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Evaluation of Two Designs for Cryogenic Insulation

Evaluations of the thermal and structural performances of two specially developed, multilayer, cryogenic-insulation systems have been reported in great detail.

The use of liquid hydrogen as a fuel has created a demand for effective cryogenic insulation of different kinds of tanks. While many basic thermal data are available, work on the application, efficient integration, and structural evaluation of insulating systems has been limited. Such systems must be thermally efficient and of minimum weight, practical in application, and able to withstand vibration, acceleration, and rapid pressure drops.

Two different systems, designed for a 105-in.-diameter tank but scaled down for a 29-in. diameter, were designed, fabricated, and tested. The first (model-1) was made of shingle-type, crinkled, aluminized polyethylene ester. A dynamic scaling analysis showed that scaling was unnecessary for either vibration or acoustics, but it was necessary for linear g loading (by a factor of 3.62) and ambient-pressure decay. After thermal testing, the models were subjected to simulated environments for evaluation of structural integrity, and finally retested thermally for detection of any degradation due to structural failure.

Model-1 failed structurally in the region of the after bulkhead during the centrifuge test; some of the taping of the battens was wrongly oriented. When the rapid-pumpdown test revealed several areas of structural failure, model-1 was not tested further and was judged unfit for specific environments without more structural support. Model-2 showed negligible structural damage during the tests, with improvement in thermal efficiency, and was judged thermally and structurally adequate.

In separate calorimeter tests of another insulating material, the equilibrium heat-flux value proved to be roughly twice as great when the material was perforated than when unperforated.

Note:

Requests for further information may be directed to:
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No patent action is contemplated by NASA.

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