TASK HISTORY	TASK TITLE Flow System Evaluation	TASK NUMBER ISS-TH-H004	PROJECT IREC Hybrid
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Purpose

In order to get more comfortable with the engine and its flow system, the team evaluated the valve that feeds the NOS into the engine. It seemed to be strangling the flow. After rudimentary analysis using provided specifications, it seems that the valve may provide too low of a flow rate. Resolving this issue will allow the engine to operate at full potential and as designed.

Background

The engine has had a seemingly difficult time ever getting enough oxidizer to flow through the whole system. This is notable in the chugging and large amounts of smoke experienced during nearly every hot-fire. It was noticed even more so in the recent hotfires of the engine. According to Rocket Propulsion Analysis, an analysis tool used by the team, the flow rate of oxidizer should be around .42 kg/s. However, from other hotfires, and the data collected, the mass flow rate out of the NOS tank was vastly too low compared to that value. There were also observations made of icing around the feed valve ("Valve A") on the side going toward the engine, whereas there is no ice on the other side, indicating the NOS is liquid on one side and evaporating, pulling in heat from the surroundings, and flowing as a gas. In essence, this valve is a cuck messing up this whole operation.

The Math

These specifications and equations were used:

- Cv: This is a variable of the valve
- SG: Specific gravity, or the ratio of the liquid density of nos at flowing temperatures to water at 15C
- DP: Pressure Drop [psi]
- Q: Flow Rate [gpm]

$$Q = Cv * \sqrt{\frac{DP}{SG}}$$

For the valve, the specifications given said that Cv = .06. SG for the conditions we are at is .786. We need to convert our flow rate from [kg/s] to [gpm]. In order to do this, we need to know the density at the approximate temperatures. Using 20C as the temperature, we can look at saturated liquid/vapor data, where the density is 786 [kg/m^3] (this is also how we found specific gravity). Converting to volumetric flow rate (.4/786) we obtain .0005089 [m^3/s]. This is converted to [gpm] using an online calculator. This is 8.066 [gpm].

Plugging it all in and solving for DP, the pressure drop in [psi], we find that the pressure drop across the valve required for this flow rate is 14204 [psi]. This is absurdly high and wholly impossible with current equipment and will remain impossible to achieve due to technical limitations.

Future Changes

- We need to run this calculation with compressibility taken into account, however it shouldn't change much if we are already at over 14,000 [psi].
- We need to change the valve.
- We need to have a better procedure for this math
- We can use the fluid flow software to simulate this setup.
- We need to gather all the useful resources from this process into a single guide.

Impact Statement

We need to change this valve, and if we do, then we will be doing real rocketry.