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Author: Mr. Hamed Gamal
SpaceForest, Poland

Mr. Robert Magiera
SpaceForest, Poland
Dr. Adam Matusiewicz
SpaceForest, Poland
Mr. Kacper Zieliński
SpaceForest, Poland
Mr. Piotr Szczepinski
SpaceForest, Poland
Mr. Łukasz Karolewski
SpaceForest, Poland

# DESIGN, ANALYSIS AND TEST OF A HYBRID ROCKET ENGINE WITH A MULTI-PORT NOZZLE

**Abstract**

A rocket nozzle is a critical part in any engine design. Flow accelration thus providing the required thrust is the simplest definition of the function of a rocket nozzle. However, lots of challenges face the design of such an element. Handling high temperatures, pressures and even external aerodynamic loads makes choosing a material for its manufacturing quiet tricky process from the aspect of maintining its weight and strength in a moderate range while fulfiling its function. Usually the higher the thrust required the bigger the nozzle is needed.

This paper presents the work done to develop a hybrid rocket engine with a multi-port nozzle. The main goal of this research is to acquire the know-how and introduce solutions for minimizing the weight of the rocket engine's nozzle and reduce its length while keeping a constant performance. The nozzle was mounted to the SF200 rocket engine which is a subscale version of the engine used to propel the SIR suborbital rocket.

As such an approach in designing rocket engine nozzles isn't widely covered neither with many researches nor publications, the mathematical calculations, conceptual study and comparisons with existing nozzle configurations and designs is mentioned briefly. This paper also discusses the design procedure, flow analysis process, structural and thermal study for the nozzle, materials selection criteria and experimental results. The research involved 8 engine static tests with various editions of the multi-port nozzle configuration. The results from CFD, FEA and thermal analysis of the nozzle alongside the problems encountered furing testing, performance analysis, operational updates and solutions and upgrades introduced during the development of the nozzle are illustrated in detail.