which flows forever, and is self-contained to the same extent as it is original.

WAHL-HENIUS INSTITUTE OF FERMENTOLOGY,
CHICAGO, ILL.

THE DETERMINATION OF TOTAL CARBON IN COAL AND SOIL.[1]

BY S. W. PARR.

Received December 26, 1903.

WHERE many determinations of carbon are to be made, the ordinary combustion process becomes a very heavy task. The method here offered was developed in the first instance for technical purposes, more especially in the study of fuel economy, but in practical use it has exhibited a degree of accuracy and a range of service which may give it wider application.

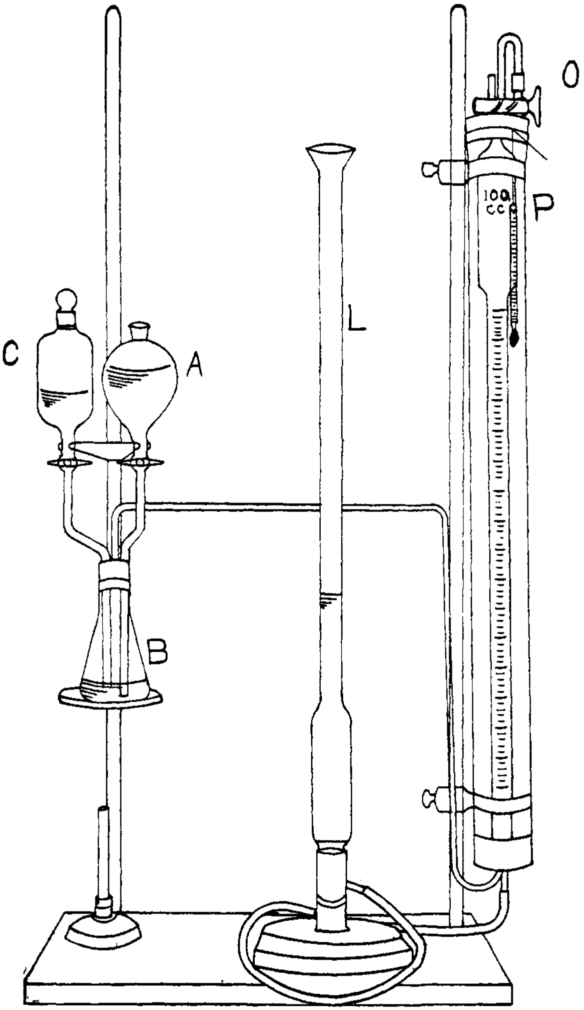
The material employed is the residue from the determination of heat values by means of the calorimeter, recently described by the writer.[2] The combustion of organic material is effected by means of sodium peroxide, the charge being contained in a closed bomb or cartridge surrounded by water. The resulting product, sodium carbonate, together with the excess of sodium peroxide is dissolved in a minimum amount of water and boiled for about five minutes to decompose the peroxide and remove all free oxygen. The carbon dioxide in the residue is determined by volume. To meet the conditions as to solution, volume, etc., the following apparatus has been devised. It has been found of much greater accuracy than various forms of alkalimeters, which have been tried for comparison, and its ease of manipulation makes it preferable to the absorption method, especially for technical work.

The holder A is of 200 cc. capacity and contains sulphuric acid of about 1.4 specific gravity. The flask B is of 125 to 135 cc. capacity. The receptacle C is for the solution of the carbonate. P is a jacketed gas burette with three-way cock at O. To operate, the acid is run in from A, filling B completely, and to the zero mark of the burette at O. Exactly 100 cc. of air at ordinary pressure is measured in the burette and this is forced over into the flask B,

---

[1] Read at the St. Louis meeting of the American Chemical Society.

[2] This Journal, **22**, 646.



thereby returning the greater part of the acid into A, leaving 25 or 35 cc. in the flask. With the acid cock closed and the cock at O open, the alkaline carbonate is admitted, thus liberating the carbon dioxide gas.

When the volume of liberated gas reaches the limit of capacity of the burette, the cock O is closed, the volume brought to atmospheric pressure by means of the leveling tube L, and after reading, discharged into the air, thus bringing the liquid in the burette to the zero mark at O. The cock is again opened to connect with the flask B. When the liquid from C is all admitted and the sides washed down, heat is applied to B. After boiling a moment, more water is added to C until B is completely filled to the zero point at O. The total volume of gas, minus the 100 cc. introduced to start with, is calculated to carbon at atmospheric pressure and the temperature indicated by the thermometer in the water surrounding the burette.

A correction blank is run in the same manner to determine the carbon dioxide in the sodium peroxide used. This correction factor is calculated to carbon and subtracted from all the tests made with the same lot of sodium peroxide.

Of course, all water used in any part of the operation should be recently boiled and this includes the water used to dissolve the fused residue from the cartridge. It is well to interpose a screen between the lamp and the jacketed burette. Unless the boiling is too long-continued, there is little danger of carrying over any appreciable amount of heat into P. The hand on the connecting tube will tell how far the steam has traveled.

The following table gives the results by this method in comparison with results obtained by means of the combustion furnace and absorption in potash bulbs. One-half gram samples of Illinois coal, oven-dried, were used in the work.

TABLE I.—TOTAL CARBON IN COALS.

No.	Kind.	Gravimetric. Per cent.	Volumetric. Per cent.	Variation from gravimetric. Per cent.
1	Bloomington lump	67.94	67.34	– 0.60
2	Carterville washed, No. 2	74.19	73.32	– 0.87
3	Danville lump	72.40	71.69	– 0.71
4	Elmwood, 3rd vein	72.55	71.84	– 0.71
5	Moweaqua	65.96	65.76	– 0.20
6	Odin pea	65.10	64.62	– 0.48
7	Pana slack	59.29	58.96	– 0.33
8	Ridgely pea	62.85	62.72	– 0.13
9	St. John lump	71.61	71.43	– 0.18
10	Spring Valley washed screenings	65.25	64.80	– 0.45

In the next table Illinois soils were used. The samples and gravimetric factors were kindly furnished by Mr. Pettit, of the Agricultural Experiment Station of the University of Illinois, and I am indebted to Mr. Chas. Edwards, who has worked out the volumetric results. In this work, 2-gram samples were used, and the amount of organic matter being insufficient of itself to complete the combustion, 0.5 gram of flowers of sulphur was used with each charge.

TABLE II.—TOTAL CARBON IN SOILS.

Sample No.	Volumetric. Per cent.	Average. Per cent.	Gravimetric. Per cent.	Variation from gravimetric. Per cent.
59	3.50 3.32 3.71 3.44	3.42	3.49	—0.05
119	3.23 3.11 3.08	3.14	3.24	—0.10
121	0.76 0.73	0.75	0.68	+0.07
473	1.06 1.02	1.04	0.01	+0.13
474	0.28 0.31 0.31	0.30	0.37	—0.06
475	0.14 0.08 0.11	0.11	0.13	—0.02
630	2.00 2.00	2.00	1.94	+0.06
661	4.25 4.07	4.16	4.15	+0.01
662	2.69 2.49	2.59	2.57	+0.02
690	1.32 1.29	1.31	1.31	—0.00

A sample of oxalic acid gave 19.08 per cent. carbon against 19.04 per cent., the theoretical amount.

UNIVERSITY OF ILLINOIS.

[CONTRIBUTIONS FROM THE UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION, NO. 11.]

THE DIRECT DETERMINATION OF POTASSIUM IN THE ASH OF PLANTS.

BY EDWARD MURRAY EAST.

Received December 18, 1903.

IN CONNECTION with a large amount of analytical work relating to soil investigations, it has been found necessary to have many determinations made of the elements nitrogen, phosphorus,