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.

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

A new insulation system employs panels of multi-layer 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 CO₂ 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-Evac-
uated 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. In-
quiries about obtaining a license should be addressed
to:
   Patent Counsel
   Mail Code 500-311
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, OH 44135

Source: L. Niendorf and G. Nies of
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under contract to
Lewis Research Center,
and P. J. Perkins, Jr., and R. P. Dengler
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(LEW-90361)