AEC-NASA TECH BRIEF

Frost as an Insulator

Frost is generally considered as an undesirable, inert, homogenous, crystalline structure that must be eliminated to enhance the heat transfer of cooling coils. However, when frost forms under other conditions, such as on the outside of cryogenic lines, its qualities can be used advantageously since it possesses an insulating capacity which compares favorably with some common low efficiency insulation materials such as shredded wood bark, insulating brick, asbestos sheet, and leather.

Basic insights on the insulating quality of frost, and mechanisms for using frost in specific applications, have been derived from recent tests and studies. Frost is an ice layer formed by condensed crystals of liquid air. If the liquid air is allowed to escape, the frost layer cracks, sloughs off, shifts position, and repairs itself with consequent changes in insulating value and thermal conductivity. However, by maintaining relative humidity above set values, and blowing the moist air past cryogenic lines at certain velocities, frost can be formed to set thicknesses and densities which can be sustained. Once this occurs, liquid air run-off is eliminated and the frost layer becomes a uniform insulator.

The quality of insulation was determined by a test in which temperature differences across a 1/4-in. thick wall of stainless steel test line were recorded. Using liquid hydrogen, the average start-up temperature difference across the wall was 203°R. After the formation of a frost layer 0.8-in. thick (89% air relative humidity at 127 fpm), the average steady state temperature difference had dropped to 31°R. For liquid nitrogen the start-up temperature was 154°R. A frost layer 0.6-in. thick (77% air relative humidity at 94 fpm) dropped the steady state temperature difference to 23°R. This technique could be applied in operations where it is difficult to wrap or attach standard insulating materials. Conditions can also exist where space constraints or lack of access impedes the placing of insulation, or where existing insulation has fallen off. With an available supply of moist air, frost possesses the inherent advantage of easy insulation of cryogenic lines which otherwise might not be protected, improving overall system efficiency.

Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
AEC-NASA Space Nuclear Propulsion Office
U.S. Atomic Energy Commission
Washington, D.C. 20545
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No patent action is contemplated by AEC or NASA.

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