

The density of water to 25kbar/1873 K

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We have performed experiments in a piston-cylinder apparatus aimed at determining the density of water at pressures and temperatures of 9.5 to 25 kbar and 873 to 1873 K respectively.

At temperatures above 1173 K the experimental method involved growing inclusions of fluid (density < 1.0 gm/cc) in synthetic pre-cracked corundum. Density was then determined by measuring the homogenization temperature along the liquid-vapour equilibrium curve at low pressure. This method yielded data to 25 kbar/1873 K with an uncertainty of 1–2%. The main experimental difficulty came from a large scatter in homogenisation temperatures in our early experiments. We found that the corundum host tends to crack during the rapid quench of the piston-cylinder apparatus and that some of the inclusions leak, causing the observed scatter. The problem was resolved with a slow quench of 100–200°C per minute. Volume data in cc/mole are as follows, with temperature in brackets. At 9.5 Kbar: 22.56 (1203 K), 25.86 (1491 K). At 17.5 Kbar: 19.15 (1293 K), 19.54 (1393 K), 20.49 (1493 K), 21.47 (1593 K), 21.79 (1693 K). At 22kbar: 20.15 (1723 K) and at 25 Kbar: 19.61 (1873 K).

At lower temperatures we have attempted to determine densities greater than 1.0 gm/cc by

using the depression of freezing point of inclusions grown in quartz. In practise hysteresis requires that the method involve measurement of the melting point of the frozen inclusion. Due to the low density of ice the expansion of the fluid during freezing causes many of the inclusions to burst and may cause inelastic stretching. Therefore we are less confident of these data than of the low density results discussed above. Preliminary results are, however, at 873 K :- 17.5 cc (15.2 Kbar), 17.12cc (17.5 kbar). Comparison of the results with the many current equations of state for water indicates that, in the P-V-T range of the experiments, the equations of Kerrick and Jacobs (1981) and Brodholt and Wood (1993) provide the best fits. In contrast the steam tables of Haar *et al.* (1984) systematically underestimate the molar volumes at high temperatures.

References

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