IONIC LIQUIDS AS LUBRICANTS FOR STEEL-STEEL CONTACTS IN SPACE DEVICES

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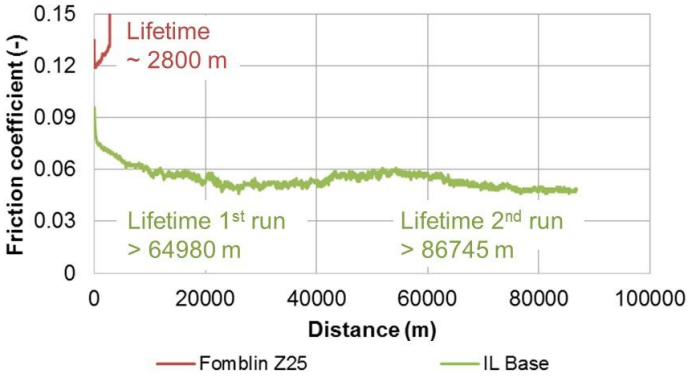
ABSTRACT
Modern television, navigation, weather forecasts and many other aspects of our everyday lives would not be possible without satellites. Space devices contain a number of tribosystems, among others precision roller bearings, actuators, and gears. 'Extraterrestrial tribology' therefore has a great influence on daily life.

For lubrication in space, typical solid lubricants are MoS_2 coatings and common liquid lubricants are based on perfluorinated polyethers (PFPE), e.g., Fomblin Z25, and multiply alkylated cyclopentanes (MAC), e.g., Pennzane 2001A. Ionic liquids, i.e., room temperature molten salts that are liquid at 25°C, are seen as candidates for vacuum and space lubricants as they offer some unique properties [1, 2]: low volatility due to their ionic nature, fluidity over a wide temperature range, and beneficial tribological properties.

The ionic liquid 1-butyl-1-methyl-pyrrolidinium bis(trifluoromethylsulfonyl)imide (IL Base) was benchmarked against PFPE Fomblin Z25 comprising the most crucial requirements: thermal outgassing due to evaporation or decomposition in thermal vacuum, corrosion protection on the ground, friction and wear performance in vacuum comprising endurance tests. The ionic liquid outperformed the reference Fomblin Z25 in vacuum stability and tribological performance as well as lifetime, the latter by a factor larger than 30 (see Fig. 1). The runs with IL Base were stopped manually as no failure of lubrication could be observed.

Ionic liquids can be envisioned to become the third pillar of space and vacuum lubrication besides PFPE and MAC. Their unique properties – i.e., low if any vapour pressure, excellent thermal and oxidative stability, good viscosity-temperature properties, load carrying behaviour, and the ability to develop customized formulations due to selection of cation and anion – make them candidates for lubricants for space.

Fig.1 Friction and distances covered by Fomblin Z25 and IL Base in lifetime runs



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