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EXTENDING LIFETIME OF ROCKET ENGINE COMBUSTION CHAMBER

Abstract

In development of a reusable rocket engine, a combustion chamber is one of the most critical components to define lifetime of the engine. Very high pressure and temperature combustion gas flows inside a chamber and very low temperature and high pressure coolant flows inside cooling channels divided by the wall made of copper alloy with the thickness of only around 1mm. These conditions are drastically changed according with start-up, shutdown, and throttling operations. Hence, the chamber liner suffers large and unsteady thermal stress change. We developed the reusable rocket engine and proved this engine would be reused over 100 flights through hot firing tests. The results were presented in the 66th IAC at Jerusalem. Since the thrust of this engine is 40 kN and the chamber pressure is rather low, performance and lifetime of the chamber could be reconciled by adjusting the operation point of the engine and the chamber. However, it will be more and more difficult to realize long-life combustion chamber for larger thrust engines. The present work will examine key factors to realize a long-life combustion chamber durable at least fifty combustions with thrust over 1,000 kN, especially focusing on materials of an inner liner, structure of an outer shell, and thermal barrier coating on the inner surface of the chamber. 2D FEM simulations have been performed to estimate damages on the inner layer of the chamber for the cross sectional area at the throat region for different materials of the inner liner and structure of the outer shell with or without thermal barrier coating. This work will provide key information in developing long-life combustion chambers of high power rocket engines.