Instrumented Pulsed Jet Propulsion (Valved)

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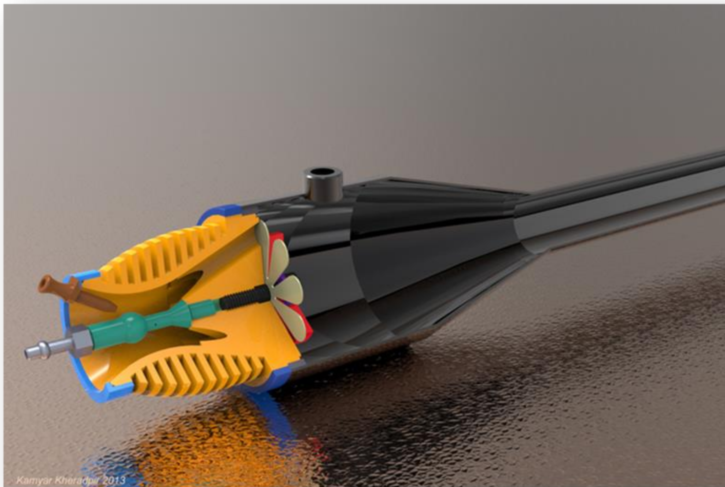
The ability of having a high thrust to weight ratio by the pulse jet is what makes it a very desirable utility in aerospace applications such as in Vertical Take Off/Landing (VTOL) aircraft. Testing will be performed on the Hobby King “Red Head” pulse jet engine to study and develop an empirical equation to calculate the thrust of a valved pulse jet engine. The scaling of the valved pulse jet will be confined to the exit length and diameter. Thrust capabilities by a pulse jet is defined by the pressure in the combustion chamber, exhaust gas temperatures, frequency, and the mass flow rates of the inlet air and fuel. By instrumenting the pulse jet at the inlet, combustion chamber, and exit pipe, studies can show how and why each of these parameters affect the thrust of the pulse jet. From these observations, an empirical formula can be created to calculate the thrust for varying sized pulse jets.

After building the thrust stand and assembling the pulse jet, a test run was conducted. For the first test run, the pulse jet was unable to start. This was because of such cold outside temperatures. These temperatures caused a pressure difference that the pulse jet was unable to overcome. After heating the pulse jet with a heat gun, the pulse jet was able to start combustion. Although the pulse jet was unable to fully sustain itself during the test run, having the engine combust was a positive outcome considering the cold ambient temperature. It was assumed that the reason for the engine not being able to sustain itself was that the reed valves were assembled too tight for an effective combustion.

Once all the instruments were purchased and obtained, a new stand for the pulse jet was built. The new stand used a rail system to place the pulse jet on. Being able to measure exactly how much thrust that was being produced is dependent on the rail system. At the front of the rail is a metal block with a load cell. The thrust being produced by the pulse jet will propel the engine forward against the load cell which will be able to measure the thrust. Also measured was the pressure and temperature at the exit nozzle and inside the combustion chamber. Due to a strict air to fuel ratio for the pulse jet, we assume the amount of air entering using the exact fuel inlet.

After running five test trials we were able to obtain all the necessary data for this project. The data collected first was the temperature and pressure at the exhaust. The thermocouple and pressure transducers were placed about three inches from the end of the pulse jet. From the five trials the average temperature and pressure at the exhaust were 447°C and 14.92 psia, respectively. Next the temperature and pressure were collected at the combustion chamber. The averages obtained were 604°C and 18.89 psia. Next the time domain and fast fourier transform (fft) was calculated using the pressure data. From the fft it was shown that the pulse jet runs at a frequency of 260 Hz.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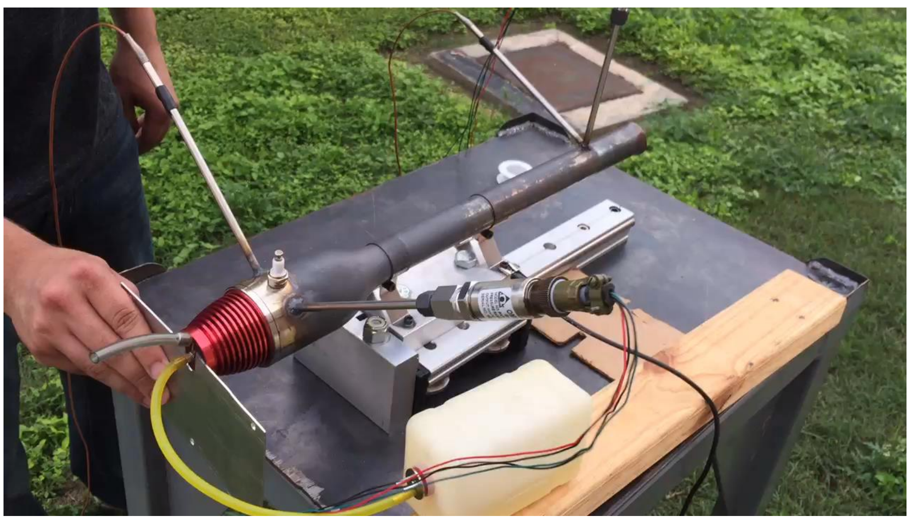

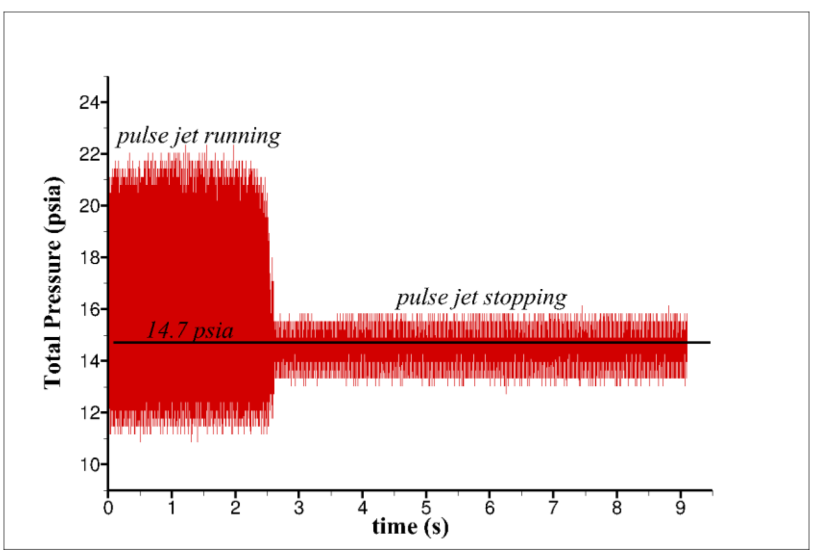
pulse jet running
pulse jet stopping
14.7 psia
Total Pressure (psia)
time (s)
24
22
20
18
16
14
12
10
0
1
2
3
4
5
6
7
8
9