particles. Annealing time was found to reduce the cohesion force between particles at various temperatures tested. This was attributed to the reduction of micropores that connect the unconverted water center of the hydrate to the exterior shell, reducing the water layer available for cohesion.

In order to further understand these systems, an understanding of the thermodynamic phase equilibria for systems containing cyclopentane is needed. The prediction capability of the in-house hydrate phase equilibria prediction tool (CSMGem) was therefore improved by optimizing the Kihara potential parameters for cyclopentane using pure and mixed cyclopentane hydrate phase equilibria experimental data. The optimized set of Kihara parameters was then used to predict the gas hydrate phase boundary as well as the fractional cage occupancy of guest molecules, where the larger cavities of structure II were confirmed, as expected, to be filled only by cyclopentane molecules.

**Keywords:** Clathrate hydrate, particle force, cyclopentane, phase equilibria

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