Multilayer Composite Pressure Vessels

Lightweight tanks can be made in diverse sizes and shapes.

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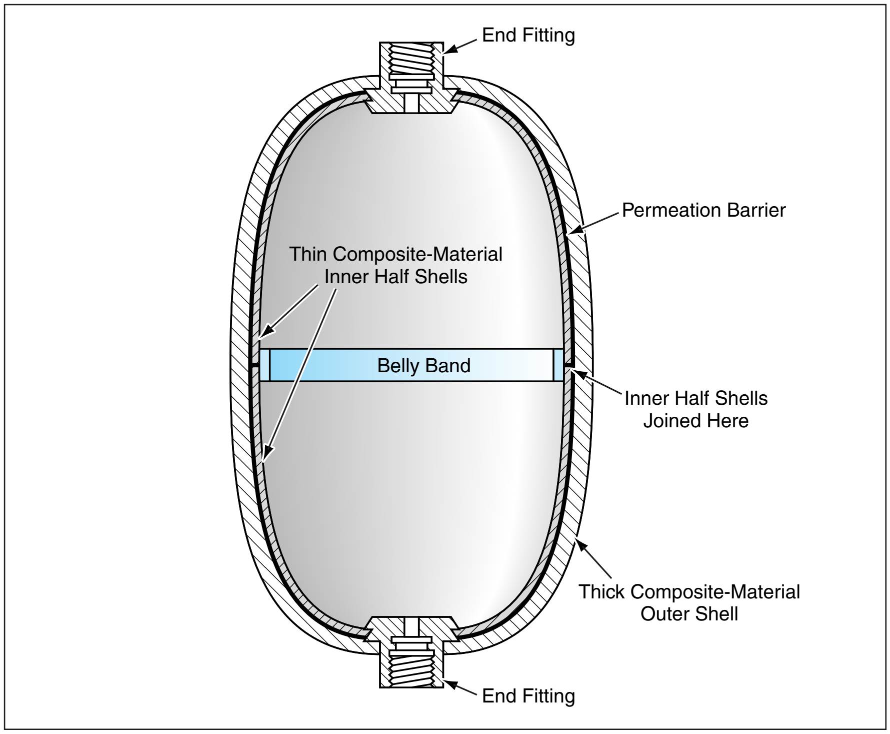
A method has been devised to enable the fabrication of lightweight pressure vessels from multilayer composite materials. This method is related to, but not the same as, the method described in "Making a Metal-Lined Composite-Overwrapped Pressure Vessel" (MFS-31814), *NASA Tech Briefs*, Vol. 29, No. 3 (March 2005), page 59. The method is flexible in that it poses no major impediment to changes in tank design and is applicable to a wide range of tank sizes.

The figure depicts a finished tank fabricated by this method, showing layers added at various stages of the fabrication process. In the first step of the process, a mandrel that defines the size and shape of the interior of the tank is machined from a polyurethane foam or other suitable lightweight tooling material. The mandrel is outfitted with metallic end fittings on a shaft. Each end fitting includes an outer flange that has a small step to accommodate a thin layer of graphite/epoxy or other suitable composite material. The outer surface of the mandrel (but not the fittings) is covered with a suitable release material. The composite material is filament-wound so as to cover the entire surface of the mandrel from the step on one end fitting to the step on the other end fitting. The composite material is then cured in place.

The entire workpiece is cut in half in a plane perpendicular to the axis of symmetry at its mid-length point, yielding two composite-material half shells, each containing half of the foam mandrel. The halves of the mandrel are removed from within the composite shells, then the shells are reassembled and bonded together with a belly band of cured composite material. The resulting composite shell becomes a mandrel for the subsequent steps of the fabrication process and remains inside the final tank.



This **Lightweight Tank** is a multilayer unitary structure. Each layer makes a distinct contribution to the overall effectiveness of the structure.

The outer surface of the composite shell is covered with a layer of material designed to be impermeable by the pressurized fluid to be contained in the tank. A second step on the outer flange of each end fitting accommodates this layer. Depending on the application, this layer could be, for example, a layer of rubber, a polymer film, or an electrodeposited layer of metal. If the fluid to be contained in the tank is a gas, then the best permeation barrier is electrodeposited metal (typically copper or nickel), which can be effective at a thickness of as little as 0.005 in (≈0.13 mm). The electrodeposited metal becomes molecularly bonded to the second step on each metallic end fitting.

The permeation-barrier layer is covered with many layers of filament-wound composite material, which could be the same as, or different from, the composite material of the inner shell. Finally, the filament-wound composite material is cured in an oven.

This work was done by Tom DeLay of **Marshall Space Flight Center**.

This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.a.nabors@nasa.gov. Refer to MFS-31594.