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C2Po1A-06 [20]: Design optimization and Calibration of a void fraction measurement capacitance sensor for LN2 flow

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Cryogenic fluids are used for wide range of industrial and laboratory applications. Vacuum or supper-insulated transfer lines are efficiently used to transfer these fluids from the storage Dewars to the end applications. As the heat transfer to the cryogens flowing through the transfer line cannot be completely eliminated, many a times two-phase flow occurs during the transfer process. It is necessary to estimate the quality of the flow (void fraction) and the amount of cryogen being evaporated in the transfer process. Many techniques are available to measure the void fraction, but implementing these techniques to cryogenic fluid flow is sometimes difficult and expensive. Capacitance measurement technique is one of the easy and simple methods to find the liquid level and void fraction. Towards this, an attempt has been made to design capacitance based void fraction measurement sensors for cryogenic applications. Most of the capacitance sensors are made with inner glass tube, which needs special attention in handling the device and also sometimes it is difficult to make end connections for the glass tubes. The present work deals with design optimization of Hylam(TM) and fibre-reinforced plastic (FRP) inner tube concave plate capacitance sensor and it's calibration with the help of capacitive based triple redundant level sensor for cryogenic fluids. 3-D modelling and thermo structural analysis of the developed sensor has been carried out in ANSYS workbench and electrostatic analysis has been carried out using ANSYS Maxwell software. The results obtained by the analysis have been validated with experimental results.

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