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SURFACE TENSION OF PARA-HYDROGEN

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The surface tension of para-hydrogen was measured between 17 and 20.5°K. It was found to be (1.5—2)% less than that of ordinary hydrogen.

ORDINARY hydrogen is as a rule a mixture of ortho- and para-molecules which have different nuclear-spin orientations in the hydrogen molecule. This difference leads to a dependence of several macroscopic properties on the ortho-para composition[1]. It has been established experimentally that in the condensed state ortho- and para-hydrogen have markedly different specific heats, densities, heats of evaporation, etc. In the present note we report measurements of the surface tension of liquid hydrogen at varying ortho-para composition.

The surface tension was determined from the difference in height (h) to which liquids rose in two capillaries of different diameters, using a previously described set-up[2]. To reduce the effect of all possible errors, the measurements were made by a relative method. Ordinary hydrogen (75 per cent ortho-hydrogen, 25 per cent para-hydrogen) was first condensed in the instrument at a temperature corresponding to the boiling point at atmospheric pressure. The difference in the capillary rises (h_0) was measured, after which the ordinary hydrogen was pumped out, the instrument filled with hydrogen having a different ortho-para composition, the value of h determined under the same conditions, the instrument was pumped out again and filled with ordinary hydrogen, etc. During each measurement the capillaries were immersed in the liquid enough to locate the menisci in the same sections of the capillaries.

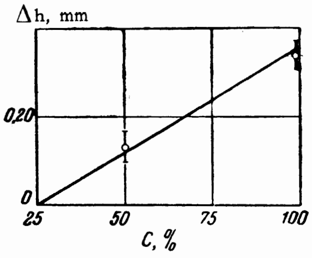

FIG. 1. Dependence of the difference in the capillary rises on the concentration of the para-hydrogen at 20.4°K.

Figure 1 shows the results of comparative measurements at 20.4°K on ordinary hydrogen and on samples obtained by desorption from activated charcoal at nitrogen and hydrogen temperatures. The difference $\Delta h = h_0 - h$ was plotted against the concentration of the para-hydrogen (the concentration was monitored by the saturated vapor tension of the liquid in the instrument). The experimental points represent average values of Δh, obtained as a result of ten measurements. We see that the difference in the capillary rises is much larger than the measurement error, and varies linearly with the concentration within the accuracy limits.

Figure 2 shows the temperature dependence of the surface tension of ordinary hydrogen and of hydrogen containing 99.8 per cent para-hydrogen.

The surface tension of ordinary hydrogen is described by the previously obtained relation $\sigma\,(\text{dyn/cm}) = 5.25 - 0.162T$[3], while the relation obtained for para-hydrogen is $\sigma\,(\text{dyn/cm}) = 5.27 - 0.165T$. At 20.4°K the surface tension of the

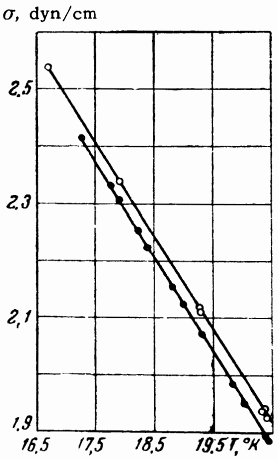

FIG. 2. Temperature dependence of the surface tension of ordinary H (o) and para-hydrogen (●).

para-hydrogen is approximately 2 per cent lower. With decreasing temperature, the difference decreases somewhat, but the change is almost within the limits of the measurement accuracy.

Using linear extrapolation of the plots of Δh (Fig. 1) and of the density [1] vs. the ortho-para concentration, we can obtain the surface tension of pure ortho-hydrogen. At 20.4°K we have $\sigma = (1.95 \pm 0.01)$ dyn/cm.

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