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PARAMETRIC DESIGN AND TESTING OF EXPLOSION-PREVENTIVE SOLID PROPELLANT ROCKET ENGINES IN THE EVENT OF UNEXPECTED BEHAVIOR DURING COMBUSTION

Abstract

Unexpected behavior and explosions during rocket engine tests are not unheard of in the industry. Therefore, rocket engines are usually tested in very secluded areas, using test benches surrounded by concrete to block shrapnel. This practically forbids amateur rocket enthusiasts, universities or small businesses to experiment with rocket engines in test benches, due to the amount of space and protection needed (along with the difficulties to achieve the necessary permissions). Our team set out to design and develop a safety mechanism which can be easily added to a rocket engine without affecting the combustion or mass flow (and therefore the thrust measurement).

Firstly, the chamber pressure, thrust and other parameters will be calculated in case of normal operation. Subsequently, a variety of plausible unexpected behaviors during combustion will be taken into account, such as detonations or nozzle blockages. The chamber pressure and other parameters will be recalculated for those cases. The main protection system performs a nozzle ejection, in order to quickly increment the throat area to that of the chamber. Said ejection automatically takes place once the chamber pressure is an order of magnitude greater to the nominal value. Moreover, the chamber is able to sustain a pressure an order of magnitude greater to that at which the nozzle is ejected. Finally, experimental data of the effectiveness of said system will be presented, all tests are performed using KNO3+sorbitol as solid propellant. Furthermore, all designs are parametrized based on the characteristic values of the engine; therefore, facilitating their use for a variety of designs.

The final design will ensure that the rocket engine is safe to test with the mentioned protocols. In conclusion, this will allow to test said engines in areas which would not regularly be possible to due to space and security constraints.