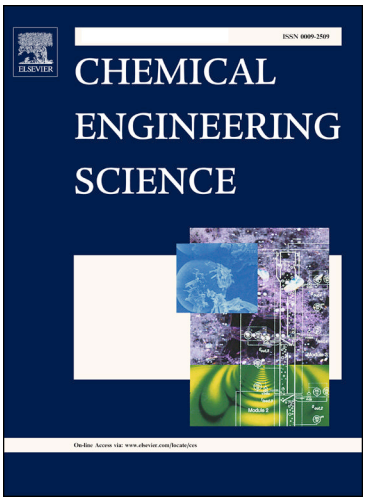

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A Three-Phase Solid-Liquid-Gas Slug Flow Mechanistic Model Coupling Hydrate Dispersion Formation with Heat and Mass Transfer

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Highlights

- First study to couple slug flow + hydrates using mass + momentum + energy equations
- Analytical expressions for pressure and temperature distributions are found
- The temperature distribution agrees with experimental data
- Effects of hydrate formation on slug flow are analyzed

Abstract. Pipe blockage due to gas hydrate formation is a main concern in the oil and gas industry due to the revenue losses caused by either production impairments or interruptions, and to the high costs associated to the elimination of such blockages. Assuming a hydrate formation rate in the gas-water interface based on the system subcooling, the present work models the transition from two-phase liquid-gas to three-phase solid-liquid-gas flows when hydrates form. The multiphase flow is assumed to be within the slug flow pattern region, as this is the prevailing flow regime in offshore production scenarios. The model couples mass, momentum and energy balances for the slug flow unit cell. The hydrate phase is assumed as homogeneously dispersed in the water. The gas and water consumption rates due to hydrate formation are modeled as source terms in the mass balance equations. The exothermic characteristic of the hydrate formation is taken into account in the energy conservation equation. The model provides analytic expressions for temperature and pressure distributions along the pipeline. However, the unit cell geometry is solved by numerical integration and the model closure is achieved only when empirical correlations for the slug frequency, the unit cell translational velocity and the slug aeration are used. The