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NASA TECH BRIEF

Lightweight, Self-Evacuated Insulation Panels

An extremely efficient system of thermal insulation, developed for a rocket's fuel tanks, may be adaptable to many uses in industry. Liquid-hydrogen fuel tanks require highly efficient insulation to prevent excessive boil-off losses during storage. They are readily protected thermally for several days in space by low-emissivity multiple radiation shields aided by the vacuum of space. But thermal protection is also needed while a vehicle is in the atmosphere, both on the launching pad and during its boost into space.

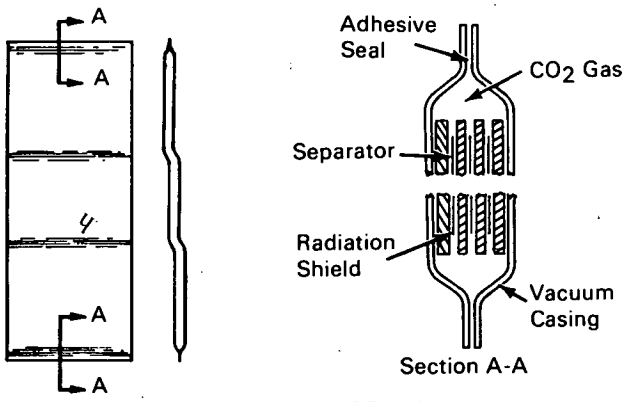

Figure 1. Details of Panel

For thermal protection in the atmosphere to be comparable to that in space, insulation by multiple radiation shields must include an integral vacuum system. Since insulation imposes a weight penalty and structural problems in its application to the tank, the materials used must be lightweight, and the overall structure (including the vacuum system) must be adequately fastened to the tank and conveniently evacuated before use. Moreover the evacuated insulation should be arranged in small sections around the tank to improve the system's reliability by preventing a small leak from causing catastrophic failure through complete loss of vacuum around the entire tank.

Development of such an insulation system has required the solution of such problems as provision of (1) a lightweight and flexible material to hold a vacuum of roughly 10^{-4} torr while the vehicle remains in the atmosphere; (2) convenient means of evacuation shortly before service, since a lightweight vacuum-retention material, perhaps not completely impermeable, may hold the required vacuum only relatively briefly; and (3) lightweight, thermally efficient, multi-

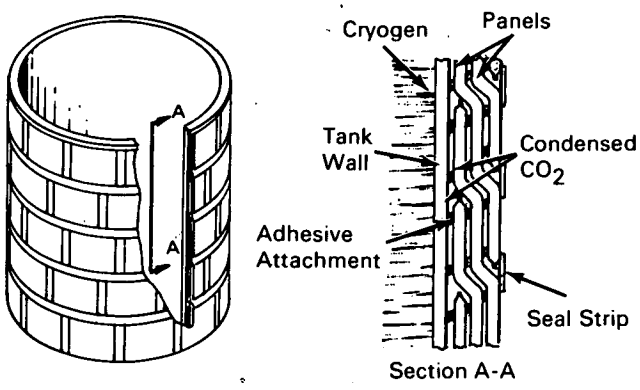

Figure 2. Shingle Arrangement of Panels

layer insulating materials properly conditioned to prevent outgassing in a vacuum.

A new insulation system employs panels of multilayer aluminized Mylar for thermal-radiation shields, with each shield separated from the next by a 0.020-in. sheet of low-conductivity polyurethane foam. The many layers are enclosed in a vacuum-tight, flexible, four layer laminated casing of thickly aluminized Mylar film (Fig. 1). Prefabricated insulating panels are arranged over a tank like shingles, with adjacent rows of panels overlapping (Fig. 2).

(continued overleaf)

The panels are self-evacuated by cryopumping at the time of use. Gaseous carbon dioxide, under slight positive pressure in a panel at ambient temperature, is condensed on the panel's inner surface adjacent to the cold tank; thus the panel is self-evacuated when the tank is cooled during filling with hydrogen. The very low vapor pressure of solid CO_2 at cryogenic temperature makes the required vacuum readily achievable.

In comparison with earlier insulations, tests have shown heat transfer by the new insulation to be less by from 90% (on the ground) to 99% (in space).

Notes:

1. The following documentation is available from:
   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-TN-D-4375 (N68-18046), Self-Evacuated Multilayer Insulation of Lightweight Prefabricated Panels for Cryogenic Storage Tanks

2. Technical Questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10646

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,379,330) and royalty-free license rights will be granted for its commercial development. Inquiries about obtaining a license should be addressed to:

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