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PRESSURE WAVE ATTENUATION IN GAS-LIQUID BUBBLY FLOW FOR LIQUID OXYGEN FEED PIPE BETWEEN PUMPS

Abstract

For a type of high pressure, liquid oxygen (LOX)/ kerosene rocket engine with staged combustion cycle, the flow in the pipe between the LOX pumps is gas, liquid and solid three-phase system. Such multi-phase phenomenon roots in the designed engine cycle type. As the mixture ratio of the mass flux of oxygen to that of kerosene in preburner is quite high, the main component of mixture is gas oxygen for the combustion in preburner. After driving the turbine, this gas oxygen mixes with the liquid oxygen in the feed pipe between the pumps, where a majority of components are LOX and oxygen-rich gas, and little are solid H2O, CO2, and et al. Thus, the mixed flow can be simplified as gas oxygen and liquid oxygen two-phase bubbly flow. By using two models and corresponding methods, the study on pressure wave attenuation in the gas-liquid flow was conducted for the feed pipe between LOX pumps. Firstly, according to the practical working conditions, the homogenous model based on the compressibility theory regarding a single bubble in an infinite liquid, and Redlich-Kwong gas equation was derived a model for the low temperature and high pressure case, especially considering the change of the ratio of density of gas to one of liquid. The numerical tests were conducted. The Results not only show the agreement between numerical simulations for this model and experiments at the normal temperature and pressure are good, but also show that the modifications of the model for the low temperature and high pressure condition are necessary. Secondly, a numerical simulation of gas-liquid two-phase flow in the oxygen transportation pipe was implemented by Fluent, the transition and attenuation of pressure vibration in cryogenic gas-liquid two phase flow was researched. The influence of two phase flow on the transition and attenuation of pressure wave was analyzed. Comparisons between different interfacial momentum models and different void fractions in the entrance were also conducted. The numerical results may guide the experiments in the future. This work is of reference to further study of oscillation restrain and relative feed pipe experiments, and also is helpful for the test of two-phase flow in feed pipe between pumps.