Development of a magnetic nozzle model for PuFF

Nathan Schilling, Propulsion Research Center, Dr. Jason T. Cassibry, Propulsion Research Center

Overview
One insufficiently developed aspect of the Pulsed Fission-Fusion (PuFF) space propulsion system is the magnetic nozzle subsystem (in red, below)

Fig. 1. PuFF vehicle overview

This subsystem is unique in that in addition to accelerating flow, is also must convert some exhaust energy to electrical energy to run itself.

Impact
Development of a pulse-recharge magnetic nozzle will allow for deep-space travel that is faster, and less expensive.

Explanation
This subsystem is modeled with the variable inductor circuit below. This model allows for impacts to thrust and specific impulse to be determined.

Fig. 2. Pulse-recharging circuit model

Key Findings
First, a simulation was run with $L_2=0$. Current gain was about 10, which is expected from the literature.

Next, a simulation was run with $L_1=L_2=1\mu H$. The blue line is current on the generator side, and the orange line is current on the load side.

Fig. 3. Generator current vs. time

Thrust is reduced from 180 MN to 40 MN and specific impulse is reduced from 4000 sec to 900 sec.

Fig. 4. Generator and load current vs. time

Acknowledgements
The authors would like to thank Dr. Rob Adams for providing technical support during this project. This research was supported by a NASA Space Technology Research Fellowship.