MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Poster Session (P)

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MOVING-BOUNDARY MODEL OF CRYOGENIC FUEL LOADING IN SPACE

Abstract

A moving-boundary model of two-phase (TP) flow in a cross-country cryogenic fuel supply line has been developed. It is based on time-dependent one-dimensional ordinary differential equations that describe mass and energy conservation of the flowing cryogen that exchanges heat with the tubes' walls. The momentum conservation is taken into consideration by relating the pressure drop across the boundaries of the control volumes (CVs) with the corresponding inlet and outlet mass flow rates through the boundaries of these volumes. With a relatively small computational effort compare to full-scale schemes, the model describes pressure and temperature variations together with kinetics of vapor void fraction and of the interphase boundary motion in the different parts of the spatially distributed system. In this part, special attention is given to detailed study of the transient and steady state two-phase cryogenic movement in a long horizontal pipe with different regimes of flow in space: with and without heat exchange between the tube walls and the cryogen and between the walls and the environment; in the presence of local mass and heat leaks, and the appearance of sudden obstructions, etc. The convergence of the computational procedure with respect to the number of the CVs is discussed.