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From Earth Missions to Deep Space Exploration (05)
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PARAHYDROGEN-ORTHOHYDROGEN CONVERSION FOR IMPROVED HEAT-SHIELDING IN DEEP SPACE MISSIONS

Abstract

Long-term space missions require minimized boil-off from liquid hydrogen and oxygen fuel tanks to reduce payload at take-off. Leading rocket technologies utilize liquid hydrogen boil-off vapors to refrigerate and potentially eliminate boil-off from the liquid oxygen tank. The use of liquid hydrogen allows a substantial amount of heat to be conveyed out of the system. Statistical thermodynamic calculations estimate that the amount of heat carried with the hydrogen refrigerant can be increased up to 50 % through catalysis of the parahydrogen-orthohydrogen conversion. This paper discusses the Cryo-catalysis Hydrogen Experiment Facility (CHEF) in the HYdrogen Properties for Energy Research (HYPER) laboratory at Washington State University. The purpose of this facility is to experimentally validate statistical thermodynamic predictions of cooling capacity while catalyzing parahydrogen-orthohydrogen conversion. The intent of this research is to optimize the use of parahydrogen-orthohydrogen conversion catalysts for improved heat-shielding. Initial system capabilities and a plan for incorporating future tests into the CRYogenic Orbital TEst bed (CRYOTE) project are presented.