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DEVELOPING A CHARGING SUBSYSTEM FOR THE PUFF ENGINE

Abstract

The magnetic nozzle for the engine of the interplanetary Pulsed Fission-Fusion (PuFF) spacecraft is unique because in addition to providing vehicle thrust it must also charge the engine power system. While there has been preliminary work characterizing how the nozzle will provide vehicle thrust, and optimizing the nozzle design for thrust, little work has been done characterizing how the nozzle will charge engine power banks for continued engine operation. Current literature has suggested that the charging system will utilize the phenomenon of Magnetic Flux Compression for system charging. Current literature also suggests this necessitates seed coils and an impedance-matched transformer. First, a T-equivalent transformer model, and a conventional lumped-parameter circuit model that both can be numerically integrated in MATLAB are proposed and validated. Next, this model is combined with a MATLAB-compatible model for how the currents and inductances in the exhaust plasma plume develop and change with time to power the charging circuit. Then, the combined models are used to determine charging circuit performance, and several trade-study optimizations are run to optimize both the impedance-matching transformer and current-carrying seed coils. This optimization aims to maximize the efficiency of the charging circuit, where the efficiency is characterized by the system gain (energy out divided by energy in). With this analysis, propulsion systems can use this study as a benchmark for less-intrusive magnetic flux compression energy conversion systems, which are more compact and can be easily integrated into propulsion system nozzles.