

Making a Metal-Lined Composite-Overwrapped Pressure Vessel

The metal liner reduces loss of gas by diffusion without adding much weight.

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A process has been devised for the fabrication of a pressure vessel that comprises a composite-material (matrix/fiber) shell with a metal liner on its inner surface. The use of the composite material makes it possible for the tank to be strong enough to withstand the anticipated operating pressure and yet weigh less than does an equivalent all-metal tank. The metal liner is used

as a barrier against permeation: In the absence of such a barrier, the pressurized gas in the tank could leak by diffusing through the composite-material shell.

The figure depicts workpieces at four key stages in the process, which consists of the following steps:

1. A mandrel that defines the size and shape of the pressure vessel is made

by either molding or machining a piece of tooling wax.

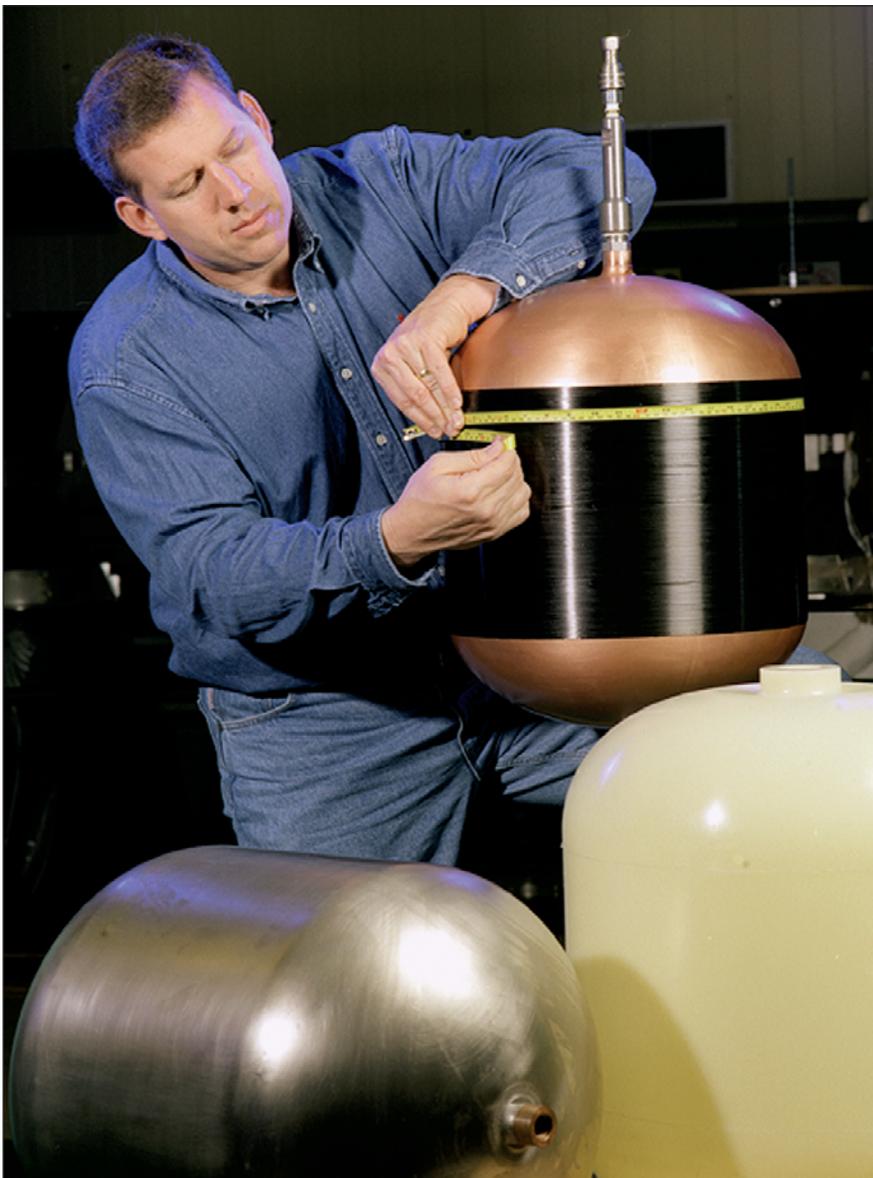
2. Silver paint is applied to the surface of the mandrel to make it electrically conductive.
3. The ends of the mandrel are fitted with metal bosses.
4. The mandrel is put into a plating bath, wherein the metal liner is electrodeposited. Depending on the applications, the liner metal could be copper, nickel, gold, or an alloy. Typical liner thicknesses range from 1 to 10 mils (0.025 to 0.25 mm).
5. The wax is melted from within, leaving the thin metal liner.
6. A hollow shaft that includes holes and fittings through which the liner can be pressurized is sealed to both ends of the liner. The liner is pressurized to stiffen (and hence stabilize) it for the next step.
7. The pressurized liner is placed in a filament-winding machine, which is then operated to cover the liner with multiple layers of an uncured graphite-fiber/epoxy-matrix or other suitable composite material.
8. The composite-overwrapped liner is cured in an oven.
9. The pressure is relieved and the shaft is removed. The tank is then ready for use.

The process as described above accommodates variations:

- The mandrel could be made of a wax that melts at a higher temperature and not removed until the tank is cured in the oven.
- The tank need not be cylindrical or axisymmetric, as long as the filament-winding machine can accommodate the chosen shape.
- Shallow grooves could be formed on the surface of the mandrel to give the liner a bellowslike character for reinforcement and/or to accommodate expansion and contraction.

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 sammy.a.nabors@nasa.gov. Refer to MFS-31814.



A Wax Mandrel (on the bottom right) defines the size and shape of a composite-overwrapped metal liner (top center) that, after further processing, becomes a lightweight pressure vessel. Sample on the bottom left shows a mandrel coated with silver paint before it is placed into a plating bath.