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STUDY ON POGO VIBRATION SUPPRESSION OF GAS-LIQUID FLOW IN CRYOGENIC PUMP FEED LINE

Abstract

The pogo vibration arises from the inherent interaction of a flexible rocket structure with a liquid propulsion system. Such instable vibration may deteriorate the performance of the propulsion system, cause problems with instruments and sensors in the rocket, and even lead to ultimate mission loss. As one of the means of pogo suppression, the gas-liquid flow in cryogenic pump feed line has been employed on heritage vehicles. In present study, the detailed mixing condensation process of gaseous oxygen and liquid oxygen in cryogenic pump feed line was numerically simulated using the thermal phase change model. Moreover, pressure oscillation analysis was conducted for the two-phase flow with respect to frequency, amplitude, phase, void fraction, mass flow rate, temperature, etc. Thereby the equations for calculating pressure and flow oscillations in cryogenic pump feed line were updated to evaluate the feed system dynamics as well as the pogo stability. Combined with further ground and flight test verification, this study will be helpful to explain the pogo vibration suppression mechanism of gas-liquid flow in cryogenic pump feed line, and to predict the design's ability to suppress pogo oscillation. Initial application of the study has been to pogo mitigation during design a new launch vehicle configuration with liquid oxygen / kerosene rocket engines.