Honeywell’s history of spaceflight

Every U.S. human space mission

80% of all satellite missions
Honeywell products have been on every US human space mission and 80% of all satellite missions.

**Momentum Control**
- Constellation Series RWAs
- Control Moment Gyros
- Small Satellite RWAs
- Momentum Control System

**Satellite Electronics**
- On Board Computers
- Payload Processing
- Solid State Data Storage
- On Board Networks (SpaceVPX, TTE)

**Actuation Mechanisms**
- Thrust Vector Actuation
- Docking System Actuators
- Solar Array Gimbals

**Environmental Control & Life Support Systems**
- Cabin Pressurization Control Systems of N₂/O₂
- Gas & Liquid Flow Control Valves
- Heat exchangers, Pumps, Fans, Sensors
- CO₂ Removal (LiOH, CDRA, CDRILS)
- Oxygen Recovery (Methane Pyrolysis)

**Human Space and Satellite Mission Heritage**

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**Avionics, Navigation & Displays**
- Vehicle Management Computer
- Space Intg GPS/INS (SIGI), FTINU, INCA & RRGU
- C&DH IO products (i.e., PDUs, MDMs etc.)
- Displays & Hand Controls, Control Panels

**Inertial Measurement Units**
- Miniature Inertial Measurement Unit (MIMU)
- Startracker Measurement Unit (StarMU)
- SPIRIT – Satellite IRU/IMU & SRIMU
- High Performance FOG IRU

**Satellite/Payload Systems**
- Secure Communication – QKD, Optical
- Optical Imagery – Visible, IR
- Space Situational Awareness
- Astronomy – Fine pointing

**RF Products**
- LNA Switches
- Beam Forming Networks
- Isolators & Circulators
- TWTA Combiners
- Antennas

**RadHard Microelectronics & Sensors**
- ASICs & Memories
- Mixed Signal Devices
- Magnetic Sensors
- Pressure Sensors

**Magnetic Sensors**

**Pressure Sensors**

**Constellation Series RWAs**

**Control Moment Gyros**

**Small Satellite RWAs**

**Momentum Control System**

**On Board Computers**

**Payload Processing**

**Solid State Data Storage**

**On Board Networks (SpaceVPX, TTE)**

**Thrust Vector Actuation**

**Docking System Actuators**

**Solar Array Gimbals**

**Cabin Pressurization Control Systems of N₂/O₂**

**Gas & Liquid Flow Control Valves**

**Heat exchangers, Pumps, Fans, Sensors**

**CO₂ Removal (LiOH, CDRA, CDRILS)**

**Oxygen Recovery (Methane Pyrolysis)**

**International Space Station**

**Hubble Space Telescope**

**James Webb Telescope**

**Interplanetary Probes**

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Current process is limited to <50% recovery of oxygen due to the hydrogen lost in the vented methane.

Not closing the loop will result in greater consumables on a trip to Mars.

Methane pyrolysis can recover this hydrogen and close the oxygen loop.

Sabatier: \( CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O \)

Electrolysis: \( 2H_2O \rightarrow 2H_2 + O_2 \)

Pyrolysis: \( CH_4 \rightarrow 2H_2 + C \)

Net reaction: \( CO_2 \rightarrow O_2 + C \)
Advantages of Methane Pyrolysis:

- Increases oxygen recovery to near 100%
- Leverages NASA’s investment in Sabatier technology
- Product is clean, easily handled carbon – no separations steps, soot, or hazardous gases
- Robust technology
A MORE EFFICIENT, EFFECTIVE AND RELIABLE CARBON DIOXIDE REMOVAL BY IONIC LIQUID SYSTEM

Advantages of CDRILS:
- Maintains a lower CO₂ partial pressure
- More reliable and robust due to continuous system and tolerance to water
- Lower size, weight and power especially when integrating with downstream Sabatier
- Removes numerous trace contaminants

How it works:
- Exchange of EMIM Ac ionic liquid with promoter between a scrubber (CO₂ capture by the ionic liquid) and a stripper (CO₂ release)

Status:
- Six separate ground demonstrations built and under test
STATUS OF ADVANCED ECLSS TECHNOLOGIES

NASA/Honeywell Methane Pyrolysis
- Brassboard reactor delivered to NASA for integrated system testing in 2022
- Flight-like reactor completing Preliminary Design Review in 2023

NASA/Honeywell CDRILS
- Six separate ground demonstrations built and under test
- Flight demonstration unit design in progress

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