

due to phase change of the wax from solid to liquid. For use as a heat switch on a spacecraft, multiple devices may be permanently attached to a radiator via the plunger, and the body attached to a rigid structure. During a safe mode orbital maneuver if the radiator should face the Sun, the device will then push off the radiator, disengaging it from the spacecraft bus. The device could be mounted as a pull device as well, pulling the radiator closer to the thermal bus to

increase the thermal conductance between bus and radiator.

Thermal actuators of this kind are somewhat common, except that this device uses a heat pipe as a plunger, so this is an improvement. Most other devices require heat transfer through the wax chamber body, not through the plunger itself. This device will have three distinct advantages over other versions:

- Fast actuation due to quick heat transfer.
- Large stroke and stroke velocity.

- Mass savings as there is no need for thick metallic sections for conducting heat.

The actuation stroke could be designed to be large and quick enough to be used as an energy-harvesting device, converting waste heat into mechanical energy.

*This work was done by Juan Cepeda-Rizo of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46679*

## System for Hydrogen Sensing

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A low-power, wireless gas-sensing system is designed to safeguard the apparatus to which it is attached, as well as associated personnel. It also ensures the efficiency and operational integrity of the hydrogen-powered apparatus. This sensing system can be operated with lower power consumption (less than 30 nanowatts), but still has a fast response. The detecting signal can be wirelessly transmitted to remote locations, or can be posted on the Web. This system can also be operated by harvesting energy.

The electrical signal response of the sensor to the hydrogen gas can be amplified by a differential detection interface (DDI) connected to the low-power gas sensor. A microcontroller is connected and programmed to process the electrical signal, which is then wirelessly transmitted. The system also includes a central monitoring station with a wireless receiver configured to receive the sensor data signal from the wireless transmitter of the sensor device. The system further includes a power source with at least one

vibrational energy harvester, solar energy harvester, and a battery.

*This work was done by Jenshan Lin, David P. Norton, Stephen J. Pearton, and Fan Ren of the University of Florida for Glenn Research Center. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18484-1.*

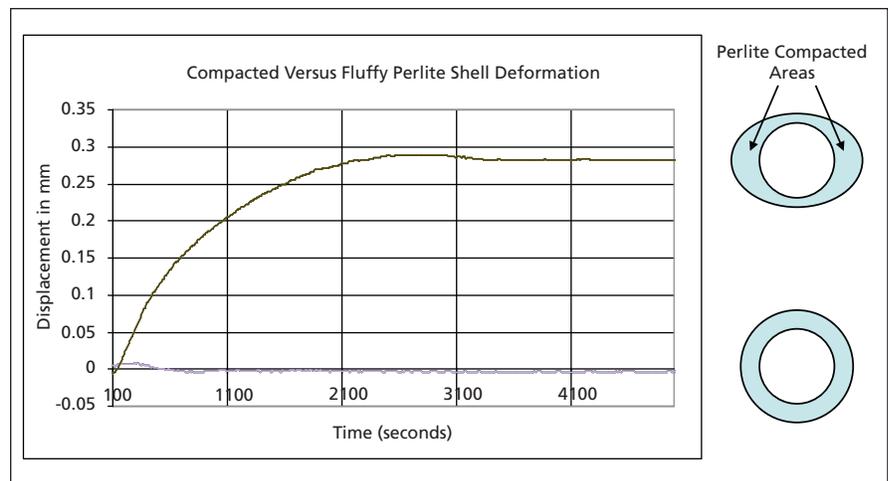
## Method for Detecting Perlite Compaction in Large Cryogenic Tanks

**This technique could be applied by companies using rail cars and trucks to deliver liquid cryogenics.**

*John F. Kennedy Space Center, Florida*

Perlite is the most typical insulating powder used to separate the inner and outer shells of cryogenic tanks. The inner tank holds the low-temperature commodity, while the outer shell is exposed to the ambient temperature. Perlite minimizes radiative energy transfer between the two tanks. Being a powder, perlite will settle over time, leading to the danger of transferring any loads from the inner shell to the outer shell. This can cause deformation of the outer shell, leading to damaged internal fittings.

The method proposed is to place strain or displacement sensors on several locations of the outer shell. Loads induced on the shell by the expanding inner shell and perlite would be monitored, providing an indication of the location and degree of compaction.



**Strain/Displacement Measurements** for the detection of perlite compaction. The curves show the differential motion of the outer tank as the inner tank thermally expanded with fluffy perlite (lower curve) and compacted perlite (upper curve).