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C3Or3C-06: Research on measurement characteristics and structure optimization of U-tube Coriolis mass flowmeter with liquid hydrogen

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The Coriolis mass flowmeter (CMF) has the advantages of a simple structure and high measurement precision. Compared with liquid nitrogen (LN2) and water, the density of liquid hydrogen (LH2) is more than one order of magnitude smaller, which leads to significantly different flow-induced vibration (FIV) characteristics in the CMF. The fluid-structure interaction (FSI) theory model for the U tube CMF was established based on the Euler beam theory in this research, and the FSI numerical simulation was conducted to solve the effect of fluid flow. The difference in measurement characteristics of CMF for LN2 and LH2 was revealed and the optimized measuring tube structure was proposed. The theory and numerical model are first validated by comparing the experimental results from the published research. Then the results of structural frequency, phase difference, and time lag for LH2 are compared with those for LN2, and the effect of flow velocity, the position of sensors, and the geometry of the tube are studied. Results show that the time lag of LH2 is an order of magnitude smaller than that for LN2. Errors of -6.84% and 0.63% will be generated if the mass flow rate of LH2 is measured with CMF calibrated with water and LN2, respectively. The effect of the position of sensors on measured time lag cannot be ignored, which the time lag can be increased by 93% as the position of sensors variate. Time lag can be increased by 115% based on the optimization of the tube structure. The results reveal the FSI characteristics of the U-tube CMF with LH2.

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