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Investigation on thermal performance of low temperature multilayer insulation technique for ground based rare physics programs.

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Multilayer insulation (MLI) is a robust passive thermal protection system which is widely used as cryogenic thermal insulation technique in high vacuum environments for minimization of radiation heat load to the cryogenic systems. It has it's applications in both, space cryogenics exploration programs as well as on the ground based programs also. There are various heat transfer modes through MLI due to the environmental effects: Thermal radiation, solid conduction and residual gas conduction, in which thermal radiation is the major part of the total produced heat load.

Here, the low temperature application of MLI technique on the ground based rare physics programs is discussed, in which MLI technique is used to reduce the the thermal radiation coming from outer wall to the inner wall of the cryostat. Cryostat is a double walled container filled with cryogenic liquid with the vacuum space between the two walls.

The basic concept of MLI technique is that multiple reflection of incident radiation is obtained by placing the reflective layers to reflect the incident radiation called radiation shields, in between the two walls of the cryostat. Because of it's multilayer structure, with each successive reflective layer reducing the radiation heat load mainly, on the next by a fraction. These reflective layers are formed with thin polyethylene or Mylar sheet, coated with highly reflecting material (Aluminium or Gold) on both the sides. Therefore, low conductivity materials (or insulators) called spacers are placed in between these reflective layers to avoid the thermal contact between them and hence the conduction heat load due to adjacent reflective layers.

The current work is an attempt to find the best materials for MLI system (reflective layer and spacer materials), which is usually asked before designing the insulation system for a cryostat in any experiment. This work discusses the effect of perforated double-Aluminized Mylar (DAM) with Dacron, unperforated DAM with Silk-net and perforated DAM with Glass-tissue on the performance of MLT technique, as the reflective layer as well as spacer materials. After that, we have discussed the effect of layer density and the number of layers on the heat load, by which the optimal layer density is observed for all three combinations. Knowing the key parameters of MLI technique, the heat load generation in spherical as well as cylindrical cryostats is compared and found the effect of layering near the inner and outer wall of the cryostat.

What is your experiment?

Neutrinoless Double Beta Decay experiment

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