

Development of IPPLM's krypton HET

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Since the first launch on board of the Russian satellite of Meteor series Hall effect thruster (HET) has become a serious competitor for the classic rocket technology as far as station keeping and positioning, orbit rising or even deep space mission driving is concerned. Despite of the fact that lasting more than 50 years development of HET resulted in the matured and well optimized design, there is still a need to resolve such issues as mission economy (e.g. in terms of mass budget, duration and overall costs), thruster miniaturization, throttling and extension of the thruster lifetime which is limited mostly due to erosion of the discharge channel. In response to these problems, increasing thruster specific impulse, modification of magnetic field topography and the use of various propellants have been suggested. For the new implementations (scaled-up or down) the well known SPT-100 flight model is regarded as a state-of-the-art reference HET. The majority of these implementations use xenon which is an almost perfect but extremely scarce in the Earth's atmosphere and consequently expensive propellant, what makes searching for other thruster driving materials an urgent need. On the other hand, operating a HET with a noble gas has so many advantages that krypton is considered as an indeed attractive alternative propellant, in spite of its slightly less favorable propulsive characteristics than those of xenon. Here, higher ionization energy, smaller ionization cross section and lower atomic mass could be mentioned however, the indisputable advantage of krypton is its price which is several times lower than the cost of xenon.

Even though the use of krypton propellant to feed a HET has been already investigated for more than 15 years in several laboratories, usually the experiments were performed with thrusters optimized for xenon. In the Institute of Plasma Physics and Laser Microfusion (IPPLM) it was decided to kick-off electric propulsion (EP) studies by designing of a new 0.5 kW-class HET dedicated to operate primarily with krypton. This new thruster was geared as a laboratory/research model aiming at assessment of krypton as a propellant for relatively small HET and compare its performance in relevance to xenon. Therefore, keeping in mind the operation of current thruster mostly with krypton, such problems as increased heat loads and magnetic field topography were addressed from the ground-up of the design phase. Extensive modeling with simulating tools for temperature distribution in the thruster body and B-field topography prediction were performed. Additionally, the parametric calculation with time dependent 1D hydrodynamic code for thruster characterization were completed for both gases. Within the frame of ESA/PECS project (under the acronym KLIMIT - Krypton Large Impulse Thruster) three subsequent versions of the thruster were designed and tested for its gradual improvement. The final version of the thruster appeared to be thermally steady and operated stably for both propellants as long as it was necessary. In the paper the guidelines for the design, its optimization, results of modeling, testing procedure as well as resulted characteristics of the thruster as measured in ESA/ESTEC and IPPLM's laboratories will be presented.

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