Gaseous Hybrid Plumbing Layout ver2.1

Combustion Chamber

Physical Barrier

3' 1500 psi stainless steel braided hose

Check Valve

12v Battery

Nitrogen Purge Solenoid

Driver Interface

FlexTek Controller

Metering Orifice

Actuator Solenoid

Pneumatic Actuator

Oxygen Ball Valve

Control Computer

Manual Purge Valve

12' 100 psi line

Manual Purge Valve

25' 1500 psi stainless steel braided hose

Flow Gauge Regulator

2 Stage Regulator

40 cu ft

Nitrogen Cylinder

150 cu ft.

GOX Cylinder

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Theory of Operation:

The gaseous oxygen/paraffin hybrid is fairly simple. The control of the static firing sequence will be done with a laptop computer running a small script that will communicate out a serial port to a 'Flextek' I/O board. This board is capable of data collection through several 10-bit A/D channels and the board is also capable of triggering single events through several digital output channels.

At T-2second the control board will signal the igniter to start. This signal will switch an IPS5451 intelligent power switch, which will dump a larger voltage and current to the igniter from a 12v battery.

Immediately after igniter start the control board will signal the actuator solenoid IPS5451 switch. The MOSFET switch will channel power from the 12v battery to the actuator solenoid, the actuator solenoid will in turn switch on the 80psi gaseous nitrogen source to the pneumatic actuator. The pneumatic actuator turns a stainless steel ball valve, which will turn on the gaseous oxygen source to the motor.

The gaseous oxygen flow, once started, will travel from the ball valve through the metering orifice. This is a small flat plate style orifice that will regulate the flow through it to the exact volume needed to react with the paraffin for optimal combustion. Once the oxygen flows through the metering orifice it will go through check valve that will protect the oxygen plumbing system in the event of an over-pressurization situation in the combustion chamber.

The gaseous oxygen will then be injected into the combustion chamber through a brass injector/diffuser that insures the oxygen will be turbulent and not have a large velocity down the central port of the paraffin fuel grain.

The motor should burn for approximately 10 seconds at 50 lbf of thrust.

The controller will handle burn termination by de-energizing the actuator solenoid. This will cause the pneumatic actuator to lose pressure and therefore close the ball valve.

Once oxygen flow has been halted the controller will switch another IPS5451 intelligent power switch. This power switch will provide power from the 12v battery to the nitrogen purge solenoid, which will open the flow of nitrogen from the source. The nitrogen will then flow through the check valve and then into the combustion chamber.

The nitrogen will serve two functions. The first is to extinguish the motor from any residual burning from oxygen still in the system or air coming back into the combustion chamber through the nozzle. Second is to cool the graphite nozzle after firing to hopefully reduce the possible effects of stored heat in the graphite further melting the remaining paraffin in the combustion chamber. We would like to keep the paraffin undamaged after firing so we can do a post-mortem analysis to look at the regression.

Once the system has finished firing and purging and is deemed safe the excess pressurized oxygen and nitrogen stored in the 12' and 25' feed lines can be discharged thorough the manual purge valves.

Once the system has cooled. We can remove the forward nozzle-retaining flange and remove the spent fuel and nozzle and replace it with a new nozzle and fuel grain and refire.

Component Details:

Name	Description	Data
Laptop computer	Toshiba Portege 660CDT (P166Mhz)	
I/O board	FC1F010 FlexController	http://www.flex-tek.com/FTman10.pdf
12v battery	Elk sealed lead-acid 12v 8.0Ah	
Actuator solenoid	Spartan Scientific 12vdc 3823 series	http://www.spartanscientific.com/file_management/3800.pdf
Nitrogen source	40 cu.ft. nitrogen tank	
Pneumatic actuator	PAS-180	http://www.contromatics.com/ACT UATOR/F-PA/FPA.HTM
Oxygen source	150 cu.ft. Oxygen tank	
Oxygen check valve	Swagelok SS-8C-VCR-1	http://www.swagelok.com/downloads/webcatalogs/MS-01-176.PDF
Injector/Diffuser	Brass fitting with diffuser holes drilled @45 deg.	
Nitrogen purge solenoid	Predyne 12vdc solenoid with ¼" NPT fittings	http://www.predyne.com/series/d.asp
Nitrogen check valve	Swagelok SS-8C-VCR-1	http://www.swagelok.com/downloads/webcatalogs/MS-01-176.PDF
Manual purge valves	Nupro SS-4P4T2	http://www.swagelok.com/downloads/webcatalogs/MS-01-59.pdf
Oxygen Regulator	Tescom Model #44-1116-24	http://www.tescom.com/images/pdf/catalog/icd/44-1100s.pdf
Nitrogen Regulator	Smith H1103B Flowmeter	
Nitrogen, Oxygen solenoid and igniter switches	IPS 5451	http://www.irf.com/product-info/datasheets/data/ips5451.pdf