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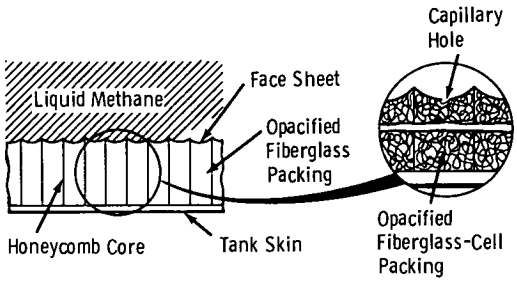
NASA TECH BRIEF

Lewis Research Center

INTERNAL CAPILLARY INSULATION FOR CRYOGENIC TANKS



Internal Insulation System Configuration.

A capillary-type insulation has been devised for installation on the inside of liquid methane fuel tanks for future aircraft. It may also be used advantageously to insulate other types of cryogenic tanks. The use of an internal insulation of this nature overcomes some of the problems frequently encountered with external insulations. For example, cryopumping is eliminated and heat leaks through tank supports are greatly reduced. Also, the tank wall affords protection against accidental mechanical damage.

A cross-section of the capillary insulation is shown in the figure. A honeycomb core of fiberglass cloth impregnated with polyimide resin is bonded onto the metal tank wall using a polyimide adhesive. A fiberglass scrim cloth is used to hold the adhesive and fill any small voids between the tank wall and core. The core is filled with finely chopped opacified fiberglass to minimize both convection and radiant heat transmission through the core voids. (A previous Tech Brief, Reference: B71-10406, describes the use of opacified fiberglass insulation for reducing radiant heat transmission.) A polyimide film face sheet is bonded to the core face inside of the tank. After bonding, the face sheet is dimpled and a capillary hole is formed in the sheet over each honeycomb cell. The dimples relieve the stresses resulting from large thermal gradients across the insulation. The capillary holes admit methane into the cells, the methane vaporizes, and the resulting gas both provides static pressure in the cells to support the honeycomb structure and further fills the cells with a low thermal conductivity material. The capillary holes are sized so that surface tension forces produce a stable liquid/gas interface at the holes that keeps further liquid from entering the cells.

The walls of the honeycomb material must be impervious to gas and must be attached to the wall so that gas flow parallel to the wall is prevented. The membrane must be mechanically stable or liquid will run into the cell and the gas will flow out. The capillary holes are formed by melting with a hot, blunt needle rather than mechanical punching. By melting, the plastic material flows away from the hole forming a torrus around the hole thus providing reinforcement and preventing tearing at the holes.

The insulation has been successfully demonstrated with liquid nitrogen in an aircraft wing tank, .61 m x .61 m x 2.44 m (2 ft. x 2 ft. x 8 ft.), with external temperature cycled to simulate ground and supersonic flight conditions.

PATENT STATUS:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to the Martin Marietta Corp., Denver, Colorado 80201.

Source: J.L. McGrew
Martin Marietta Corp.
under contract to
Lewis Research Center
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Category 06