Application of Green Propulsion Systems Using Rocket Motors and Gas Generators with Gelled Propellants

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Gelled propellant rocket motor (GRM) technology development started in Germany in 2000 and lead to two perfectly successful demonstration flights of a throttleable rocket motor burning a gelled monopropellant in December 2009 [1]. Since then work is going on to improve the functional and performance parameters of GRM and gelled propellant gas generators (GGG). This lead to different sizes of combustion chambers based on a demonstrated good scalability of the combustion process between 300 and 6000 N nominal thrust, a family of tested gelled monopropellants with different fuels, gelling agents and additives for different applications and an excellent capability to modulate the thrust very rapidly by maintaining a very stable combustion [2].

A known feature of gelled propellants (GP) is the significantly reduced hazard potential in each respect. In case of accidents, there is no spillage in case of leakage or perforation of the tanks, and gels have much lower vapour pressure than liquid fuels and hence a significantly lower evaporation rate in case of destruction of the tank. In addition, the monopropellant propulsion system described in this paper is a “green propellant” as far as storable propellants can be “green”: We have a very low degree of toxicity, no corrosivity and no acid gas components. In fact, you can hold the GP on your bare hand without suffering harm. In effect, the GRM developed in Germany has an excellent potential to substitute Hydrazine-based propulsion systems for specific applications.

An other advantage of GPs is that solid particles can be suspended without the risk of sedimentation during long storage times. This increases the density and particularly the $I_{spec,vol}$ of the propellant, but increases the production of smoke if metal particles are used.

Since the current state of GRM / GGG technology is presented in an other paper [1], this paper will give only a brief introduction into the state and particularities of the monopropellant GRM / GGG technology.

The main body of the paper outlines some promising applications of GRMs and GGGs. Significant advantages of this technology are expected in cases where:

- The manufacturing, transport, storage and handling operations represent not just a negligible part of the life cycle cost of a propulsion system
- A highly tunable and stable burning rocket motor is needed
- A low hazard potential in terms of impact on safety and environment is required
- Toxic and / or corrosive gases cannot be tolerated
- Long burning times have to be covered

The examples cover tunable upper stages and orbital insert stages, attitude and roll control motors for large launcher stages and propulsion systems for landing vehicles.

A summary will give some ideas on the further development of GRM /GGG technology and the way towards the realization of the described concepts.

References

1 K. Schmid, J. Ramsel, K.W. Naumann, R. Stierle; “Raketenmotore mit Gel-Treibstoffen – Stand der Technologie bei Bayern-Chemie”, *Deutscher Luft- und Raumfahrtkongress 2012*, Berlin., Germany, September 10-12, 2012

2 P. Caldas Pinto, J. Ramsel, K. Schmid, K. W. Naumann, H. Niedermaier, A. Thumann; “Control Characteristics of a Gel Propellant Throtteable Rocket Motor” Abstract submittet to 5th European Conference for Aeronautica and Space Sciences Munich, Germany, 1 – 5 –July 2013