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Design and Development of Cryogenic Dewar

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Abstract:
Types of Cryogenic storage vessels may vary from low-performance containers, insulated with rigid foam or fibrous insulation to high-performance containers having multilayer insulation along with high vacuum in the annular space of the double-walled vessel. Thermal insulation is the most vital factor in the design of any cryogenic system to prevent the following possible modes of heat leak resulting in low evaporation loss of cryogen. Sources of heat leakage into inner vessels are due to neck and inner vessel support conduction, the existence of residual gas in the vacuum interspace leading to both conduction and convection, radiation through walls etc. The mouth opening and closing for the use of cryogen may also lead to direct gas convection and radiation. Provision should also be made for easy repeated evacuation service for removing slow evolution of gas from inner metal surfaces and/or repairs as and when needed. Minimum weight and maximum strength of the structure, ease of assembling, handling and transport, noncorrosive, indigenous availability, reasonable cost of materials for fabrication etc are the other design considerations.
Various types of small cryogenic vessels, especially liquid nitrogen containers, with body shells fabricated from aluminium and necks made from glass fibre-impregnated epoxy resin tubes, pressure joined to aluminium bodies with imported Sycast/ Ecobond cement, are being manufactured under foreign know-how by different industrial organisations. A unique design of a cryo container of 3-litre capacity, made from austenitic stainless steel of 304 grade with neck indigenously made from glass fibre impregnated epoxy resin of comparable weight, strength and efficiency to aluminium vessels, serviceability, long life and good appearance, especially suitable for the laboratory use and transport of LN2 frozen bull semen to rural areas for animal husbandry purposes, LO2 for health services and metal fabrication work and LCH4 for supplying a high-grade non-pollutant fuel, has been designed and constructed. Details of the design, fabrication and material of construction for a 3-litre liquid nitrogen container using a stainless steel body and glass fibre-reinforced plastic as its neck are discussed in the paper. The indigenously built container is tested by filling it with liquid nitrogen and noting the evaporation loss. The results are encouraging for laboratory-scale use as well as for small-scale application.
Keywords: Glass fibre tube, cryogenic, Radiation, Conduction, convection. Multi-layer Insulation

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