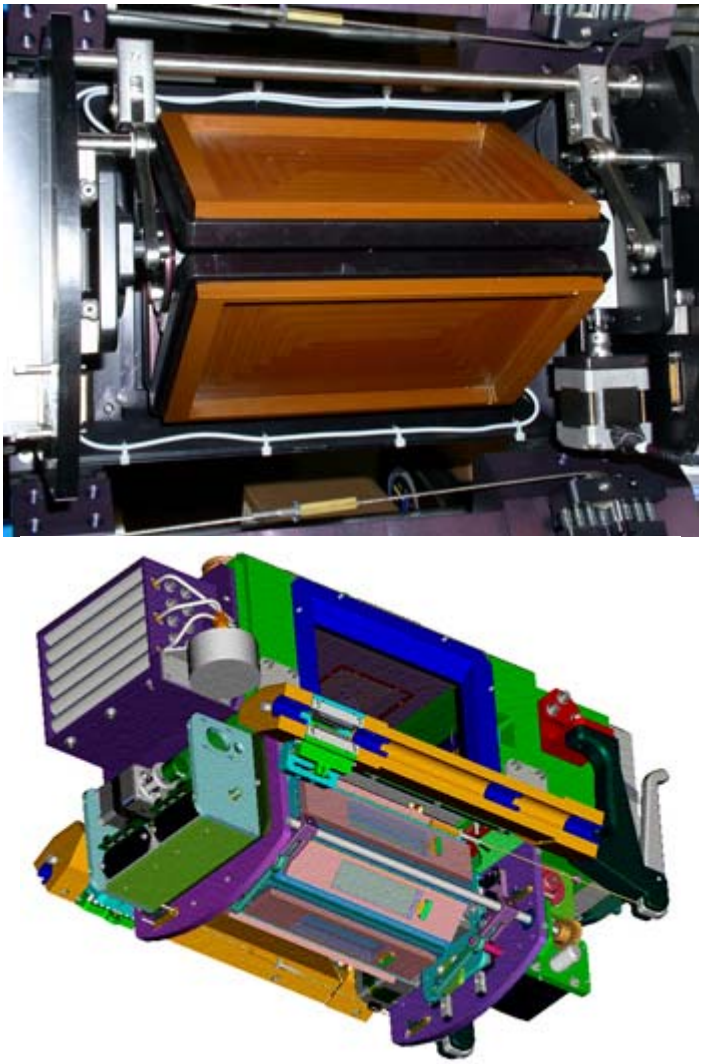
Solid Fuel Delivery System Developed for Combustion Testing on the International Space Station

NASA initiated Bioastronautics and Human Research Initiatives in 2001 and 2003, respectively, to enhance the safety and performance of humans in space. The Flow Enclosure Accommodating Novel Investigations in Combustion of Solids (FEANICS) is a multiuser facility being built at the NASA Glenn Research Center to advance these initiatives by studying fire safety and the combustion of solid fuels in the microgravity environment of the International Space Station (ISS). One of the challenges for the FEANICS team was to build a system that allowed for several consecutive combustion tests to be performed with minimal astronaut crew interaction. FEANICS developed a fuel carousel that contains a various number of fuel samples, depending on the fuel width, and introduces them one at a time into a flow tunnel in which the combustion testing takes place. This approach will allow the science team to run the experiments from the ground, while only requiring the crew to change out carousels after several tests have been completed.

The combustion experiments using solid fuel on the ISS will be performed in a 100-liter combustion chamber on the Combustion Integrated Rack, which is also being developed at Glenn. Most of the FEANICS experiments require a controlled flow environment for testing. Consequently, a key component of the FEANICS hardware is a 30-cm-long flow tunnel. This takes up a significant portion of the combustion chamber, leaving reduced space for a mechanism to introduce the solid fuels for testing and remove them at completion. Many of the solid fuel experiments utilize large samples that are instrumented for temperature and radiometric readings, making them harder to maneuver. Another design challenge was to find a way to shield the crew from the burnt fuel samples while they remove the fuel holder mechanism and stow it. The fuel carousel was designed to meet these challenges and has been successfully built and tested by a FEANICS team of in-house and support service contractor researchers.

The carousel is a rotating hub that can have a different number of sides, depending on the fuel width requirements. For example, for a 3-cm-wide fuel, an eight-sided carousel can be built, allowing eight consecutive tests without crew interaction. The carousel can accommodate a maximum fuel width of 11.5 cm, but this reduces the number of samples (carousel sides) to three. Each face of the carousel contains the fuel being tested, which is held by a nonflammable tray. This tray is equipped with an electrical connector that allows instrumentation and igniter power to be wired to each sample. The carousel has two modes of actuation. The translation mode allows the carousel to raise and lower a fuel into the flow tunnel for testing. The rotation mode allows the carousel to rotate from one sample to the next in between test runs. This entire carousel hub is enclosed in an aluminum shroud. Also, there is a motorized shutter at the top of the carousel that can cover the hole where the fuel is introduced in the tunnel. This serves two purposes. One is

to completely seal the contents of the carousel during crew change-out, shielding them from any postcombustion particulate matter from the burnt sample, and the other is to provide a means to put out the flame on the fuel surface at the end of a test.



Top: A three-dimensional model of an eight-sided fuel carousel (without shroud) mounted to the FEANICS flow tunnel. Bottom: Underside of an engineering model of a three-sided fuel carousel with shroud removed. Two fuel trays are shown (no fuel installed).

The FEANICS project is currently in the engineering model development phase. A three-sided carousel has been built and tested, and two others are being fabricated. The next stage will be to qualify the design and build the flight hardware.

Find out more about this research at
http://microgravity.grc.nasa.gov/combustion/feanics/feanics_index.htm

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