

Pressure was measured with a wire resistance gauge. Such a gauge must be calibrated against a primary pressure standard or against pressure-fixed points, such as phase-transition pressures, which have been themselves accurately established relative to a primary standard. In this work the gauge was a loosely wound coil of 0.005-in.-diam Au-2.1% Cr alloy of about 13- Ω resistance. The details of the gauge preparation and calibration against a precision free-piston gauge have been given elsewhere.³³ The gauge resistance is determined with the aid of a six-dial potentiometer to an accuracy of 5 ppm, which means that it was possible to detect a pressure change on the order of 6 bar. The calibration of the gauge is given in Table I. The coefficients given there were obtained by a quadratic least-squares fit of the gauge-resistance-vs-pressure data. The standard deviation of the data from the least-squares curve was 0.00008 Ω in approximately 12 Ω , which is equivalent to 6 bar.

There is some difficulty with drift in the calibration of Au-Cr pressure gauges. A check on the gauge calibration at 21.9°C at the time of the velocity experiments showed that it had drifted by an approximately

TABLE I. Coefficients of the pressure gauge calibration curve, $\Delta R/R_0 = AP + BP^2$.

| Temperature (°C) | A (bar ⁻¹ × 10 ⁻⁶) | B (bar ⁻² × 10 ⁻¹³) |
|------------------|---|--|
| 21.9 | 1.070 | -4.7 |
| 40.5 | 1.057 | -7.4 |
| 52.9 | 1.044 | -6.2 |

linear factor of 0.4% ± 0.2% over the eight-month period between the free-piston-gauge calibration and the velocity experiments in such a way as to make the relative change of resistance smaller for a given change of pressure. Since it would have been prohibitively difficult and expensive to check the calibration at the other two temperatures, it is assumed that the calibration drifted in the same way for those temperatures. The calibration in Table I represents the corrected calibration and is therefore reliable to about 0.4%.

RESULTS

For the purpose of calculation, the measured pressure dependence of the sound velocity given in Table II is fitted to the equations

$$P = A + Bc_T + Dc_T^2, \quad (1)$$

$$c_T = A' + B'P + D'P^2, \quad (2)$$

where P is pressure and c_T is sonic velocity at temperature T . Equation (1) is found to give a better fit at each T since the standard deviation in each case is

³³ L. A. Davis and R. B. Gordon, Rev. Sci. Instr. 38, 371 (1967).

TABLE II. Sonic velocity in Hg.^a

| T=21.9°C | | T=40.5°C | | T=42.9°C | |
|----------|----------|----------|----------|----------|----------|
| Pressure | Velocity | Pressure | Velocity | Pressure | Velocity |
| 1 | 1450.1 | 1 | 1441.5 | 1 | 1435.8 |
| 299 | 1457 | 516 | 1453 | 464 | 1447 |
| 584 | 1463 | 932 | 1463 | 925 | 1457 |
| 989 | 1472 | 1 458 | 1474 | 1 485 | 1469 |
| 1 276 | 1478 | 1 930 | 1484 | 1 942 | 1478 |
| 1 532 | 1483 | 2 144 | 1488 | 2 511 | 1490 |
| 2 106 | 1495 | 2 769 | 1500 | 2 537 | 1491 |
| 3 254 | 1517 | 3 080 | 1507 | 3 019 | 1500 |
| 3 264 | 1518 | 3 893 | 1522 | 4 232 | 1524 |
| 3 490 | 1522 | 4 298 | 1530 | 4 548 | 1530 |
| 4 565 | 1542 | 4 483 | 1533 | 4 942 | 1537 |
| 5 772 | 1564 | 5 539 | 1552 | 5 470 | 1546 |
| 5 907 | 1566 | 5 642 | 1555 | 6 885 | 1572 |
| 6 138 | 1570 | 6 518 | 1569 | 6 915 | 1573 |
| 7 542 | 1594 | 7 168 | 1581 | 7 746 | 1587 |
| 8 310 | 1606 | 7 175 | 1581 | 8 255 | 1595 |
| 8 858 | 1615 | 8 309 | 1599 | 9 533 | 1616 |
| 8 950 | 1616 | 8 538 | 1604 | 9 954 | 1623 |
| 9 894 | 1632 | 9 399 | 1618 | 10 939 | 1639 |
| 10 695 | 1644 | 10 318 | 1632 | 11 203 | 1642 |
| 10 926 | 1648 | 10 384 | 1634 | 11 503 | 1647 |
| 11 485 | 1656 | 11 830 | 1656 | 11 792 | 1651 |
| 11 532 | 1657 | 11 922 | 1657 | 12 968 | 1669 |
| 11 985 | 1664 | 12 315 | 1663 | 13 023 | 1670 |
| 12 035 | 1665 | 13 270 | 1677 | 13 332 | 1675 |
| | | 13 709 | 1684 | | |
| | | 14 213 | 1691 | | |
| | | 14 695 | 1698 | | |
| | | 14 921 | 1701 | | |

^a Pressure in bars, velocity in meters per second.

about a factor of 3 smaller than for Eq. (2). Equation (1) presents a more reasonable picture physically since it predicts a steady increase of velocity with pressure while Eq. (2) predicts a maximum in c_T with pressure and a subsequent decrease. The standard deviations from the least-squares curve of Eq. (1) for the three experimental temperatures are shown in Table III along with the coefficients of the curves. The solid curves in Fig. 4 represent the least-squares equations.

It is possible to use the sound-velocity data described above, in conjunction with certain other data, to calculate the specific volume of Hg as a function of T and P . The calculation starts with the relation between the sound velocity and adiabatic compressibility

$$\beta_{ad} = 1/\rho c_T^2 \quad (3)$$

and the relation

$$\beta_T = \beta_{ad} + (T\alpha^2/\rho C_P), \quad (4)$$

where β_T is isothermal compressibility at temperature T ,

TABLE III. Least-squares coefficients of the curve $P = A + Bc_T + Dc_T^2$ and the standard deviation (σ) of the velocity data.

| Temperature (°C) | 21.9° | 40.5° | 52.9° |
|--|--------|---------|--------|
| A (bar × 10 ⁵) | 4.1489 | 3.9067 | 4.0715 |
| B (bar per m/sec × 10 ²) | -1.025 | -0.9885 | -1.006 |
| C (bar per m ² /sec ² × 10 ⁻²) | 5.096 | 4.976 | 5.034 |
| σ (m/sec) | 0.2 | 0.3 | 0.3 |