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Combustion Analysis of Pulse Jet Engine Using CFD

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ABSTRACT

Using CFD methodologies, this study examines the various fuel inlet design variants used in pulsejet engines. The ANSYS CFX software was used to analyze the one, three, and five distinct fuel inlet setups. Eddy dissipation is the combustion model utilized for study, and Creo 2.0 software was used to create the CAD model. Thrust force generated and static enthalpy are two factors used in the comparison analysis. Two-variable k- epsilon is the turbulence model employed. The dynamics of a pulsejet engine moving vertically in an even gravitational field without friction are examined using analytical modeling and the momentum conservation law. In light of the frequency of the brief pulses, the model predicts the presence of a speed. The circumstances under which the engine fails to start are known. When the engine restarts, the number of brief periodic pulses is discovered to depend on the force field intensity and exhaust speed for a specific pulse frequency.

Keywords- Jet propulsion, ANSYS CFX, Pulsejet engine, CFD, turbulence

1. INTRODUCTION

A pulsejet engine is a type of engine that burns in pulses. A pulsejet engine can be built with fewer parts and run statically. Although pulsejet engines typically have low compression ratios and low specific impulses, they are a lightweight form of jet propulsion. One important area of research for pulsejet engines is the pulse detonation engine, which employs repeated detonations in the engine and may be able to give high compression and good efficiency. The pulsejet is one of the most fundamental kinds of propulsion created by humans. They are recognized for having few to no moving parts, being scalable, affordable, easy to use, and operating at a very loud volume. Pulsed combustion is the fundamental component of pulsejets, which were created in the early 1900s. Typically, pulsejets are either waveless, with the combustion chamber always open to the free stream, or valved, with the inlet and combustion chamber separated by some sort of mechanical valve. The modern valveless pulsejet was created by Schmidt and Marco net in the early 20th century. This simple propulsion system had a back exhaust tube that was frequently on fire and an open entrance that led to a combustion chamber.

2. PROBLEM STATEMENT

Despite the fact that pulsejet technology has existed since World War II, there were no analytical and computational models available. Researchers haven't paid much attention to the application of computational fluid dynamics to the study of pulsejet engines. The size of the fuel inlets, angle of the nozzle, and combustion chamber all have a significant impact on how much thrust a pulsejet engine can produce. In this work, pulsejet engines are examined using CFD, with a particular emphasis on the thrust produced by changing the design of the combustion zone.

3. OBJECTIVES

By increasing the number of fuel inlet nozzles and the diffuser angle, this study's goal is to use CFD to study pulsejet engines. These specifics are

1. Creo-based CAD modelling of a pulsejet engine 2.0 design tools

2. CFD analysis with the basic design and ANSYS CFX software

3. Calculating the velocity plot, pressure plot, and thrust generated for base design

4. Computer-aided design (CAD) modelling of novel fuel-inlet designs

5. Using ANSYS CFX software and a novel design with numerous fuel inlets, CFD analysis

6. Calculating the thrust generated and plotting the pressure and velocity for a new design with numerous fuel inlets

7. CAD modelling of new designs that affect the shape of the combustion chamber

8. CFD analysis utilizing ANSYS CFX software and a novel combustion chamber design

9. Determining thrust generated, pressure plot, velocity plot, and conducting comparison research for the aforementioned novel design

4. PULSE JET DESIGN

The CAD model of pulsejet engine is modelled using dimensions as shown in figure 6.1 below. The schematic shown below shows length of pulsejet 600mm and opening nozzle 79.5mm, inlet nozzle 95mm

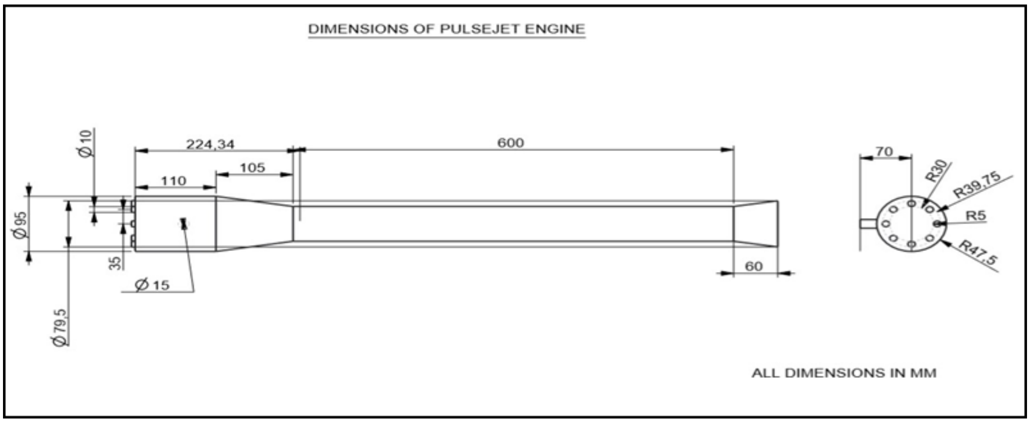

Figure 1: Dimensions of pulse jet engine

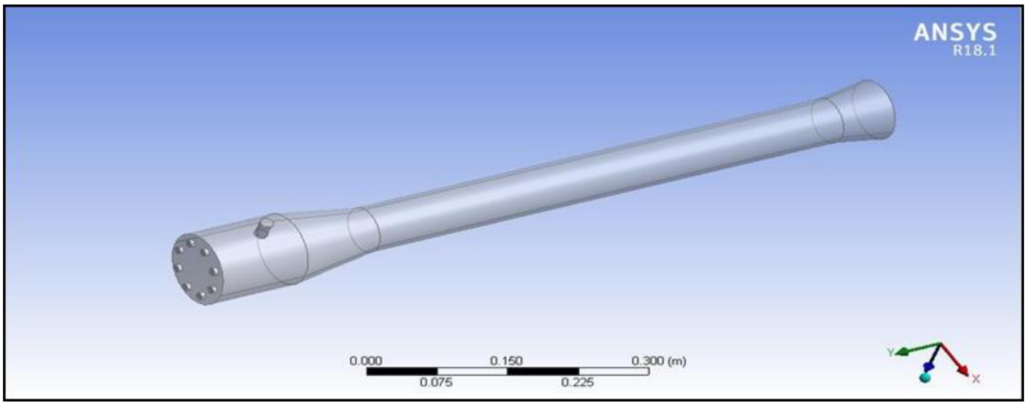

Figure 2 - 3D CAD model of pulsejet engine

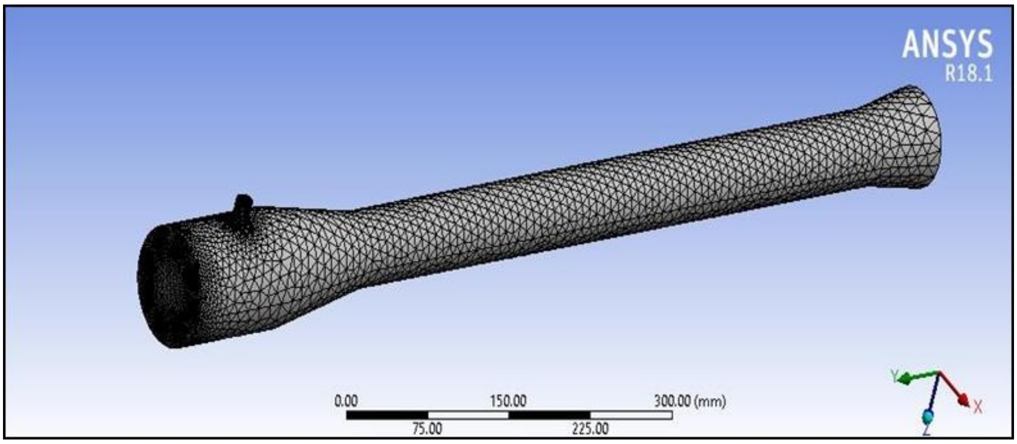

Figure 3 - Meshing of Pulsejet Engine

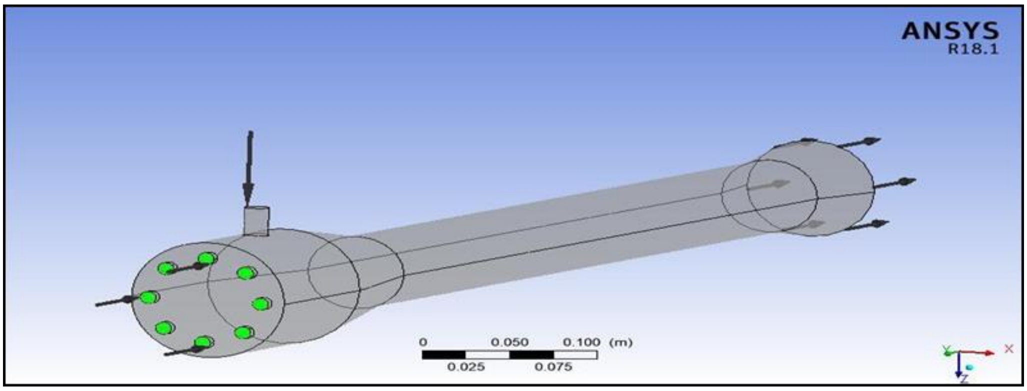

Figure 4 - Air Inlet

5. RESULT AND ANALYSIS

Thrust calculation

Cross sectional area = 4963.8 mm^2 Thrust = Pressure * cross sectional area

Thrust (single fuel inlet) = 1788.23 * 4963.8 = 8.876594 N

Thrust (double fuel inlet) = 4737.16 * 4963.8 = 23.514835 N

Thrust (three fuel inlet) = 4787.16* 4963.8 = 23.763031 N

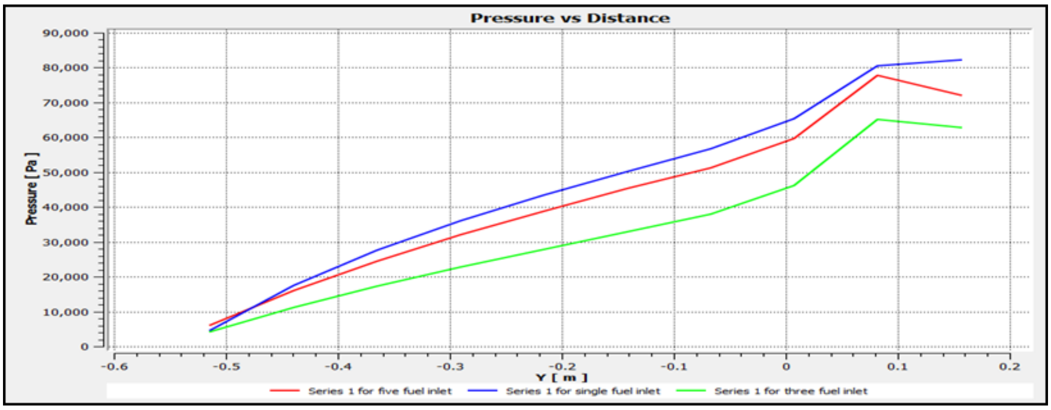

Figure 5: Pressure vs Distance curve

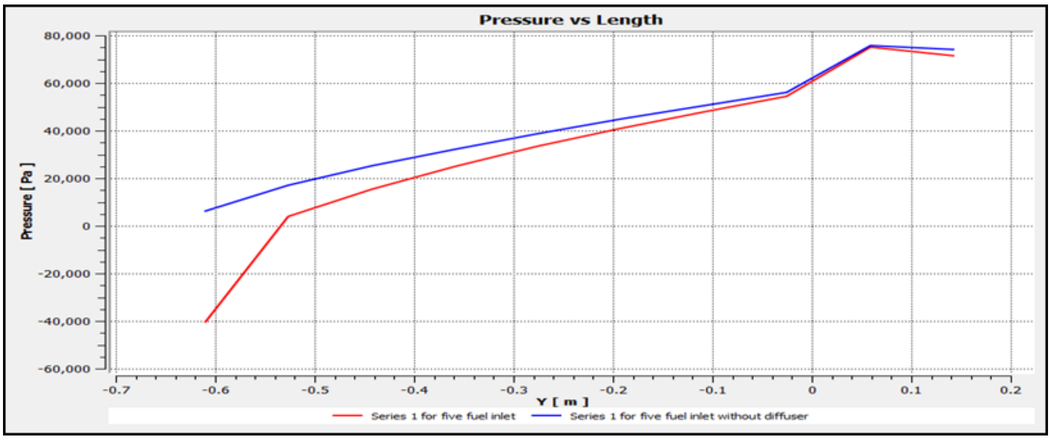

Figure 6: Pressure plot without divergent nozzle at the end

6. CONCLUSION

The detailed conclusions are:

1. The Eddy dissipation combustion model, which is utilized for CFD analysis and provides superior fluid flow prediction than other models.

2. For all design configurations (1, 3 and 5 inlet), the pressure plot of all the designs indicates the maximum value of pressure in the combustion zone.

3. The highest pressure is in the combustion zone as the pressure decreases throughout the length of the pulsejet engine tube.

4. Using numerous fuel inlet configurations over a single fuel inlet configuration results in a significant gain in thrust force generation.

5. When compared to designs with 3 and 1 fuel inlets, the pulsejet design with 5 fuel inlets generates the most thrust.

7. REFERENCES

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