BillikenSat-II

The First Bio-Fuel Cell Test Platform for Space

Dr. Sanjay Jayaram
Ben Corrado

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Enzyme catalyzed bio-reaction that produces power in a manner similar to a hydrogen fuel cell or an alkaline battery.
In space?

Human waste is used in bio fuel cell

Astronaut drinks water

Fuel cell produces power and water

GOAL: Proof of concept

CHALLENGES:
- Sizing – Volume, mass
- Pressure Regulation
- Temperature Regulation
- Experimental Verification
Payload

- Able to utilize variety of fuels
- Smaller, lighter flight version
- Large fuel reservoir, resists corrosion
- Good conduction between plates:
  - Gold plating, 4 bolts

- Anode
- Cathode
- Membrane Electrode Assembly (MEA)
- Air Tight Fill Port
- Finished Anode
- Pressurized Chamber
Structure

- Common fasteners used throughout
- Component positions interchangeable
Attitude Control

Geo-Magnetic Lines of Force

Passive Control using Permanent Magnets and Hysteresis Dampers
Potentiostat

- Digital to Analog Converter
- Current to Voltage Amplifier
- Analog to Digital Converter
- Reed Relay
- Reed Relay
- Bio-Fuel Cell

Digital to Analog Converter

Current to Voltage Amplifier

Analog to Digital Converter

Reed Relay

Reed Relay

Bio-Fuel Cell
Fuel Cell Output

**BillikenSat-II:** 20 mW

**Comparison:** A cell phone on average draws 200 mW

**With flow:** 20 mW/cm² is possible ⇒ Cell the size of a small book can power a laptop
Fuel Versatility

Components of Bio-Fuels

Alkaline
Lithium Ion
Urea
Liquid Hydrogen
Methanol
Sugars
Ethanol
Glycerol
Biodiesel

Energy Density (Whr/L)
Communications

- Ground Station
- FSK 433 MHz
- Antennas
- T/R Switch
- Band Pass Filter
- Oscillator
- Melexis TH7122 Transceiver
- External IF IC
- FSK Generator
- RF Power Amplifier
- Band Pass Filter
- Microprocessor

Features:
- IF 10.7 MHz
Antenna

Antenna: Nitinol shape memory alloy

Nylon & Nichrome for deployment

Spiral etching

Silver epoxy for contact
Facilities

1. Ground Station
   - Software: NOVA
   - Antenna:
     Model 436CP42 U/G Yagi
     Beam-width 21° circular

2. Clean Room
   - Vertical Flow
   - Soft Wall
Students Involved

- **AEROSPACE SENIORS:**
  - Nathaniel Clark
  - Sonia Hernandez
  - Paul Lemon
  - Darren Pais

- **ELECTRICAL SENIORS:**
  - Thamer Bahassan
  - Mac Mills
  - Brian M. Vitale

- **COMPUTER ENGINEERING SENIORS:**
  - Justin Kerber
  - Jorge Moya
  - Elena Nogales

- **DEPT. OF CHEMISTRY GRADUATE STUDENT (PAYLOAD):**
  - Robert L Arechederra

- **JUNIORS:**
  - Ben Corrado (EE)
  - Yusshy Mendoza (ME)

- **SOPHOMORES & FRESMHEN:**
  - Rehan Refai (ME/AE)
  - Daniel Rooney (AE)
  - Nicholas Reder (AE)
  - Brandon Smith (AE)
  - Morgan Quinley (AE)
  - John Woodman (AE)

Questions?
**Power**

- **Solar Array**
  - Sun Light
  - $V_{in} > V_{min}$

- **Battery Array**
  - Diode

- **Unregulated Bus**
  - 3V Bus
  - 5V Bus
  - 7V Bus

- **Battery Chargers**

- **Diode**
Vibrations

- First natural frequency falls within range of frequencies expected on launch
- Deflections are 0.00116 mm