IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IP)

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A CONTEMPORARY APPROACH TO PROPULSION SYSTEM FOR AN INTERPLANETARY MISSION TO VENUS

Abstract

Interplanetary missions have always been a field of interest for humans. We ponder upon the questions like: “Did other planets have life earlier?” or “Will we be able to thrive on other planets?” In order answer these we must be able to study the planet’s environment and its conditions. Venus, the hottest planet of our solar system has an atmosphere and can have signs of life on it which is yet to be verified. Here, we present the design of a new propulsion system that would take a payload from LEO to a desired orbit around Venus. We investigate trajectory designs, required thrust, system architecture, main engine and thruster design, propellant selection and feed system parameters required to reach Venus’ orbit. The proposed propulsion system makes use of existing technologies with flight heritage from various missions.

The rocket includes highly efficient main engine and thrusters designed for maximum thrust with an efficiency of 93%. In this, PMD (Piston Metallic Damper) type of piston is used with the newly designed propellant tank. A bipropellant liquid rocket fuel (UDMH and N2O4) with more than 300s of ISP turned out to be ideal for the mission because of its high density, leading to an overall reduction in the mass of the propellant. A certain ratio of oxidizer to fuel in the combustion chamber will yield a maximum performance value, in which the basic stoichiometric combustion equation is as shown C2H8N2 + 2N2O4 -> 2CO2 + 4H2O + 3N2. This fuel has been considered in the picture over the rest due to easier designing of fuel tank, optimum ISP and adequate thrust output. Focusing on the aspect of affordability, mass budgeting gives a prior insight to the mass distribution and optimization of fuel consumption in multiple-staging of the spacecraft. The propellant mass of each stage and the total propellant required was determined with the ideal rocket equation and MATLAB simulation .

The presented research will enable an affordable, efficient and optimized way to realize interplanetary missions with limited resources.