NASA TECH BRIEF

NASA Tech Briefs are issued to summarize specific innovations derived from the U.S. space program, to encourage their commercial application. Copies are available to the public at 15 cents each from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Adhesive for Cryogenic Temperature Applications

Filament-wound fiber glass composite structures have been recognized for their potential utility for cryogenic pressure vessels because of their high strength-to-weight ratios. However, many problems have arisen in the evaluation and application of this potential. One of the main problems has been the containment of a cryogenic fluid in the vessel during desired pressurization cycles as the fiber glass composite structures become permeable after stress-induced straining. One solution is the use of a nonpermeable thin metal liner.

The adhesive which bonds the metal liner to the filament-wound composite structure must perform one function, that is, to prevent the metal liner from buckling during depressurization. It must strain with the composite without losing adhesion to either surface or failing internally. The properties which an adhesive must exhibit for successful use in this application must include the following:

1. Sufficient shear and tensile strength to withstand the high axial and hoop stress conditions imposed on the composite by pressure cycling operations at cryogenic temperatures.
2. Sufficient rigidity, as indicated by the modulus and ultimate elongation of the adhesive, to restrain the liner from buckling during the depressurization cycle at ambient temperatures.
3. Sufficient toughness, as indicated by the peel strength of the adhesive, to permit the adhesive to resist further failure after it begins. An adhesive with high peel strength can absorb and distribute large stress concentrations evenly over a wide area.
4. A coefficient of contraction compatible with both the fiber glass composite and the metal liner to the extent that adhesion can be maintained between each of these components when the composite structure is strained during the depressurization operation.

An adhesive for cryogenic temperature application has been developed which consists of adducts of urethane and epoxy resins. The adduct exhibits the best properties of each of the individual resins, having the higher strength and the modulus of the epoxy and the strain capabilities and peel resistance of the urethanes. The adduct material does not show the characteristic brittleness of epoxies nor the soft rubber appearance of polyurethanes.

The urethane-epoxy adducts are produced by blending a commercially available epoxy resin based on the diglycidylether of bisphenyl A with a toluene diisocyanate prepolymer and curing this mixture with methylene-*bis*-orthochloroaniline. Two formulations were prepared. Relatively large filament wound pressure vessels with very thin (foil) aluminum liners bonded with both formulations were fabricated and tested. All of these vessels were subjected to 2% strain in a 1:1 biaxial strain field without primary liner failure at room temperature and in liquid hydrogen.

Notes:

1. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10074
2. Technical questions concerning this innovation may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B69-10074

(continued overleaf)

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights.

Patent status:

No patent action is contemplated by NASA.

Source: H. M. Doyle
of McDonnell Douglas Corporation
under contract to
Lewis Research Center
(LEW-10264)