0·5 l. helium-3 (at s.t.p.), and connected to a mercury gauge. The V_0 volume to which they are connected comprises two pressure measurement devices: a McLeod gauge fitted with liquid nitrogen trap and a Médiovac gauge (Pirani type) calibrated with the other gauge for continuous measurements at constant volume. The adsorption pump is connected to V_0 by a short large bore mains. The circuit is connected to a secondary pump, and a valve serves for recharging with helium-3.

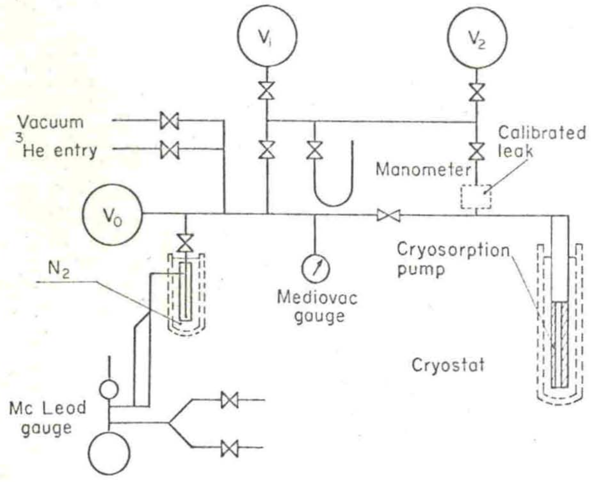

Figure 2. Apparatus for adsorption equilibrium and pumping speed measurements

The adsorption isotherms were plotted by a very well known volumetric method. Successive quantities of gas from V_1 or V_2 were admitted into V_0, of known volume, whereupon V_0 was connected to the cryopump. Measurement of the initial and final pressures in this volume gives the quantity of gas contained in the cryopump at equilibrium pressure. From this must be deducted the effective clearance volume of the cryopump. The total clearance of the pump is determined by tests without adsorbant at different temperatures and the volume initially occupied by the zeolite is deducted from it. This gives the effective clearance volume and hence the quantity of gas adsorbed at equilibrium pressure.

We plotted the helium-3 adsorption curves for zeolite 5A at different temperatures as a function of cell pressure (Figure 3). The adsorbed volumes are given in cubic centimetres (s.t.p.) per gram degassed adsorbent. At 20 and 15° K we used 4·7 g zeolite, with hydrogen as coolant. No saturation was detectable in the pressure range studied. Henry's law

$$V = K'P$$

holds good only at low pressures, as was observed by Stern et al. who studied helium-4 adsorption with a different zeolite, 13X. On the other hand, at 4·2° K we obtain a saturation level at 190 cm^3(s.t.p.)/g.

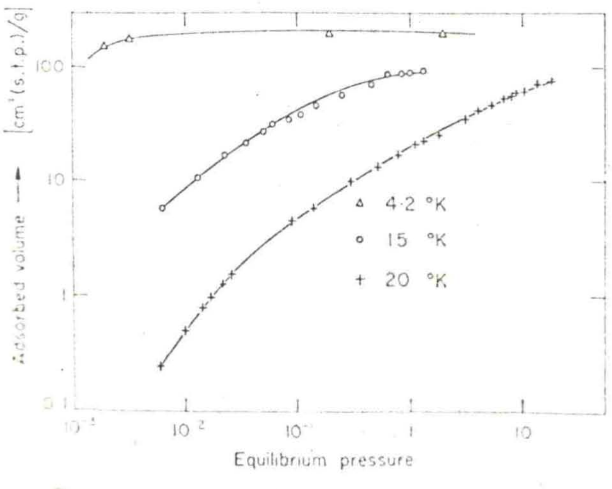

Figure 3. Adsorption of helium-3 at 20, 15, and 4·2° K

We measured the cryopump pumping rate by simply introducing in the preceding circuit a calibrated leak between the tanks and the pump (Figure 2). Only the 'constant flow' method at steady state proved applicable for adsorbents, because a method of decreasing pressure cannot be used in the case of zeolite which does not attain thermal equilibrium quickly enough. The calibrated leak was a very fine orifice in a thin wall. Flow Q is thus proportional to the upstream pressure if this is definitely higher than the pump pressure

$$Q = PC$$

where Q is the flow in torr-litre/second, P = the pressure upstream of the leak in torrs, and C = the leak rate in litres/second. The downstream pump pressure, as read off the Médiovac gauge is p and for the same flow, the pumping rate of the cryopump is

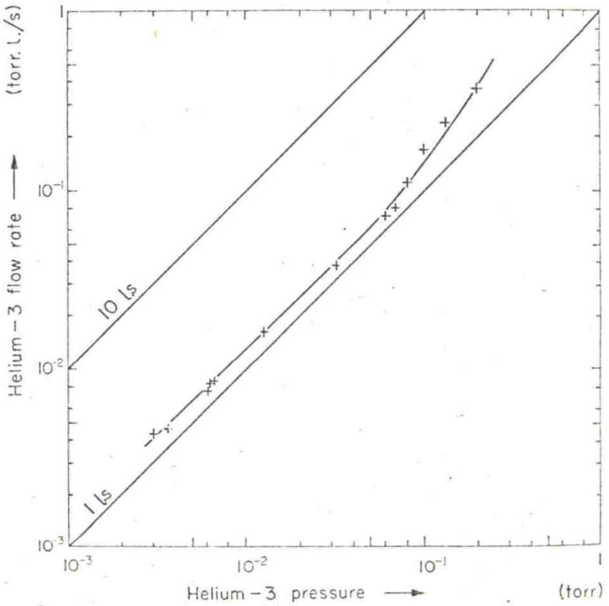

Figure 4. Cryosorption pump at 4·2° K

$$S = \frac{Q}{p}$$

At hydrogen temperatures the pumping rate proved negligible. At 4·2° K we plotted (Figure 4) the pump flow curve as a function of pressure, with 4·7 g of zeolite in the arrangement. In the linear section the pumping rate is 1·3 l./s The effect of saturation becomes evident by a slight decrease of the pumping rate when the adsorbed quantity reaches 100 cm^3/g.

On the basis of the above results we designed a cryopump for our cryostat, with greater capacity (adsorption