DETERMINATION OF THE DENSITY AND THE COMPRESSIBILITY OF ACETYLENE.

By **Jitsusaburo SAMESHIMA.**

Received October 27, 1925. Published March 28, 1926.

Material. The acetylene gas was prepared by the action of water on calcium carbide and then passed through tubes of copper sulphate solution, chromic acid solution, potassium hydroxide solution, solid calcium oxide and phosphorus pentoxide successively, and then frozen by liquid air.

Density of Acetylene. The density of the gas thus prepared was measured by the Dumas' method at 0°C. and 25°C. and under various pressures. The results are shown in the following table.

Temp. degree	Pressure atm.	Volume of the Dumas' bulb c.c.	Weight of acetylene gr.	Weight of one litre of acetylene gr.	Relative value of pv	
					Taking $pv=1$ at 25° and 1 atmosphere	Taking $pv=1$ at 0° and 1 atmosphere
0.00	0.5341	143.422	0.08951	0.6241		1.0053
„	0.6279	143.424	0.10539	0.7348		1.0038
„	0.9988	143.431	0.16837	1.1739		0.9995
„	1.0007	143.431	0.16852	1.1749		1.0005
„	1.5096	143.441	0.25597	1.7845		0.9938
„	1.0000	143.431	0.16849 *	1.1747*		1.0000
25.00	0.9972	143.534	0.15371	1.0709	1.0002	1.0939
„	1.0067	143.534	0.15522	1.0814	0.9998	1.0936
„	1.6391	143.546	0.25386	1.7685	0.9954	1.0888
„	1.0000	143.534	0.15416 *	1.0740*	1.0000	1.0937

* Obtained by interpolations.

The volume of the bulb was 143.4310 c.c. at 0° and 143.5338 c.c. at 25° when the pressure inside and outside were the same. The contraction of the bulb by the addition of one atmospheric pressure outside was determined by the method given in Travers' book[1], the result obtained being 0.0195 c.c. The third column of the table was calculated from these data.

The value of pv at 0°C. will be expressed by the linear equation $pv=1.0114-0.0114\,p$, for the pressure range between 0.5 and 1.5 atmospheres. If we calculate $(pv)_{p=0}$ from this equation we obtain $\frac{(pv)_{p=0}}{(pv)_{p=1}}=1.0114$.[2]

(1) Travers, Study of Gases, London, 1901, page 119.

(2) Howarth and Burt (*Chem. Abst.* 19 (1925) 3176) obtained the value $\frac{(pv)_1-(pv)_0}{(pv)_0}=-0.00884$ or $\frac{(pv)_0}{(pv)_1}=1.00892$.

The weights of one litre of acetylene under one atmosphere are given in the table, thus 1.1747 gr. at 0° and 1.0740 gr. at 25°. The mean expansion coefficient of the gas between 0° and 25° under one atmosphere is $\frac{v_{25}-v_0}{25\,v_0}=0.0037496$. The weight of one litre of acetylene at 0° and 1 atmosphere as determined by other authors is :

1.1712, Leduc, *Ann. Chim. Phys.*, **15**, (1898) 36.
1.1791, Stahrfoss, *J. Chim. Phys.*, **16**, (1918) 175.
1.1695, Maass and Russell, *J. Am. Chem. Soc.*, **40**, (1918) 1847.

Compressibility of Acetylene. Two calibrated tubes, one of which contained acetylene and the other hydrogen, were connected with each other and dipped in a thermostat. These two gases were subjected to compression simultaneously by means of a bomb of compressed air, and the change of volume of each gas was observed. The pressure was calculated from the change in the volume of hydrogen. The following values were used for the compressibility of hydrogen.

Pressure atm.	pv at 0°C.	pv at 25°C.
1	1.0000	1.0915
5	1.0024	1.0940
10	1.0055	1.0971
15	1.0086	1.1004

The results of observations and the values calculated therefrom are summarized in the following table.

Temp. degree	Volume of gases observed		Pressure atm.	Relative value of pv	
	Hydrogen c.c.	Acetylene c.c.		Taking $pv=1$ at 25° and 1 atmosphere	Taking $pv=1$ at 0° and 1 atmosphere
0.00	2.6484	1.6756	1.000		1.0000
„	1.6062	1.0076	1.650		0.9919
„	1.4890	0.9328	1.780		0.9907
„	1.0770	0.6703	2.461		0.9846
„	1.0321	0.6418	2.568		0.9837
„	0.5935	0.3624	4.472		0.9671
„	0.3677	0.2183	7.234		0.9425
„	0.2513	0.1446	10.600		0.9148
„	0.2467	0.1415	10.798		0.9119
„	0.2366	0.1353	11.263		0.9095
25.00	2.8930	1.8309	1.000	1.0000	1.0937
„	1.2027	0.7515	2.407	0.9881	1.0808
„	0.6604	0.4064	4.389	0.9742	1.0655
„	0.3982	0.2396	7.291	0.9541	1.0436
„	0.3341	0.1989	8.697	0.9448	1.0333
„	0.2560	0.1499	11.368	0.9307	1.0180

The following values of pv have been obtained by interpolations from the above tables.

Pressure atm.	pv at 0°C. (Taking $pv=1$ at 0° and 1 atm.)	pv at 25°C. (Taking $pv=1$ at 0° and 1 atm.)
0.5	1.0057	1.0989
1.0	1.0000	1.0937
2.0	0.9891	1.0841
4.0	0.9708	1.0684
6.0	0.9530	1.0531
8.0	0.9360	1.0385
10.0	0.9194	1.0255
12.0	0.9026	1.0139

Laboratory of Physical Chemistry,
Faculty of Science, Tokyo Imperial University.