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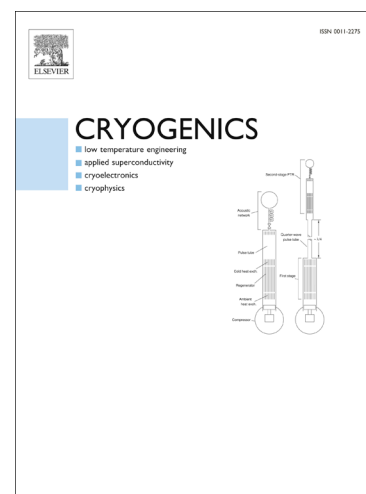
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Preliminary evaluation of cryogenic two-phase flow imaging using electrical capacitance tomography

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Abstract: The potential application of the 2-D eight-electrode electrical capacitance tomography (ECT) to the inversion imaging of the liquid nitrogen-vaporous nitrogen (LN₂-VN₂) flow in the tube is theoretically evaluated. The phase distribution of the computational domain is obtained using the simultaneous iterative reconstruction technique with variable iterative step size. The detailed mathematical derivations for the calculations are presented. The calculated phase distribution for the two detached LN₂ column case shows the comparable results with the water-air case, regardless of the much reduced dielectric permittivity of LN₂ compared with water. The inversion images of total eight different LN₂-VN₂ flow patterns are presented and quantitatively evaluated by calculating the relative void fraction error and the correlation coefficient. The results demonstrate that the developed reconstruction technique for ECT has the capacity to reconstruct the phase distribution of the complex LN₂-VN₂ flow, while the accuracy of the inversion images is significantly influenced by the size of the discrete phase. The influence of the measurement noise on the image quality is also considered in the calculations.

Keywords: Cryogenic; Two-phase flow; ECT; FEM; Void fraction

1. Introduction

The gas-liquid two-phase flow phenomenon is widely existed in the industrial equipment, such as the evaporator, condenser, distillation column and other chemical reaction equipment. For the cryogenic conditions, since the liquid nitrogen (LN₂) and liquid oxygen (LO₂) works at temperature much lower than the ambient temperature,

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