DRINKING-WATER STANDARDS

IT is frequently not realized that in Great Britain there are no legal standards of quality to which water supplies must conform; nevertheless the quality of our public supplies is such that it is automatically assumed that water from the tap is safe. This is not the case in many parts of the world, and in 1958 the World Health Organization published the minimum standards which it considered should be required everywhere in the world¹. It was always hoped that these standards would be surpassed in more highly developed areas, and a second publication has now appeared which recommends higher standards which should be attainable in all European countries².

The recommendations specify the minimum bacteriological and chemical qualities that should be expected of piped supplies of water for domestic use. In the section on bacteriological examination, methods of sampling are described, the organisms which should be regarded as indicators of pollution are discussed, and tests for coliform organisms, faecal *Streptococci*, and anaerobic spore-forming organisms are outlined, before specific recommendations for bacteriological

standards are made. It is considered that, in any water entering the distribution system, coliform organisms should be absent in 95 per cent of the 100-ml. samples taken each year, and that at least 100 such samples should be examined at regular intervals during the year.

In the section on physical and chemical examination the main requirements limit the concentrations of toxic substances (lead, arsenic, selenium, chromium, cadmium, cyanide and radioactivity) and give the methods of analysis which should be used to estimate them. In addition, limits are suggested for certain constituents of water which may give rise to trouble if present in excess (for example, fluoride, nitrate and zinc), and of others, such as free carbon dioxide, and hardness, which should preferably be controlled although they do not affect the hygienic quality of the water.

NORA H. JOHNSON

¹ *Nature*, **183**, 867 (1959).

² World Health Organization. *European Standards for Drinking Water*: Pp. 52. (Geneva: World Health Organization; London: H.M.S.O., 1961.) 2 Swiss francs; 3s. 6d.; 0.60 dollars.

SPECIFIC HEAT AND EXPANSION COEFFICIENT OF LIQUID HELIUM-3 UNDER PRESSURE BELOW 0.1° K.

By DR. D. F. BREWER and J. R. G. KEYSTON

The Clarendon Laboratory, Oxford

RECENT measurements of the specific heat of liquid helium-3 near its saturation pressure have shown that the second-order phase transition predicted by theory¹⁻⁴ does not occur above 0.008° K. Anderson, Salinger, Steyert and Wheatley⁵ found a linear variation of specific heat with temperature between 0.008° K. and 0.04° K., and Strongin, Zimmerman and Fairbank showed that no anomaly occurred between 0.054° K. and 0.085° K.⁶, the latter being the lowest temperature to which previous measurements had been made⁷. Unpublished measurements by us, also near the vapour pressure, between 0.03° K. and 0.1° K., covered the intermediate region. According to the theory of Emery and Sessler, the transition temperature, T_c , is given by the equation:

$$kT_c = 1.09 \frac{\hbar^2 k_F^3}{m} \frac{m}{m^*} \exp - \left(\frac{\pi}{2} \frac{m}{m^*} \frac{1}{t} \right) \quad (1)$$

(provided that the Fermi liquid model holds above the transition temperature), where $\hbar k_F$ is the Fermi momentum and m^*/m (the ratio of the effective mass at the Fermi surface to the true mass of the helium-3 atom) is equal to the ratio, as $T \rightarrow 0$, of the observed specific heat and the specific heat of a perfect Fermi gas with the same particle mass and number density as liquid helium-3. The quantity $1/t$ takes the values 5.56 for the Yntema-Schneider potential, and 5.46 for the de Boer-Michel potential between helium-3 atoms, yielding transition temperatures at the vapour

pressure which are only slightly below 0.1° K. (later modifications of the theory by Anderson and Morel (*Phys. Rev.*, to be published) and by Bardasis and Schrieffer⁸ reduce the transition temperature to about 0.01° K. and 8×10^{-4} ° K., respectively. Details of this work are not yet available, but according to Emery (private communication), the functional dependence of T_c on m^* would not be drastically changed from that given by equation (1)). Specific heat measurements by Brewer, Daunt and Sreedhar⁷ allowed a provisional computation⁹ of m^*/m at high pressures, and showed it to be increasing quite rapidly, in general agreement with the Fermi liquid model¹⁰. It follows from equation (1) that T_c will also increase with pressure, but the variation cannot be calculated with certainty since at the lowest temperature reached by Brewer *et al.* (0.12° K.) the specific heat was not linear in the temperature, and their values of m^*/m were not considered completely reliable.

We have now carried out measurements of the specific heat at constant pressure, C_p , at several different pressures between 15 cm. mercury and 27 atmospheres, and between the temperature limits 0.04° K. and 0.35° K. Again, there is no indication of any anomaly in the specific heat, which decreases smoothly with decreasing temperature, tending to a linear dependence at the lowest temperatures. We have also measured the change in temperature on adiabatic expansion and compression of the liquid near the melting pressure, and find that the mean expansion coefficient (over a range of pressure and