TASK HISTORY	TASK TITLE Hybrid Hot Fire	TASK NUMBER ISS-TH-H002	PROJECT IREC Hybrid
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DATE	MILESTONE	REVIEWER'S INITIALS	
5/27/18	1st Unsuccessful Summer Hot Fire 😊	CL	

Purpose

Test 2 fuel grains of 1.75" inner diameter at varying pressures (1200 psi and 1400 psi). The rest of the remaining NOS would be used on a third fuel grain of 1' inner diameter as the team is unsure if there would be a sufficient amount of NOS left for a full fire. Any remaining NOS would be drained so that a base NOS tank weight could be measured. Having a zero weight for the tank would allow us to be sure of the amount of nitrous oxide we have left always.

Background

In preparation for this hot fire, as several of the experienced members had left for the summer, a dry set-up was run to help to ensure that the set up was all completed correctly and efficiently on the day of the hot fire. During the set up several issues were encountered including not being able to get the electronic valves A and B to open or close with the control box/code. This issue was later resolved by rewiring the Arduino but brought a larger issue to light which was whether or not the valves were providing enough gas flow to the system at all. The valves that are currently being used are solenoid valves and have a very small opening that allows the gases to flow. This small opening would potentially cause the NOS pressure to drop significantly before it reaches the engine. Regardless of this discovery, the team planned to continue on with the hot fire as usual and work out the math to evaluate the effectiveness of the valves after the test.

Results

The hot fire was not successful due to a series of issues and ultimately the largest issue being the regulator not reading the helium tank pressure any higher than 100 psi. When the high-pressure regulator was switch outed for the regulator used for pressure casting and using the same dial that was attached to the high-pressure regulator, immediately read a much larger input pressure. For safety, the hot fire was called off as the team did not wasn't to fire the engine without being able to regulate the pressure flow. The other significant issue that the team encountered was the 12V car battery in the control box being at too low of a voltage to power the system. Eventually this was solved by purchasing a car battery charger from Walmart and recharging the battery. After about 30 minutes, the battery was fully charged and reading ta 12V with load. After messing with the pressure system and trying to get the regulator to read the helium tank pressure and having to purge the system through the hand and electronic valves several times, the car battery voltage was around 6V. Nonetheless, this was significantly better than the 3.6V with load reading that the team was reading before charging the battery. The team assessed that car battery's cells may just be going bad, or the battery needs to be more consistently charged as normally car batteries are supplied constant power while functioning. The on anomaly in all of this is the fact that this specific battery has never been charged. It has been used and depleted throughout all the past hot fires, but only reached an unusable limit now. The NOS tank was weighed at 12.59lbs prior to not testing which was consistent with the value measure after the last hot fire on May 13th.

Lessons Learned

- Some items were forgotten to be added to the checklist so then were also forgotten while packing up. These items are now added to the update HRE Hot Fire Checklist
- The entire pressure system needs to be reevaluated with a specific focus on the valves that are currently in use. Several calculations need to be done on the system to ensure that the pressure input to the engine is sufficient to provide enough thrust to fly the rocket of a project 12' length and 60lbs size to 10k ft.
- The control box battery needs to be revaluated or at least improved as the team cannot fire with a car battery that's running under 5V with load. This could cause ignition failure or valve opening/closing failure which are both safety risks that the team is not willing to take. The battery could potentially be replaced with lypos or hooked up to a continuously charged system or just more consistently charged or a deep-cycle battery (as recommended by Dalton's father)
- There are still several items that need to be purchased/considered to be purchased listed below:
    - Vice Grips
    - Ratchet Straps x3
    - Blue Putty
    - Relief Valve of 300 psi (for pressure casting safety)
    - A stronger chain for tanks in 18C
    - Gasket for NOS tank
    - Ignitors (First Fire 36" Aerotech from Apogee Rockets)
    - A Power Supply for the Thermocouple
    - Protective Cover for the *Fire* Commit Switch
    - U-bolt for securing the engine to test stand (threads are messed up)
- The current procedure for wiring the Arduino is confusing and the team deemed it worthwhile to renumber the board in a more logical way so that the Arduino does not get wired incorrectly again and cause unnecessary confusion again.
- The precombuster section seems redundant with the current setup as the injector does not have holes drilled into sides to allow the oxidizer to flow directly to the precombuster grain anyway. This could be unnecessary as the precombuster grain does seem to burn during each fire, but the reasoning for the precombuster section of the engine should be looked into/explained by a previous hybrid member.

Impact Statement

Formal procedures still need to be written to increase the hot fire setup efficiency and safety. The pressure system setup and the high-pressure regulator need to be evaluated before the next hot fire. A lot of math needs to be done to evaluate and optimize the current system, but no major changes should take place without consulting some of the past dedicated hybrid members to ensure that we are not repeating something that they had already tried to implement in the past.