ESA overview of Fluidic Passivation State of the Art and available passivation valves

TEC-MPC (Presenter: A.Gernoth)

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Passivation

ISO 24113 is stating:

6.2.2 Accidental break-ups

6.2.2.1 The probability of accidental break-up of a spacecraft or launch vehicle orbital stage shall be no greater than 10−3 until its end of life.

6.2.2.2 The determination of accidental break-up probability shall quantitatively consider all known failure modes for the release of stored energy, excluding those from external sources such as impacts with space debris and meteoroids.

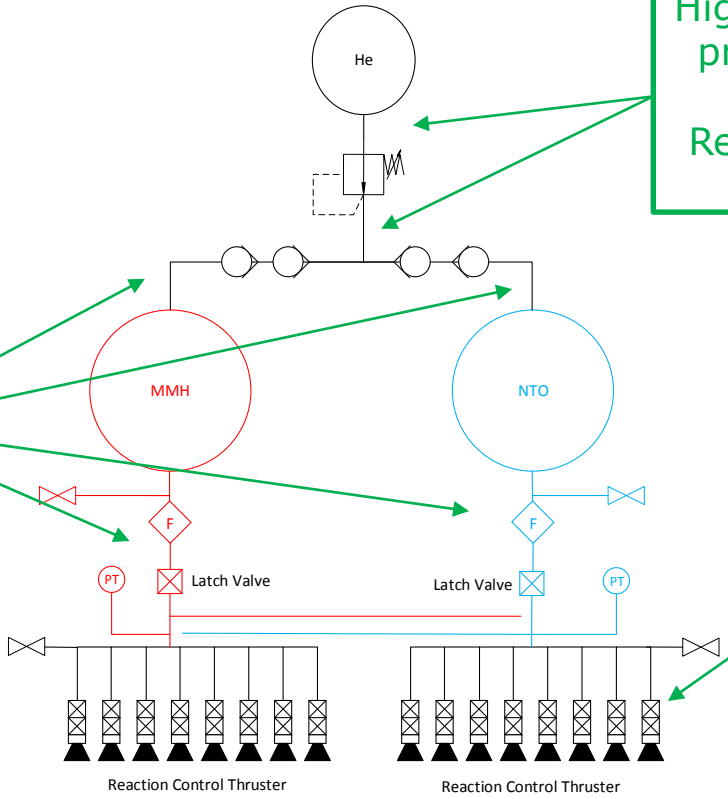
6.2.2.3 During the disposal phase, a spacecraft or launch vehicle orbital stage shall permanently deplete or make safe all remaining on-board sources of stored energy in a controlled sequence.

Bipropulsion system – Places and areas for passivation

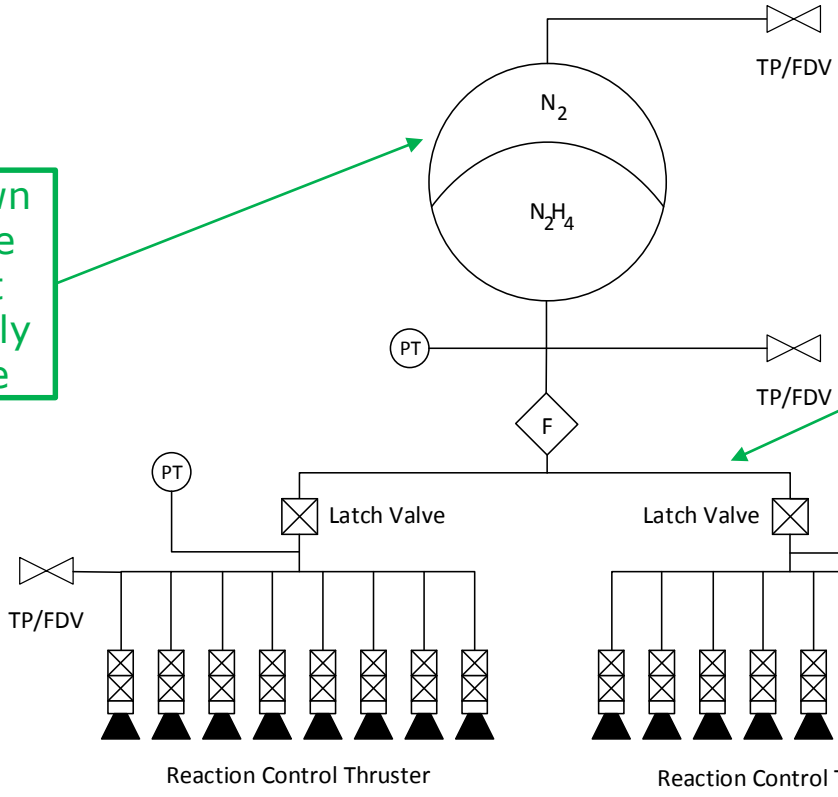
High pressure or low pressure option → Thrust/ Reliability/Pressure level

Propellant impact assessment needed, but overall entire passivation possible.

Partial Passivation using thruster at EOL → Residuals of the system to be assessed



Monopropulsion system



Passivation down to low pressure for pressurant side and possibly propellant side

Passivation of propellant side down to lowest possible level

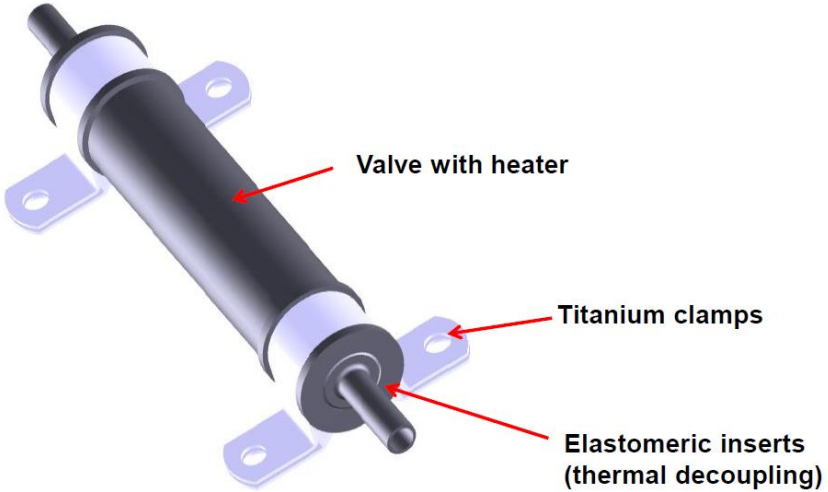
Reduction of pressure to nearly empty level

Passivation valves– Main requirements

1. Lifetime: The valve should for passivation of Helium (after closing the pressurization system) has only to work for a few month (including storage time)
2. Propellant compatibility: Passivating the entire system needs the valve to work in the propellant or under propellant vapour conditions
3. Reliability: This valve has to fulfill the reliability figure and it has to be designed in such a way that it stays permanently open. This means that the valve has to be as simple as possible to minimize any kind of failure on board.
4. Leakage allowed during mission lifetime: **None**

Passivation valves for MMH/NTO ArianeGroup

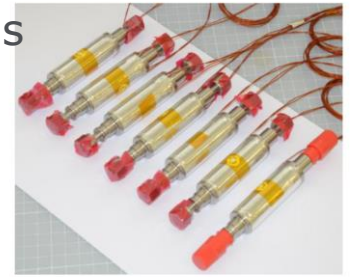
SMA valve from ArianeGroup (currently running Qualification in ARTES)



Qualification for Pressurant and Propellants MMH & NTO

Single shot valve for passivation

Lifetime not limited by Squibs and corresponding substances



Single shot of flight like EM valves (2015)

http://epic-src.eu/wp-content/uploads/21_EPICWorkshop2017_ARIANEGROUP_2017-10-25-SMA-Presentation_EPIC.pdf

Current valves under development/qualification von Hoerner & Sulger

Small passivation valve to use as venting device as well

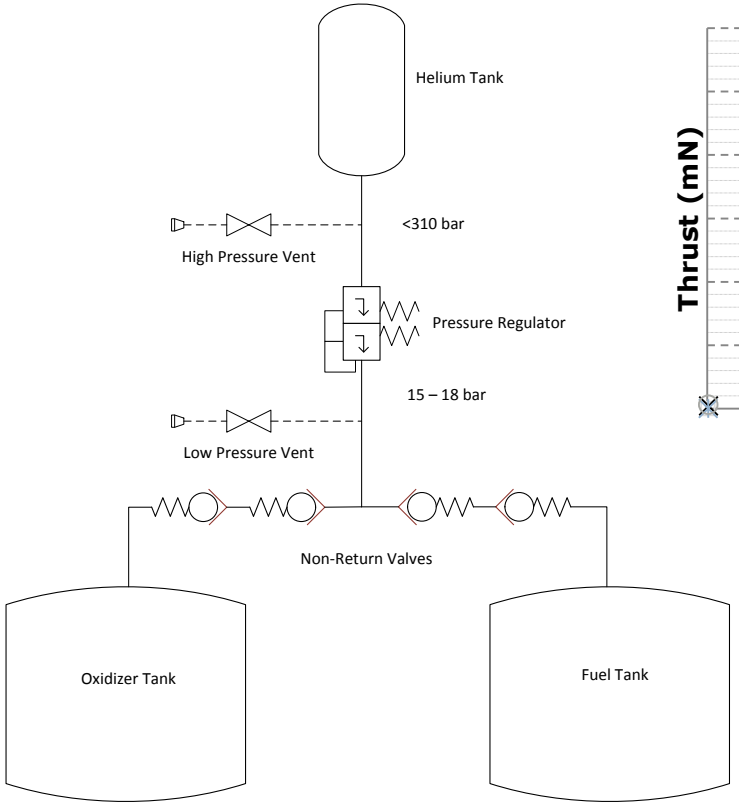
Intention is to develop this valve for the pressurant side.

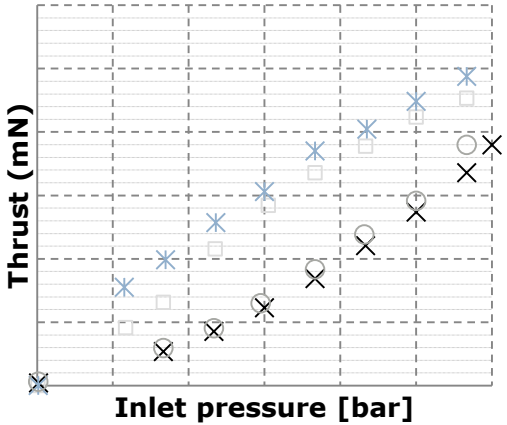
Lightweight equipment (less than 10g)

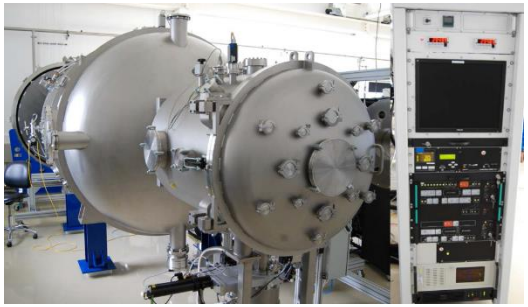
Hermetic Miniature Single-Shot Valve

https://vh-s.de/space/developments/moma/

Venting and passivation of Helium







Propellant need for unbalanced passivation

Current valves under development/qualification Lacroix/CNES

Different configurations for different pressure levels

Less than 95g

Designed for a wide range of media

Extended life time demonstrated in Qualification up to 28.5yrs

Firing in hydrazine vapour and hydrazine liquid are planned as well

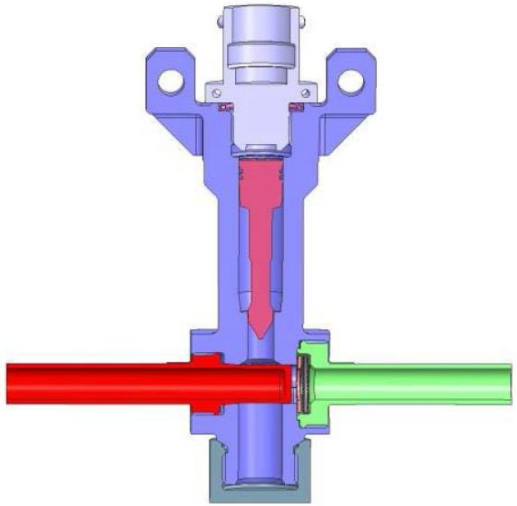


Figure 2: Cut view of the µperforator

Initial application is the passivation of the pressurant side, not the propellant side

µPERFORATOR, A SOLUTION FOR FLUIDIC PASSIVATION

Marine Petrantoni(1), Nicolas Bocquillon(1), Denis Dilhan(2)

Space Propulsion 2018

Pyro valve squibs

Pyro valve squibs are impacted by REACH (currently squibs to be used until 2027)

New powder in development

Testing ongoing, not only to get a valve for passivation but also for long term missions (e.g. JUICE)

ArianeGroup Gmbh
pyrotechnics valve simulator

http://blogs.esa.int/cleanspace/2017/12/15/reach-treatment-of-pyrotechnics-initiators/

Comparison of valve types: Non-exhaustive and only intended as overview for this presentation

	SMA valve	MOMA	Microperforator	Pyro
Pyro shock	+	+	-	-
Short power consumption needed	-	-	+	+
Lifetime	+	+	+	0
Usage as venting device	-	+	-	-
Total passivation possible	+	-	+	+
Other usage	+	-	-	+

Conclusion

Passivation of the spacecraft would mean

- Total passivation of helium as well as the propellants to permanently deplete all possible sources. Testing of the valve in propellants is therefore mandatory
- Current ongoing developments are focusing on a combination of at least two equipments or on the focus on replacing current available valves (SMA valve as replacement for pyrovalves). But also development and qualification to maintain valve capabilities (pyro valves) are ongoing.
- Valve design is chosen based on the system requirements and trade-off's, no valve design is the "Best"
- Currently (public available information) no valve design is qualified for usage in the pressurant side as well as the propellant side to achieve the passivation of the entire system → Needs to be closed as soon as possible!

Thanks to all members of TEC-MPC and to all contributors to this presentation