

Propellants beyond Xenon for Radio Frequency Ion thruster operation

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Abstract

In the early times of ion propulsion mercury and caesium were the standard propellants. In respect to the propulsion requirements both have advantageous properties:

- The high atomic mass provides an excellent power to thrust ratio.
- The ionisation threshold is low. Together with the high ionisation cross section the ionisation is very effective.
- The propellant is easy to store

Nevertheless, mercury as well as caesium are fully replaced by the noble gas xenon.

- Mercury and caesium are highly reactive with surfaces. Especially spacecraft's solar panels might be spoiled by contamination with these elements.
- Both propellants have to be vaporised before they come into a thruster's discharge chamber.
- Contamination of people during the manufacturing and spacecraft integration lead to severe illness or death.

All these problems are overcome by the use of xenon. For common earth orbital applications performed by ion propulsion xenon is now well established. Also other electric propulsion concepts (SPT) take advantage of this propellant.

Nevertheless, for some applications alternative propellants might be very interesting to:

- For an increased specific impulse capability, the use of propellants of lower atomic mass might be advantageous.
- For large missions, the demand of xenon might exceed the world wide production capabilities.
- For return missions, the use of gas available on the target might be also under consideration.

The cathodeless radio-frequency principle enables operation with nearly any propellant. Up to now, RIT (Radio Frequency Ion Thruster) engines are successfully operated with Xe, Kr, Ar, and Ne. The related ion sources RIM for material modification are also under operation with a number of reactive gases too.

The proposed paper shall describe the principle influence of the selection of the propellant on a radio-frequency ion propulsion system, a selection of experimental investigations and an outlook to further applications.