graphite. Furthermore, each carbon atom is connected with the carbon atom directly opposite by its fourth bond consisting of two electrons rotating in long orbits about the two nuclei of these atoms. The six crossed orbits form a stable arrangement, accounting for the stability of the benzene ring. Similar electronic structures are proposed for naphthalene and anthracene.

In support of the proposed structures the evidence concerning this dynamic model of the shared bond is summarized. Crystal structure evidence is also advanced to show that the carbon atom does not always have four electron pairs arranged about it tetrahedrally, but may have other stable electronic arrangements, notably one with three electron pairs.

The properties of benzene, naphthalene and anthracene, in particular the sizes of their molecules, are discussed with reference to the proposed structures.

PASADENA, CALIFORNIA

[CONTRIBUTION FROM THE SIR WILLIAM RAMSAY LABORATORIES OF PHYSICAL AND INORGANIC CHEMISTRY, UNIVERSITY COLLEGE]

AN APPARATUS FOR THE ANALYSIS OF SMALL AMOUNTS OF VAPOR WHEN PRESENT IN PERMANENT GASES

BY IVAN ROY MCHAFFIE

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The apparatus to be described was constructed to measure very small amounts of water vapor present in air but might well be employed for other vapors and other gases.

It is essentially a device for measuring the mass of very small amounts of water (0.5 mg.) with an accuracy of 1 in 1000. The construction of the apparatus is shown in Fig. 1. One limb of a U-tube, A, which has a capacity of approximately 30 cc., is joined to a tap B and the other limb is connected with glass tubing to a mercury manometer G. A glass tube 78 cm. long is sealed to the bottom of the manometer and the other end is sealed to a mercury air trap H which is joined to a mercury reservoir with a length of rubber tubing. A McLeod gage is sealed to the side of the manometer at D. A two-way tap is placed at C. E is connected to mercury diffusion pumps; F to an aspirator bottle or other means of measuring the volume of gas passed through the apparatus. A glass scale calibrated to 0.01 mm. is mounted behind the manometer tube. The volume of A to the tip of a ground-glass pointer in the manometer tube is accurately measured.

As it is necessary in making a measurement to heat the apparatus to a temperature of 40° with a very low pressure in A, the tap B (as used by Professor F. G. Keyes) was constructed so that it would remain firmly seated as the tap grease softened. The small end of the barrel is closed by a small bulb, the plug contains a channel permitting the bulb to be connected to A, and hence it is possible to evacuate this small bulb and to close it off from the other portions of the apparatus. The plug is forced in by the pressure of the atmosphere and when well greased with suitable tap grease held a vacuum when heated to 40°.

The apparatus is mounted in an air thermostat, the side tube D and the tap C being outside. Plate glass windows are placed in the sides of the thermostat so that readings of pressure can be made. The front is so arranged that it can be removed.

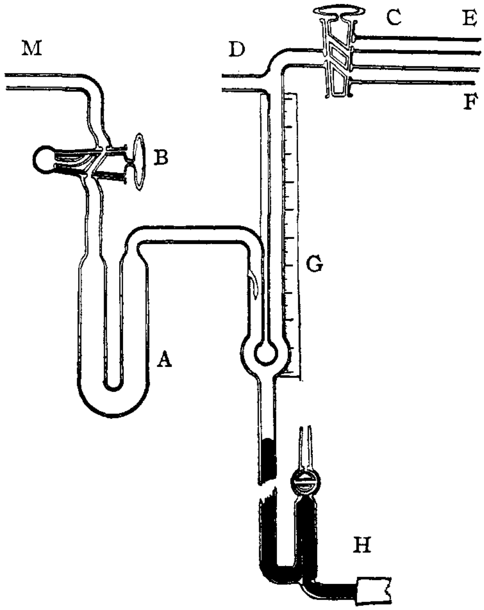

Fig. 1.

A determination of the dissociation pressure of sodium sulfate decahydrate was carried out as a test of the method. A tube containing a mixture of equal parts of sodium sulfate decahydrate and the anhydrous salt was attached at M. This tube was maintained at constant temperature in a thermostat. The apparatus was filled with dry air free from carbon dioxide and the U-tube A was then immersed in liquid air. Dry air free from carbon dioxide was then passed through the connected apparatus by means of an aspirator. When sufficient air had been passed through, B was closed and A evacuated to full diffusion-pump vacuum. The mercury was then raised into G and the liquid air removed. Readings of the pressure in A, due to water vapor, were then made, the temperature being maintained constant by the air thermostat. In order to determine the amount of gas (if any) present in A, other than water vapor, a reading was made at as low a temperature as possible. The amount was given by the difference between the pressure measured and the vapor pressure of water at that temperature. This residual gas was found to be carbon dioxide which had not been entirely removed from the apparatus. The pressures were read at successively increasing temperatures until the increase of pressure was proportional to that of the absolute temperature.

The plot of such a series of readings is given in Fig. 2. The significance of such a curve has been discussed elsewhere[1] and need not be detailed

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[1] McHaffie and Lenher, *J. Chem. Soc.*, **127**, 1560 (1925).

here. The data necessary for the calculation of the dissociation pressure are given in Table I, where *p* is the pressure.

TABLE I

THE EXPERIMENTAL DATA FOR SODIUM SULFATE DECAHYDRATE AT 154°

Temperature of the sodium sulfate system	15.4°
Temperature of the aspirator	15.1°
Water removed from the aspirator, cc	70.0
Barometric pressure	759.3 mm. at 16.5°

Temperature of A, °C.	*p* in A, mm.	*p* at 0° mm. of Hg	Vapor press. of H_2O, mm.	Diff., mm.
15.2	14.14	14.10	12.95	1.15
16.5	15.23	15.19	14.08	1.11
34.2	25.53	25.37	40.34	1.27 (calcd.)

The pressure in A at 34.2° is the sum of the partial pressures of water vapor and some additional gas present in A. The partial pressure of this gas at 15.2° was 1.15 mm.; at 34.2° the pressure would be 1.27 mm. The pressure due to water vapor is, therefore, equal to 24.10 mm. of mercury at 0°. The volume of A was 29.58 cc.

If p is the pressure of water vapor in A at the temperature T_m°K, T_a°K the temperature of the aspirator, B the barometric pressure, F the barometric pressure corrected for the vapor pressure of water at the temperature of the aspirator and V the number of cubic centimeters of water removed from the aspirator, then the dissociation pressure of the hydrated sodium sulfate in millimeters of mercury is given by the expression, $[29.58pB/T_m]/[(VF/T_a) + (29.58p/T_m)]$. Substitution in this expression of the values determined for 15.4° gives 9.59 mm. A second determination at 13.6° gave 8.29 mm. and a third at 25.0°, 19.24 mm. The values at these temperatures, interpolated from those given in the Landolt-Börnstein tables, are 9.54, 8.29 and 19.21 ± 0.02 mm., respectively.

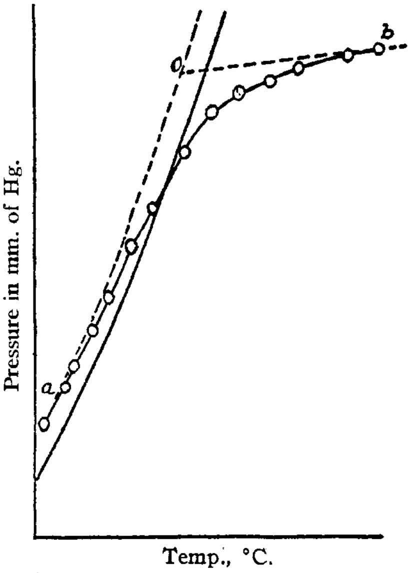

Fig. 2.—The solid line represents the vapor pressure of water.

The degree of accuracy obtained is comparable with that of other methods, while the present one has distinct advantages where the amount of vapor present in the gas is very small.

LONDON, ENGLAND