

In this paper the authors describe a novel approach to the use of the cryopump in obtaining temperatures in the region below 1° K and indicate some of the advantages.

HELIUM-3 CRYOSTAT WITH ADSORPTION PUMP

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MECHANICAL or mercury diffusion pumps are generally used in conjunction with helium-3 refrigerators. Cryopumps have been used to a minor extent; their advantages are a considerable reduction of vibrations which generate heat, and a tight circuit.¹⁻⁴ In contrast to the usual cryopump design we completely separated the adsorption device (pump) kept at 4.2° K, from the cooling device (cryostat) at 1.2° K. This avoids an additional thermal load for the helium-4 bath. It also facilitates the repetition of cooling cycles.

The Cryostat

Figure 1 is a diagram of the cryostat. The solid copper container 1 for helium-3 has a cavity of 3 cm^3 volume to which is welded a copper-foil 2 for lowering the thermal

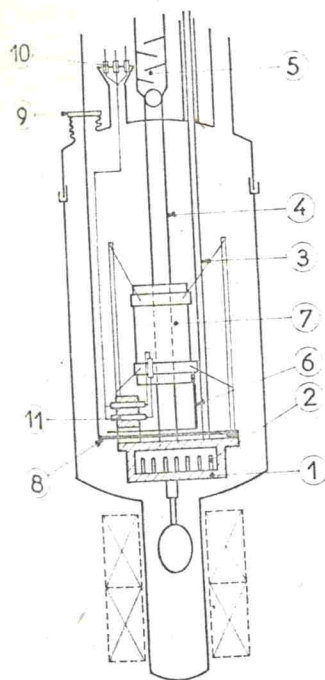


Figure 1. Helium-3 cryostat

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resistance between the liquid helium-3 and the container block. A stainless steel capillary 3 measures the pressure over the helium-3 bath. Two pumping tubes 4, only one being shown, provide rigid suspension for the block and issue from the calorimetric enclosure by two copper sections connected to a radiation trap 5 with sloping baffle plates for draining the helium-3 condensed by contact with the bath at 1.2° K.

All the pumping lines consist of tube sections of increasing diameter up to room temperature, thus reducing the admission of heat to the bath without lowering the pumping rate.

For specific heat measurements a copper tongue 6 connected to the sample 7 is pressed against the block by a gilt copper blade 8 actuated from outside by a stainless steel wire that passes through a tombac bellows 9. In order to reduce the intake of heat by the sample, the measuring wires from the helium-4 pass into the calorimeter through glass-metal plugs 10 and are welded to varnished copper wires 11 (1.5 mm diameter) fixed in holes on the helium-3 block.

Adsorption Studies

Adsorption has been studied in the field of physico-chemical research^{5,6} and in the field of applications, such as those described here.⁷ Tests by Stern et al. with helium-4 have shown that of all the adsorbents mentioned the Linde zeolite 5A is the most suitable (saturation and pumping rate). After having ascertained the characteristics for helium-3 we adopted this adsorbent.

The adsorption cell used for pumping consists of a stainless steel pipe, 13-14 mm diameter, with a coaxial cylinder made of copper gauze, of 7 mm diameter. The zeolite 5A is in the annular space, as cylindrical granules previously degassed in a vacuum for 24 h by means of a heater coil wound around the pipe. The whole channel can be plunged into a vessel containing a cryogenic fluid (hydrogen or helium). Facilities for pumping these 2 baths to lower the temperature are provided.

The circuit comprises two tanks V_1 and V_2 , holding 5.5 and 13.5 l., respectively, of stainless steel and containing