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Flow visualizations and pressure drop measurements of isothermal ice slurry pipe flows

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Abstract

The objective of the present project is to analyze the flow patterns resulting from isothermal ice slurries flowing in a straight horizontal pipe using combined flow visualizations and pressure drop measurements. Ice slurry is composed of an initial solution of 9.5% weight propylene glycol. The influences of the inlet mean axial velocity and ice volume fraction on the flow patterns and pressure drops are investigated experimentally for volume ice concentrations up to 18.4% in both the laminar and turbulent flow regimes. An original transition diagram has been proposed and new more complex stratified regimes are identified compared to the existing literature. Finally, pressure drop measurements have been performed for the straight horizontal pipe but also for more complex geometries such as elbows and T-junctions. At high ice fractions, ice particles agglomerate in the singularities leading to a sudden increase of the pressure drops.

Keywords: Ice slurry, propylene glycol, flow visualizations, pressure drop measurements, isothermal flow regimes

1. Introduction

Over the last decades, a growing interest for multiphase secondary refrigerants and more especially for ice slurries, has been observed in the industry. They are used in many applications, going from building cooling to food conditioning or medical usage (see the review of Kauffeld *et al.* [1] for more examples). This type of complex fluid includes all mixtures made of an aqueous solution and ice particles. The aqueous solution incorporates a freezing-point depressant like ethanol, ethylene-glycol or mono-propylene

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