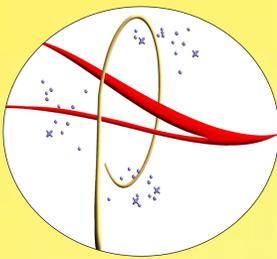




# Tri-Gas Thruster Testing



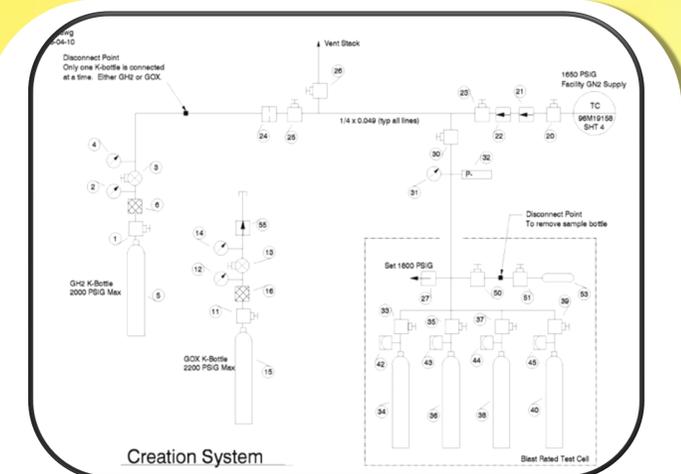
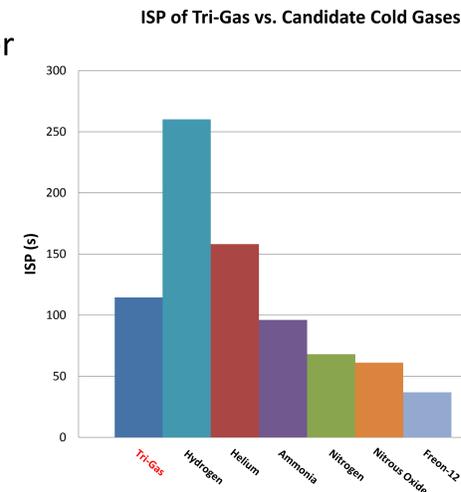
John Brendel (Iowa State University) Sarah Isert (Utah State University)  
Matthew Kuhn (Carnegie Mellon University) Brandie Rhodes (University of Kansas)

## Summary

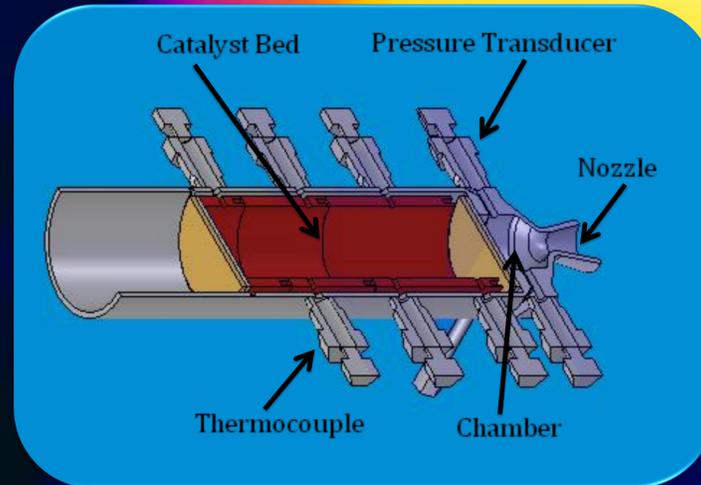
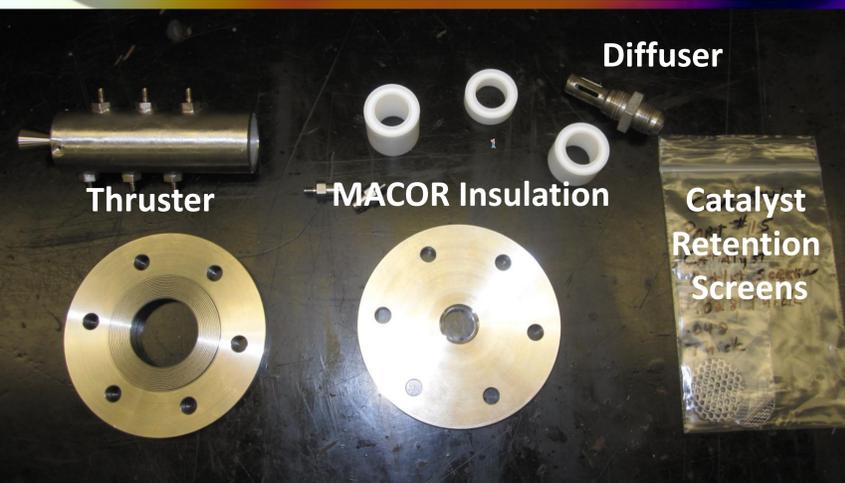
- **Tri-Gas:** Composed of three gases: hydrogen, oxygen, and nitrogen
  - This project uses **92% nitrogen, 5.33 percent hydrogen, and 2.66% oxygen**
  - Mixed in these ratios, **Tri-Gas is inert**
- **Tri-Gas Thruster:** Small rocket thruster where Tri-Gas gas is passed through a catalyst bed, heats up, and expands through a nozzle to produce thrust
- This project designed a Tri-Gas creation procedure and rig, the thruster test procedure and rig, and performed analysis on the constituent parts.

## Advantages of Tri-Gas Thrusters

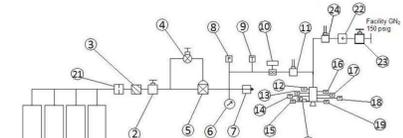
- ❖ Cold gas thrusters are currently used for space craft attitude control
- ❖ Specific Impulse (ISP) improves with an increase of gas temperature
- ❖ Tri-Gas thrusters obtain higher temperatures by catalysing the reaction between oxygen and hydrogen
- ❖ The products of the catalytic reaction heat up the exiting gas, increasing ISP



- Tri-Gas creation rig designed as part of the project
- Allows creation of Tri-Gas with various gas H2, O2, N2 percentages



Tri-Gas Thruster Test Rig



Test Rig Schematic

## Test Variables

- Catalyst type effect on **exit temperature**
  - **Platinum** or **Palladium** coated alumina
- **Inlet/chamber pressures** effect on ISP
- **Catalyst bed length** effect on exit temperature
- Effect of **catalyst bed starting temperature** on time to reach steady state conditions
- On all tests catalyst bed **temperature profile** and pressure drop across catalyst bed will be recorded

## Test Rig Design

### Safety

- ❖ Sizing a flow limiting orifice to meet relief valve criteria
- ❖ Determining Tri-Gas feed tubing diameter to minimize pressure drop
- ❖ Over-pressure safety calculations for thruster body rupture
- ❖ Heat transfer analysis to estimate thruster cooling time

### Data Acquisition

- ❖ Two Pressure transducers to determine pressure drop through the catalyst bed and chamber pressure
- ❖ Six thermocouples evenly spaced throughout the catalyst bed to measure temperature profile
- ❖ FLIR Camera for thermal imaging

## Acknowledgements

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Randy McGuire	The people who have candy on their desks.

The background picture is a thermal (infrared) image of a k-bottle during the Tri-Gas creation venting process.

