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EXPERIMENTAL DETERMINATION OF THE p — v — t RELATIONSHIP FOR HELIUM

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The thermal properties of helium have been studied experimentally by many research workers. The values of the compressibility of helium at pressures up to 107 bar and temperatures up to 400°C were obtained by Holborn and Otto [1]. For the temperature range 25 to 175°C and pressures up to 127 bar compressibility data were obtained by Gibby, Tanner, and Masson [2], and for the temperature range between −70 and +200°C and pressures of 100 to 1000 atm data were obtained by Wiebe, Gaddy, and Heins [3]. Keesom and Van Santen [4] determined the compressibility of helium on three isotherms (0, 20, and 100°C) for the pressure range 11 to 22 bar. Michels and Wouters [5] studied the p — v — t relationship for helium at temperatures of 0 to 150°C up to a density of 200 Amagat units. Schneider and colleagues [6-8] used the Bernett method to study the thermal properties of helium at low pressures up to temperatures of 1200°C. These properties were presented in the form of curves relating the virial coefficients to temperature. It follows from this review that for temperatures of over 200°C and pressures of over 200 bar there are no experimental data relating to the compressibility of helium.

In order to study the p — v — t relationship for helium we used a method involving a nonballistic piezometer (pressure gage) of the constant volume type with a "hot valve." After measuring the parameters of the experiment, p and T, a certain amount of helium was separated out in the piezometer by means of the "hot valve." Then the helium in the piezometer at the temperature and pressure of the experiment was passed into a "gas balance" and the mass of helium admitted was determined. The experimental method, the gas balance, and the experimental apparatus are described in [9, 10].

The specific volume of the helium for the parameters p and T measured in the experiment equals

$$v = \frac{V_p}{m}, \tag{1}$$

where V_p and m are the volume of the piezometer and the mass of helium in the latter at the experimental parameters p and T. After closing the hot valve, the helium was released from the piezometer and the gas balance was preliminarily evacuated. Thus a common pressure p_B was established in the piezometer and the main volume of the gas balance and the hot valve. The mass of helium m in the piezometer equalled

$$m = m_B + m_p + m_{hv} \tag{2}$$

TABLE 1. Comparison between the Experimental Values of the Compressibility of Helium and the Data Presented in [5] and [3]

Data presented in [5]				This paper			
p, kg/cm^2	t, °C	$\frac{pv}{1 \cdot v_0}$	z	p, kg/cm^2	t, °C	z	δ, %
187,909	150	1,63967	1,05897	187,913	150,00	1,05850	−0,04
292,153	150	1,68792	1,09014	292,147	150,00	1,09039	+0,02
Data presented in [3]				**This paper**			
206,646	100±0,1	1,4660	1,07370	206,651	100,01	1,07477	+0,10
413,292	100±0,1	1,5635	1,14510	413,297	99,98	1,14682	+0.15
206,646	200±0,15	1,8283	1,0560	206,653	200,03	1,05750	+0,14
413,292	200±0,15	1,9179	1,10780	413,296	200,00	1,11267	+0,44

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