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SPACE PROPULSION SYMPOSIUM (C4)
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SPACE PROPULSION ROCKET ENGINES: WHERE IS THE PROGRESS?

Abstract

Propulsion technologies used in space-oriented programs aim to deliver missions to explore the near space (Earth's orbit) and the outer space (Moon, planets, and beyond). They can be framed following three different categories: "escape propulsion" (from Earth to orbit), "in space propulsion" (in orbit), and "deep space propulsion" (from orbit to outer space). The launch vehicles currently used for "escape propulsion" relies on very mature technologies, in which only small incremental improvements were made. Breakthroughs in this kind of propulsion do not seem to be on the near horizon; yet, developing propulsion technologies that have the potential to dramatically reduce total cost and to increase the reliability and safety of access to space will require a significant amount of time and financial investments in research and development. Nowadays, as evidenced by researched data from space agencies, the propulsion system can be responsible for over 50% of failures when launching vehicles. The reason is that rocket propulsion system is very complex for both solid and liquid propulsions; moreover, in some cases early detection of a failure source is not so easy. Most of the technological innovations in "escape propulsion" come in small steps, similar to what is seen in the automotive and airline industries. This paper gathered information about the main operational heavy-lift space launch vehicles (capacity over 5,000 kg into GTO) in the United States, Russia, Europe, China, Japan and India. The results show that performance was improved mainly by adding boosters, increasing the weight of gross propellant with larger diameter rocket motors and using more efficient liquid propellant pairs. The missions planned for delivering satellites into geostationary or circular orbits will be accomplished still with the so-called chemical rockets, perhaps with some advances regarding the discovery of propellant materials with more thrust capability than today, but still based on the old chemical propulsion paradigm. There is also a trend to restrict toxic and pollutant propellants by replacing them with propellants considered environmentally friendly (green propellant). In this case, the only remaining chemical rocket engine would be the liquid oxygen and hydrogen. Moreover it is also analyzed spacecrafts that run into 'in space' and 'deep space', where there are prospects of significant technological advances; however, real progress in interplanetary missions will be possible only if technology changes towards other propulsion types. So, a question worries the authors: why space propulsion development and research seems stagnant? Are there prospects for progress?