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NASA TECH BRIEF

Ames Research Center

Light-Weight Spherical Submergence Vessel

The problem:

To provide a very light-weight pressure vessel which can be submerged safely in a high-pressure, high-temperature fluid. At present, spherical submergence vessels are designed with relatively high thickness-to-radius ratios so that they can only fail by yielding; vessels of this kind are very reliable, but they are much too heavy for spacecraft applications because thick sections must be built-in at points where stresses from thermal distortion and geometric imperfections can accumulate.

The solution:

Design the vessel with a very low thickness-to-radius ratio to obtain a low weight, and fabricate it with the aid of a precision tracer-lathe to limit and control imperfections in the spherical shape.

How it's done:

The pressure vessel is a thin-walled, spherical, monocoque shell constructed (in titanium when appropriate) from hemispheres joined with a sealed and bolted meridional flange. Test data have shown that instability failures are more highly predictable than previously assumed if the magnitude of imperfections in the vessel's sphericity is known. More importantly, however, it was also shown that thermal distortions resulting from submergence of the vessel in a high-temperature fluid can be treated as equivalent imperfections.

For a given radius, a minimal thickness for the shell is established on the assumption that the sphere will buckle at 70 percent of its theoretical maximum; the thickness is computed in the usual way with the aid of formulas provided by buckling theory. To be certain that the finished vessel will buckle at 70 percent of its theoretical maximum, the dimensional tolerances of the sphere are controlled so that the inside and outside radii are maintained constant to within 2–2.5% of the computed wall thickness. This geometric accuracy is obtained by precision machining of the hemispheres (from forgings) on a tracer-lathe. The closure flange is machined integral with each hemisphere.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Patent status:

NASA has decided not to apply for a patent.

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