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Author: Mr. Roy Ramirez
Purdue University, United States

THE P-5 ENGINE: A COSTA RICAN, COST-EFFECTIVE, LOW POWER LIQUID ROCKET ENGINE

Abstract

This paper introduces the progress in all the engineering systems of the P-5 engine, which is candidate for being the first liquid rocket engine of the Central America and the Caribbean region. The focus of this project is to explore the feasibility of developing a low power but cost-effective engine. The P-5's design and desired performance was limited to an extent by the commercial availability of components in the market, and thus non-cryogenic propellants (95% ethanol and 50% hydrogen peroxide) were chosen for a theoretical thrust of 315 N, a specific impulse of 158 seconds and a low chamber pressure (165 psi) that would allow using economically accessible valves and piping. The geometry of the engine was carried out by using an in-house software, the Rocket Engine Designer (RED) which gave the thruster a height of 130 mm, a length of 100 mm and a width of 100 mm. The feed system, together with the electric system was designed as a semi-automatic pressure fed (CO2) system that can be reliable enough for multiple hydrostatic tests and a three-second-long hot fire. Custom-made propellant tanks were manufactured, and commercially available sensors and regulators that are used for the automotive industry were used. The electrical system was designed using a common microcontroller together with a programmed mission control interface that allows testing the engine remotely from a computer. To house both systems, a modular test bench was designed and manufactured. Three injector elements: unlike-pentad, like-doublets, and pintle, were considered and deeply studied from both and economical and technical point of view through a manufacturing exploration process that considered about 45 companies around the world. Based on the estimated heat transfer for a three second burn and the scope of this project, it was decided to keep the engine uncooled and to use a relatively high safety factor for the chamber's walls. The atmospheric conditions of the test site, in Heredia, Costa Rica, were measured and taken into account for a possible first hot fire in August 2019.