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LIFE CYCLE PREDICTION OF A LIQUID PROPELLANT ROCKET ENGINE THRUST CHAMBER USING UNIFIED CHABOCHE VISCOPLASTIC MODEL

Abstract

High thrust liquid propellant rocket engines are used in space technology to power heavy lift satellite launch vehicles. The engine investigated in this paper works on liquid oxygen and kerosene propellants. The thrust chamber of the engine is of double walled construction and regeneratively cooled. A high conductivity copper alloy is selected for the inner wall in regions of high heat flux and for other regions an austenitic stainless steel is used. Outer wall is of a high strength stainless steel throughout the chamber which is brazed on to the inner wall by vacuum brazing at elevated temperature. Combustion of propellants occurring inside the thrust chamber induces high thermal and pressure loads on inner wall while the passage of coolant through coolant channels imparts shrinkage and pressure loads.

Materials at high temperatures are sensitive to strain rate effects and thus exhibit viscoplastic behaviour. Viscoplasticity in metals is observed at temperatures above half the melting point temperature. The main aim of this work is to evaluate the cyclic life of the thrust chamber using the Chaboche unified viscoplastic material model for the inner wall austenitic stainless steel. The model parameters are calibrated by matching finite element simulations with test results, by trial and error. Elevated temperature low cycle fatigue tests are conducted on smooth specimens at 1.5