Advanced Cryotanks

Engineering Directorate Technology Thrust Area

Marshall Space Flight Center (MSFC) • Huntsville, Alabama

Advanced Cryotanks is a high emphasis technology activity of the Engineering Directorate. A multi-discipline team of scientists and engineers is dedicated to maturing advanced cryotank technology for the Nation's future launch vehicles and spacecraft. NASA's cryotank team builds on a rich legacy dating back to the Apollo program and continuing today on the Space Shuttle's Tank. The next generation of space exploration will require lighter materials and innovative design concepts. NASA is building partnerships with industry, academia, and other government agencies to share knowledge and resources. Our deep experience base combined with new partnerships will result in the advancement cryotank technology.

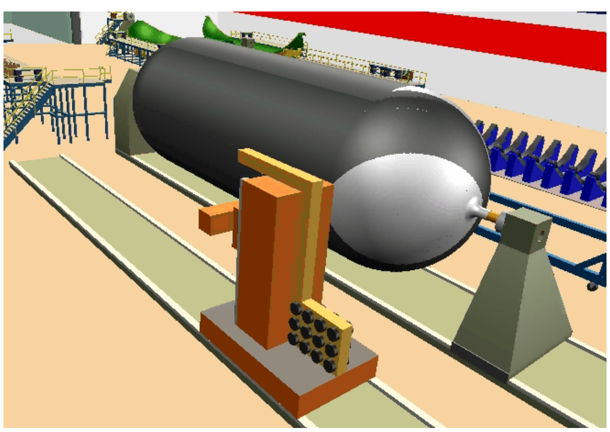
Technology Spotlight

Composite Cryotanks

Reusable Composite Cryotanks

Composite (non-metallic) cryotanks made from a variety of fiber-resin combinations offer reduced weights or increased design margins for Reusable Launch Vehicle (RLV) designers. Composite materials have low thermal contraction and expansion values, simplifying the design of Thermal Protection Systems (TPS) and airframe wing interfaces. Composites can be bonded to many different materials, offering more options to design engineers searching for lightweight, structurally efficient cryotank systems.

Maturing composite cryotank technology for the tank sizes needed for NASA's RLFs will require a disciplined, incremental approach, adding to the materials and design database in a systematic manner. The most recent research conducted at NASA in the 2nd Generation RLV Program has generated a "building block" technology database, significantly advancing technology readiness. Development will continue with a six-foot diameter tank structurally tested under cryogenic conditions, projected to begin in the summer of 2003.



Inner Skin Lamination

Critical to the success of composite cryotanks is limiting the permeation of hydrogen through the tank wall. Very small cracks in the resin material develop under thermal and mechanical strain and can lead to several failure scenarios. Various permeation resisting concepts are being evaluated: internal liners, nano-scale materials as barriers, and thermal expansion coefficient matched fiber-resin systems. (See the paragraph on the reverse side for a description of a new permeation test apparatus.)

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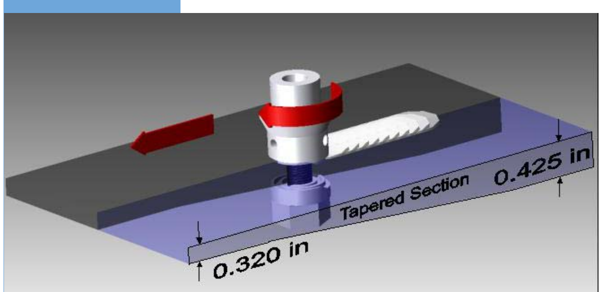
Additional Advanced Cryotanks Technologies

Reusable Launch Vehicle (RLV) Cryotanks

RLV Concepts

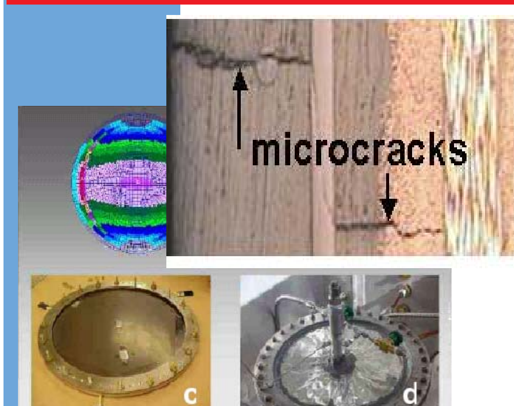
Advanced propellant cryotanks being developed for Reusable Launch Vehicles provide a fully cross-cutting cryogenic liquid storage capability for a wide range of space launch vehicle configurations. The largest components in a launch system, propellant cryotanks have the most potential for weight reduction through innovative design and new technologies. Creating reusable and reliable cryotanks will lower the cost of access to space. In order to create such tanks, engineers are currently exploring the unique benefits of aluminum and composite cryotanks.

Metal Cryotanks and Friction Stir Welding



Large scale reusable metallic cryotanks are fabricated by joining various components such as barrell sections and domes. Fusion welding is traditionally used for welding the joints, but it leaves small defects and reduced material strength, two enemies of a joint that needs to last for hundreds of uses. An alternative to fusion welding is self-reacting Friction Stir Welding (FSW). FSW spins a small threaded cylinder into the joint, "stirring" but not melting the two sides into each other and forming a very strong and defect free joint. NASA welding engineers have recently developed a FSW process and tool to perform welds on a joint that is changing in thickness.

Cryo-Baxial Permeability Apparatus



Cryo-baxial Permeability Testing

NASA's Cryo-Biaxial Permeability Apparatus (CBPA) is a low cost and efficient lab test to determine if a candidate material has potential to be used to manufacture a cryotank. Twenty-six inch diameter test speciment disks are made of the material and bolted to a reservoir of LH2. Pressure is used to cyclinically strain the material at cryogenic temperature. The fixture includes sensors that measure the amount of gaseous hydrogen that leaks through the disk's surface. During testing, gas permeation measurements are monitored to evaluate the material. After testing, the disk can be examined under a microscope to determine a material's resistance to microcrack formation.