Investigations of Electric Propulsion Systems at ERAU Prescott

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My Team

• Current group of students working on Electric Propulsion (EP) Projects
  • 2 Space Physics Majors, 1 Aerospace Eng. Major

• Designed arcjet thruster based on contemporary designs
  • In the process of optimizing design and operating parameters

• Designing/simulating miniature Hall-effect Thruster
Motivation for Project:

Arcjet Thruster

ERAU already has teams working on the following rocket propulsion types:

- Solid
- Liquid
- Hybrid

NO groups focusing on in-space propulsion

Most rudimentary form of EP: Electrothermal

- Good place to start?

Source: https://crowdfunding.erau.edu/project/1159
Thruster Operation Principles

• We utilize a type of electrothermal thruster known as an **arcjet**
  • Arcjets work by passing a plasma discharge through a propellant gas to heat it, then expand that heated gas through a diverging nozzle\(^1\)

Our arcjet utilizes Nitrogen as propellant, since it is easily stored and virtually harmless for students to work with.
Initial Arcjet Design

- First design utilized open discharge “chamber”
- No nozzle section
- Allowed for easy troubleshooting in early testing
Arcjet Upgrade

Initial Design

New Design

Added constrictor section and diverging nozzle

Support Stand
Technical Difficulties

- After new design, faced issues with electrical grounding
- Easier for arc to travel from bolts to mounting stand than through constrictor

This is NOT ideal
Operational Success

- Isolated entire ground plane for successful tests
- Conducted tests without Boron Nitride insulator section
  - Heat dissipation issues immediately noticeable
- Note the swirling, stabilized plasma sheath around the cathode
- Bright, focused plume
Motivation for Project:

**Hall-Effect Thruster**

- ERAU Prescott’s prized project: EagleSat
  - Undergraduates construct CubeSat that is launched into space (launched aboard Delta II rocket in Nov.)[^3]

- My dream for the project:
  - A student-built satellite with student-designed/built propulsion system
  - Could be used for satellite orbit drag correction

- I’d like to see this be realized via a miniature Hall-Effect Thruster (HET)

Source: [http://prescott.erau.edu/about/labs/axfab-eaglesat/](http://prescott.erau.edu/about/labs/axfab-eaglesat/)
HET Design Progress

- Leaning towards a cylindrical HET design
  - Would use permanent SmCo magnets
  - Reduces power requirements & weight

- My team has used FEMM\(^1\) to simulate the magnetic field strength of a possible thruster design
  - Performed this simply to demonstrate capabilities, and visualization purposes

Source: https://htx.pppl.gov/cylindricals.html
Future Directions

• Nearing initial thrust measurements with the arcjet
• Focusing on the design and construction of a highly-sensitive inverted pendulum thrust stand\(^4\)
• Would like to also obtain sensors/equipment for plume diagnostics
References


QUESTIONS?