National Aeronautics and Space Administration

Mechanical Technology

Composite Tank Technologies

Ideal for cryogenic liquid applications

Innovators at NASA's Marshall Space Flight Center have developed several new designs and fabrication methods for composite tank vessels that help make them ideal containers for cryogenic fluids such as liquid methane and liquid hydrogen. NASA's innovations also offer improvements in structural integrity, enhancing protection against impact, harsh environments, and fire. Several embodiments of this technology enable production of composite tanks that are suitable for transporting and storing liquid natural gas and other cryogenic liquids. These methods are applicable to important aerospace needs, such as propulsion systems, as well as to new and growing fields such as natural gas transportation.

Benefits

- **Adaptable**: Features a combination of strength and superior insulating properties, providing ideal containment for cryogenic liquids
- **Strong**: Enables improved structural integrity for vessels that can withstand impact, fire, and other harsh conditions, as well as contain high-pressure contents as desired for some cryogenic applications
- **Lightweight**: Provides versions that can be lighter than previously available tanks that relied on heavy metallic liners for strength and low-temperature reliability
- **Scalable**: Offers designs and methods that can be easily tailored to large structures and easily handle tooling and materials changes

technology opportunity

Commercial Applications

- Pressure-fed propulsion systems
- Liquefied natural gas (LNG) and other fuel transportation
- Storage tanks for fuels, gases, and cryogenic fluids

Technical Details

How it works

NASA's methods for constructing lined (metallic or non-metallic liners) and all composite pressure tanks, suitable for cryogenic liquids, involve an inner layer composed of metal or a mix of fiber and resin as well as a supporting outer layer of fiber-resin composite. In one implementation, materials comprise the inner layer (from a braided sleeve and a matrix resin) that contains the fluids and provides high strain to failure at cryogenic temperatures, protecting the vessel from cracking and producing leaks. The outer layer serves as a high-performance structural support for the inner layer. In addition, the braided material enhances the structural integrity of the composite layers. By employing a hybrid structure that consists of at least two reinforced composite materials, researchers at NASA have demonstrated production of a superior, lightweight composite structure that will help control the propagation of cracks in a vessel over wide temperature and pressure ranges.

Other NASA innovations increase the strength and structural integrity of these vessels, further improving their applicability to high-pressure cryogenic tanks and containers. Outer layers consisting of fibers and epoxies or other durable coatings can provide further impact resistance. Additional insulation can also be added to the outside of the composite over-wrapped pressure vessel.

Why it is better

Commercially available tank materials used previously employed materials that were not designed specifically for use in cryogenic conditions. NASA's innovations provide reliable methods for constructing composite vessels made of two or more materials to provide protection against leakage caused by micro-cracking.

Unfortunately, many currently available composite vessels are easy to damage by impact and do not perform well in high temperature environments. Vessels made for containment of natural gas for the auto industry must meet strict standards for impact and fire resistance. NASA's methods produce damage-tolerant and fire-resistant composite vessels that perform cryogenically and withstand standard U.S. Department of Transportation (DOT) pressure vessel tests. Such vessels sometimes are repairable in the field, helping to improve performance while lowering overall lifecycle costs.

Patents

NASA's Marshall Space Flight Center has received patent protection for these technologies (U.S. patent Nos. 6,158,605; 6,193,917; and 6,953,129), and is seeking additional patents.

Licensing & Partnering Opportunities

These technologies are part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for these composite tank technologies (MFS-31379-1, MFS-31379-2-DIV, MFS-31727-1, MFS-31838-1, MFS-32024-1, MFS-32099-1, and MFS-32390-1) for commercial applications.

For More Information

If you would like more information about these technologies, please contact:

Sammy A. Nabors
Manager, Technology Commercialization and Licensing
NASA's Marshall Space Flight Center
256-544-5226
sammy.nabors@nasa.gov

Karen Hiser
Senior Consultant
Fuentek, LLC
919-249-0327
nasa.msfc@fuentek.com

www.nasasolutions.com

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/centers/marshall

www.nasa.gov

FS-2009-09-171-MSFC

Fuentek is a contractor to NASA's Innovative Partnerships Program, providing support for the access and transfer of technology.