Development and Testing of HTP monopropellant thruster for space applications

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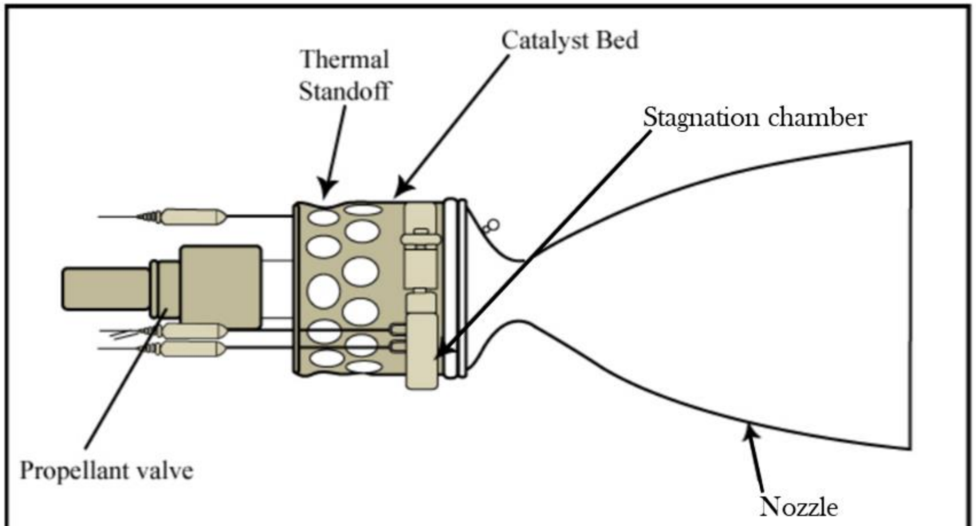
Introduction to Monopropellant Thrusters



Typical monopropellant thruster. (Courtesy Hamilton Standard.)
Image adapted from:
SPACECRAFT PROPULSION, by Ch. D. Brown AIAA Education Series, 1996

- Single propellant flows through a catalyst bed
- Adiabatic decomposition of the propellant creates hot gases
- The decomposition products flow through the nozzle to obtain thrust
- Conventional propellant – Hydrazine (N_2H_4)

Applications of Monopropellant Thrusters

RCS for micro-launcher upper stage

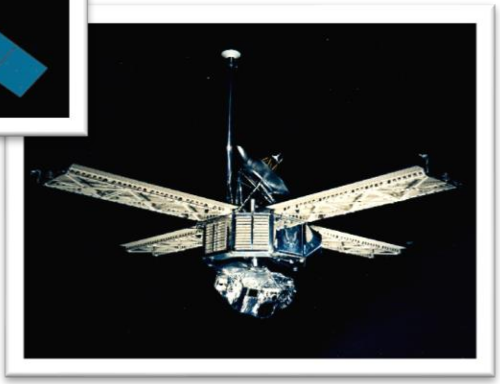
ALTAIR Orbital Module

Satellites or space vehicles maneuvering and de-orbiting

Amos 8

Intelsat

Mariner



Main Characteristics

- Relatively low decomposition temperature
- No thermal protection

  ⇒ **Simple motor structure**

- Stop and restart capability
- Throttling

  ⇒ **Operational versatility**

Technology Readiness Level (TRL)

- Large variety of monopropellant thrusters are available
- Wide range of thrust capabilities
- Most of them are based on hydrazine

5N, Hydrazine

440N, Hydrazine

3100N, Hydrazine

22N, Hydrazine

22N, HAN

Why Hydrogen Peroxide?

HTP (High Test Peroxide), concentration > 80%

$$H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2 + 98\ kJ/mol$$

- “Green” propellant, reduced pollution and toxicity
- Safety during handling, manufacturing and testing
- Storable at room temperature

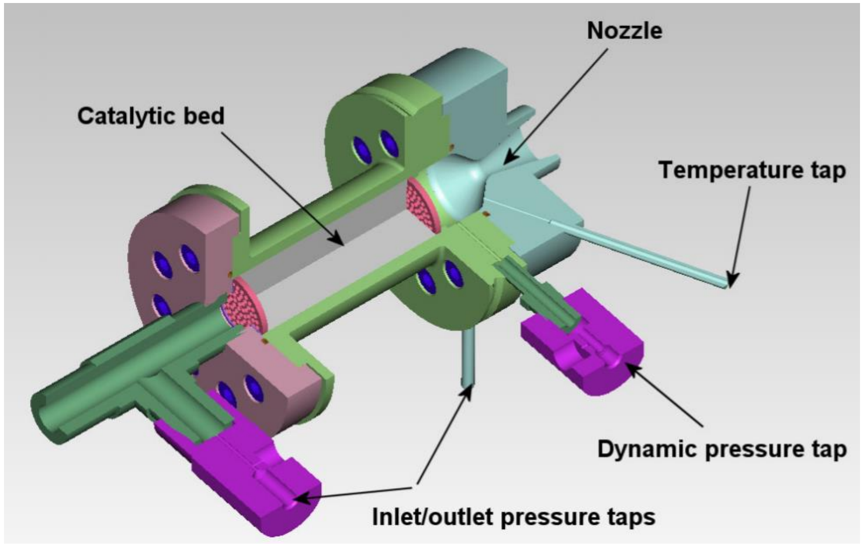
  ⇒ **Low operative cost**

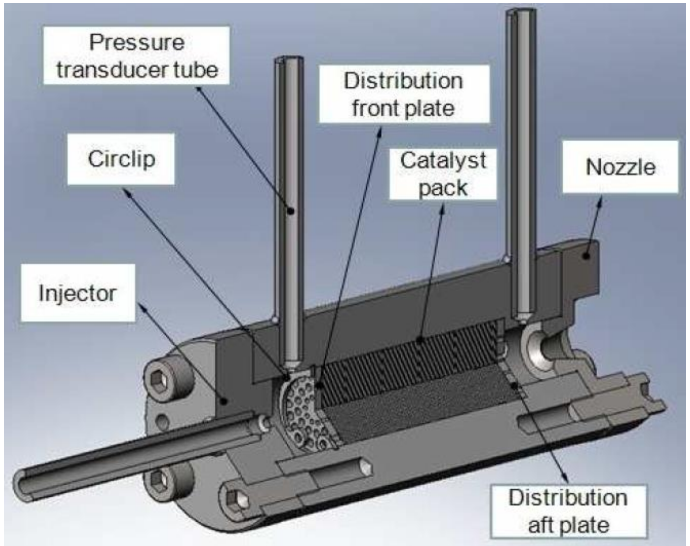
- High volumetric specific impulse

  ⇒ **Compatible for space applications**

HTP Monopropellant Thrusters

- Growing interest in the use of “green” propellants, leads to an extensive work on the field of HTP propulsion technologies
- Most of this work is based on lab-scale design thrusters
- In this research, the goal is to improve TRL of HTP monopropellant thruster

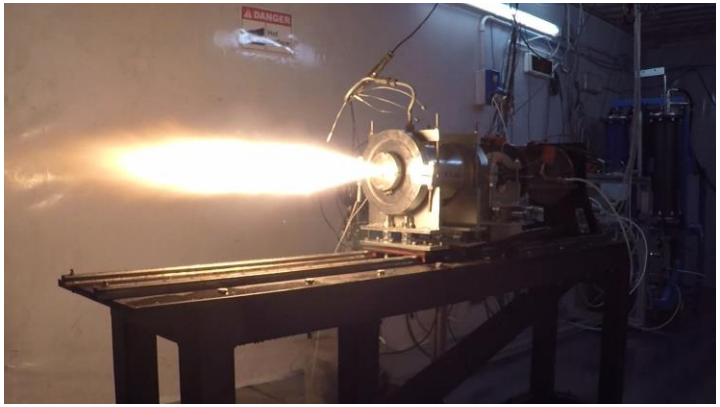




PhD Activity

- Development of a flight-design thruster
- Fire tests
- Motor scaling tests

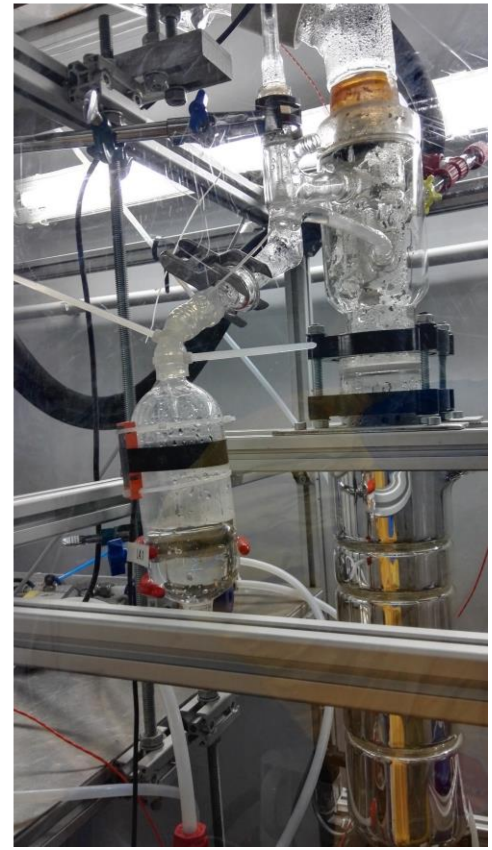
- Achievements:
  - ➢ High efficiency
  - ➢ Short response time
  - ➢ Weight and volume optimization



Propulsion Group Test Capability

Equipped Test Facility

Test Bed



HTP Concentrator

PhD Activity

Level	Work Package	Hours	1st Year				2nd Year				3rd Year			
1.0	**Bibliographic Research**	**210**	**150**	**60**										
1.1	State of the Art Research	70	70											
1.2	Methods of Numerical Analysis	70	40	30										
1.3	Methods of Experimental Analysis	70	40	30										
2.0	**Numerical Investigation**	**1200**	**150**	**250**	**330**	**270**	**200**							
2.1	Motor design	150	100	50										
2.2	Injector Design	150	50	100										
2.3	Thermal Analysis	150		100	50									
2.4	Test Matrix	350			200	150								
2.5	Data Analysis	300			80	120	100							
2.6	Numerical Correleation	100					100							
3.0	**Experimental Activity**	**700**					**100**	**350**	**250**					
3.1	Experimental Set-up	250					100	150						
3.2	Test Matrix	300						150	150					
3.3	Data Analysis and Validation	150						50	100					
4.0	**Motor Scaling Test**	**950**							**100**	**270**	**330**	**250**		
4.1	Up-Scaled Motor Design and Analysis	300							100	200				
4.2	Experimental Set-up	100								70	30			
4.3	Test Matrix	350									250	100		
4.4	Data Analysis and Validation	150									50	100		
4.5	Experimental Correleation	50										50		
5.0	**Exploitation**	**100**											**100**	
5.1	Spacecraft / Satellite Attitude Control and Main Propulsion System	50											50	
5.2	Engine Comparison / Market Analysis	50											50	
6.0	**Thsis and Documentation**	**600**				**50**				**50**		**100**	**200**	**200**
	Total Hours	**3760**	**1260**				**1320**				**1180**			

Thank you for your attention

Any questions?