Hybrid Meeting Minutes August 3rd, 2003



In Attendance: Vernon Blomquist, Jim Cloer, Brian O'Neel, Jim Ward

Topics Discussed:

We discussed the preliminary gaseous oxygen prototype. Brian calculated initial grain geometry on a spread sheet using Stanford's regression rate formula for paraffin and sized the prototype at 50 lbs of thrust to keep things economical. A preliminary hand drawing of motor layout was done by Brian and then revised by Jim W. in CAD. Another revision will be done today after discussing O-ring seal placement and fasteners.

Aluminum was chosen as the combustion chamber material in order to evaluate the thermal issues associated with the material since this (6061 T6) will most likely be used in a LOX/Paraffin flight article hybrid. This seems like the appropriate time to start addressing any problem with structural integrity due to heating.

The current design will directly expose the injector plate to the combustion chamber gases therefore stainless steel was selected for this portion. The exact configuration of the injector needs to be decided though the eventual design will most likely not be representative of the final LOX injector since atomization will be more of an issue. Also Jim C. will look into to possibility of using brass instead of stainless for the actual injector.

Casting or pouring of the paraffin was tossed about and it was decided to make the propellant section integral with the graphite nozzle and graphite sleeve insulator/ premix chamber. Once cast this entire assembly would slide into the

combustion chamber then only the ends (nozzle retainer and injector plate) would need to be bolted on.

Ignition of the paraffin was debated. To attempt to keep things as simple as possible for the prototype it was decided to try a simple electric match igniter with a solid AP/HTPB booster ring that could be embedded in the forward section of the paraffin. This may or may not work but we figured it would be simpler to implement than a 3rd gas to initiate combustion or a small solid propellant rocket motor that would increase the complexity of the manufacturing of the injector side of the motor.

Inspired by a linear bearing static test stand used at Penn State University (AIAA2001-3535) we came up with a design for our stand that will incorporate a breakaway load cell and motor stop that will hopefully save our load cell in the event of motor failure. Jim W. is working up this design.

The current preliminary design still needs to be verified with the appropriate factors of safety applied to the pressure vessel, bolted and welded connections and any shortcomings corrected.

In addition we all committed to spending some more time reviewing the current state of the art for hybrids and many of the past technical papers written on both LOX/Paraffin and LOX/HTPB hybrids as well as Sutton's Chapter on Hybrids.

Next Hybrid Meeting will be in 2 weeks. During the interim design on the static test stand will continue. Revisions to the prototype motor design incorporating safety analysis findings. Also roughing out of raw materials for combustion chamber will commence and various components selections will be researched.

To Do List:

- Pressure vessel analysis
- Bolted connection analysis
- Weld analysis
- Nozzle design Throat dia, exit dia., converging and diverging angles, O-ring placement
- Injector Design Simple orifice, pintle, swirling, impinging doublet, (stainless steel or brass)?
- Calculate maximum flow rate give Cv for '42 series' Parker solenoid and Spartan Scientific solenoid valves.
- Grain jig layout for pouring paraffin.
- Research oxygen and nitrogen feed lines Braided stainless steel? Look at different connectors and how they can adapt to the solenoid valves

Action Items:

Vernon Blomquist:	Verification Spread sheet of motor design using Stanford's numbers.
Jim Cloer:	Researching injector design Researching possibility of mating Swagelok connectors to NPT connectors
Brian O'Neel:	Create plumbing diagram Formal write up and spread sheet used for preliminary design Machine combustion chamber flanges and injector plate Post valve data sheets on Twiki
Jim Ward:	Update preliminary gox/paraffin motor drawing Acquire load cell and research appropriate pressure transducer

Need to add to website:

GOX/Paraffin and LOX/Paraffin pages General specifications CAD drawings, dimensions, tolerances, materials Test Stand Parts list and data sheets