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LOW COST SOLID ROCKET MOTOR FOR SUPERSONIC TEST VEHICLE

Abstract

We describe the development of a reusable solid rocket motor intended as a propulsion unit for a supersonic test vehicle. The solid rocket motor is developed as an end burner due to the relatively long burning time needed for the application: 12 seconds. The average thrust is 5000 N with a specific impulse varying and dependingon the type of solid propellant. Two solid propellant formulations are investigated: composite propellant and sorbitol-based propellant. The characteristics of the solid rocket motor for which of the above fuel loads are measured on a custom designed rocket test stand with an acquisition system that allows the capture of up to 5 sensors at 10 kHz sampling rate. The combustion chamber, nozzle and the end cap are manufactured using high strength steel. The end cap is filleted onto the combustion chamber and high temperature sillicone substance is used for sealing. Between firings, only the sillicone needs to be replaced. An internal ballistic model is developed which takes into consideration two-phase flow. The solver basically evolves density and temperature as functions of time by using their respective differential equations. The two-phase flow is taken into consideration by using a modified universal gas constant R as well as a modified ratio of specific heats. Comparison between the theoretical predicted parameters and the measured characteristics is performed. Besides the internal ballistic model, we also developed a thermal transfer model that computes the temperature variation within the combustion chamber wall and also outputs the needed thickness of the wall depending on chamber diameter and combustion pressure. We show that for long burning time solid rocket motors some significant thermal insulation is needed to prevent motor CATO. Also, the chamber thickness should take into account the material decrease in strength with the elevation of temperature. The general schematics of the supersonic test vehicle is shown with trajectory estimations: maximum velocity, maximum acceleration, altitude (for 90 degree launch inclination).