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CERAMIC MATRIX COMPOSITES FOR IMPROVED ROCKET ENGINE COMBUSTION CHAMBERS

Abstract

Proposed in this paper is a new thrust chamber configuration based on previous work, which consists of a perforated ceramic matrix composite liner inserted inside an ablative outer wall. The improved configuration is straightforward, reliable and can combat the extreme temperatures of combustion (which can exceed 3000 C), while reducing the amount of performance loss attributed to material consumption and excessive fuel film cooling. This becomes increasingly important when considering significant interest has been given to the development of vehicles powered by methane, which produces high energy combustion, for the purpose of future space exploration. In order to validate the proposed configuration, a new predictive thermal model has been developed based on a modified Stechmann model and is used to determine the appropriate amount of fuel film cooling needed during nominal operation. Furthermore, a 1790 N (402 lbf) LOX/methane engine has been developed with attention given to the determination of desired engine characteristics. A static fire test was conducted on February 4, 2012 with the intent to perform 2 hot fire tests totaling 185 seconds; however, issues on engine start up ended the test after the initial 5 second burn. Relevant thermal data was collected from thermocouples strategically placed in and around the engine walls and initial comparisons suggest that the predictive thermal model was on the conservative side. This implies further performance gains could be achieved by reducing the amount of fuel film cooling used during operation; however, additional data is required before relevant conclusions can be made. As such, plans are set for a second static fire test later this year aimed at completing an additional 180 second burn. Data gathered from the test will be used to determine the validity of the proposed thrust chamber configuration, evaluate the use of the developed thermal model as a predictive tool, assess post-test engine performance and determine whether adjustments can be made to further increase performance gains. All work in this paper was conducted under a NASA SBIR Phase II contract.