

SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (1) (1)

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MODELING STUDY ON NATURAL CIRCULATION PRECOOLING FOR CRYOGENIC LIQUID
ROCKET PROPULSION SYSTEM**Abstract**

Cryogenic propulsion system of liquid rocket should be precooled to suitable state before the engine ignition in order to avoid unexpected phase change of cryogenic propellant due to extreme temperature difference between cryogenic propellant and high temperature structure components, e.g. pipes, valves and turbopumps. Gaseous or gas-liquid two phase propellant entering the feed line can deeply effect the starting system characteristics of rocket engine, resulting the cavitation of turbopump or structural damage, even total failure of starting. Circulation precooling method is commonly used in cryogenic liquid rockets for the purposes of saving precooling propellant, simplifying processes before launching, and enhancing the safety coefficient of precooling. The precooling methods of typical cryogenic liquid rockets in the main space countries are reviewed in this article. This research focuses on the mechanism of circulation precooling and influence factors. A new simulation system of circulation precooling based on AMESim has been developed and verified. The natural circulation precooling system of cryogenic propulsion system is analyzed in details by applying this model, including circular flow rate, temperature and pressure distribution. Good agreements are achieved between the simulation results and published experiment data. For the further research, the effect of variation of load factor is under consideration, and whether it is feasible that the natural circulation precooling system is applied to upper stage cryogenic propulsion system of liquid rocket are discussed as well.