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Design Guide for Glass Fiber Reinforced Metal Pressure Vessel

The potential of glass fiber reinforced (GFR) metal tanks for space applications has been demonstrated by a continuing series of technology development programs conducted during the past ten years. GFR metal tanks consist of a metal inner shell overwrapped with a glass filament composite shell which together comprise a load sharing structure. GFR metal tanks offer maximum operating performance at reduced weight compared to all metal construction, and provide a comparable or improved safelife (guaranteed specific lifetime).

A Design Guide has been prepared for pressure vessel engineers concerned with a specific GFR metal tank design or a general tank tradeoff study. Design philosophy, general equations, and curves are provided for the safelife design of GFR metal tanks operating under anticipated Space Shuttle service conditions. The high weight efficiency of the composite vessel is shown to be relatively insensitive to shape, providing increased flexibility to designers establishing spacecraft configurations. Spheres, oblate spheroids, and cylinders constructed of GFR Inconel X-750, 2219-T62 aluminum, and cryoformed 301 stainless steel overwrapped with S-901 continuous glass filaments impregnated with an epoxy resin, are covered in the Guide. Design parameters and performance efficiencies for each configuration are compared at ambient and cryogenic temperature for an operating pressure range of 690 to 2760 N/cm² (1000 to 4000 psi). Design variables are presented as a function of metal shell operating to sizing (proof) stress ratios for use with fracture mechanics data developed for this purpose. Application of the fracture mechanics data of this Guide provides a basis for selection of vessel proof test levels and safelife design configurations.

Notes:

1. Further information is available in the following reports:

NASA CR-120917 (N73-18932), Glass Fiber Reinforced Metal Pressure Vessel Design Guide

NASA CR-120918 (N73-28889), Development of a Fracture Control Method for Composite Tanks with Load Sharing Liners

- Copies may be obtained at cost from:

Aerospace Research Applications Center
Indiana University
400 East Seventh Street
Bloomington, Indiana 47401
Telephone: 812-337-7833
Reference: B73-10311

2. Specific technical questions may be directed to:

Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference: B73-10311

3. Data contained in this Design Guide were prepared using the computer program described in NASA Tech Brief 68-10405, "Analysis of Filament Reinforced Metal-Shell Pressure Vessels."

Patent Status:

NASA has decided not to apply for a patent.

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