

containing temperature and pressure with our constant and rewrite Equation (23) in the form,

$$S_{298^\circ} = R \ln m^{1/2} a_1 a_2 \sigma^2 + S_2'.$$

Using the available data we have determined the value S_2' , and may rewrite our equation in the form,

$$S_{298^\circ} = 4.573 \log m^{1/2} a_1 a_2 \sigma^2 + 28.26, \quad (24)$$

where S is in calories per degree, m , a_1 and a_2 are in grams per mol and σ is in centimeters times 10^{-8} .

Applying Equation (24) to the only gases for which Sutherland has given values of molecular diameter σ and Latimer of entropy S we obtain the results shown in the following table:

Gas.	σ in cms. $\times 10^{-8}$.	S Experimental.	S Equation 24.	S Latimer.
H ₂	2.17	31.8	32.06	32.30
N ₂	2.95	45.6	46.36	45.42
CO	2.74	45.55	46.03	45.50
O ₂	2.71	48.2	46.68	46.08
Cl ₂	3.76	55.6 (50.0)	51.93	50.04

As far as expressing the experimental facts, there is little to choose between Equation (24) and Latimer's equation.

It is very unfortunate that Sutherland's data on molecular diameter do not include a diatomic gas with atoms having widely different atomic weights, since our Equation (24) and Latimer's show greater differences for such a case. Assuming, however, that the diameter of the hydrogen chloride molecule is the mean of the diameters of the hydrogen and chlorine molecules, Equation (24) gives 43.24 for the entropy of hydrogen chloride, Latimer's equation gives 44.49 and the experimental value is 43.25.

An exact correspondence between the experimental data and Equation (24) is not to be expected, since the derivation of the equation assumes a perfect gas with rigid diatomic molecules in the temperature range where the specific heat at constant pressure is exactly $7/2R$, and these conditions are presumably not exactly true for any actual diatomic gas.

The data on the molecular diameters and entropies of polyatomic gases do not seem suitable for testing Equation (15).

WASHINGTON, D. C.

NOTE.

Modifications of the Adiabatic Calorimeter.—The adiabatic method of calorimetry was introduced in 1905 by T. W. Richards.¹ In 1914,² I constructed a modified adiabatic calorimeter, in connection with my measurements on the heat of combustion of benzoic acid, which it appeared to me was more convenient in use. The heating of

¹ *Proc. Am. Acad.*, **41**, 3 (1905); *Z. physik. Chem.*, **52**, 551 (1905).

² *J. Russ. Phys. Chem. Soc.*, **46**, 935 (1914).

this calorimeter was accomplished electrically, the cooling by means of a current of cold water flowing through a metallic spiral. As the adiabatic jacket was filled with petroleum, the constant heating wire required no insulation. In 1916 Daniels¹ constructed an adiabatic calorimeter differing but slightly from mine, but adapted to the precise measurement of minute quantities of heat.

With the object of simplifying further the construction and operation of the adiabatic calorimeter, I have made certain modifications in a calorimeter recently constructed, which seem to me worthy of mention. First, I have simplified the construction of the detachable cover of the adiabatic jacket. This cover is usually attached by means of flanges and bolts to the lower portion of the jacket. I have made the inner wall of my calorimeter jacket shorter than the outer wall, and provided it with an annular slot at the top into which the downward-bent rim of the bottom of the cover will fit, and which can be sealed with vaseline, paraffin, or some similar easily melted material. This hydraulic seal affords a very convenient means of quickly removing the cover. Second, I have heated (or cooled) the calorimeter jacket by hot or cold water, introduced from without by means of a current of air. This air serves not only to inject the water into the calorimeter jacket, but escaping at the bottom of the calorimeter from a series of minute holes in the entrance pipe serves to stir vigorously the water in the jacket, and so to maintain a uniform temperature. By this method of heating or cooling the jacket, its temperature can be rapidly and certainly adjusted to that of the calorimeter.

The behavior of this apparatus can be seen from the following tabulated results.

Time, min.	Temperature of calorimeter. °C.	Temperature of jacket. °C.
0	1.821	1.821
2	1.820	1.822
5	1.822	1.823
REACTION STARTS.		
5.5	3.000	2.530
6.0	3.860	3.630
6.5	4.010	3.940
7.5	4.052	4.077
8.5	4.100	4.089
12.0	4.090	4.090

Evidently the temperature of the jacket can be brought to within 0.1° of that of the calorimeter in a minute and a half after the reaction starts, and to within a few thousandths of a degree in five minutes. The change in the temperature of the calorimeter due to a 0.1° thermal head is only about 0.0006° per minute, so that substantial adiabaticity is secured.

¹ THIS JOURNAL, 38, p. 1473.