DETERMINATION OF WATER IN COAL.

By P. L. Teed.

At first sight the determination of water in quantities of coal would appear to be a simple operation in the hands of the assayer, and because of its simplicity one would expect great accuracy in the operation. In a paper read at a meeting of the Institute of Mining and Metallurgy, Mr. Teed makes clear, however, that the task does not admit of such accuracy as one might suppose. In his paper he endeavors:—(1) To show that in the simple drying method universally employed for determining the percentage of moisture in a fuel, reactions other than the simple volatilization of the water take place, which may materially affect the accuracy of the result, and (2) to describe an accurate and rapid though more complex process for determining the percentage of moisture in fuel. The method universally employed is that of taking a weighed quantity of 80-mesh coal, drying the same in a steam oven, and recording the loss in weight, but sources of inaccuracy exist due to the following reactions:—(a) Oxidation of pyrites making the result too low; (b) volatilization of matter contained in the coal making the result too high; and (c) oxidation of the coal itself making the result too high.

The following method has been evolved:—The apparatus, consists of a 100-cc. pressure flask, a "U" tube, of about ½-in. bore, and a sulphuric-acid drying tube, all of which must be capable of withstanding atmospheric pressure; besides these, sound rubber corks and some form of vacuum pump are necessary. With regard to the latter, the Sprengel water vacuum pump worked off the main supply has been found to give a reduction in pressure equal to about 725 mm., and to be in every way satisfactory.

The employment of the apparatus is as follows:—In the dry weighed flask a quantity of finely divided coal (80-mesh) is placed, and the weight of the same determined by difference; this flask is connected to the weighed "U" tube, whose limb nearest the flask is filled with lump quicklime, while that more remote is filled with finely-ground quicklime; this "U" tube is connected to the sulphuric acid drying tube, which is itself joined up to the Sprengel pump with an intervening tap. The pump is started and a vacuum gradually created (the speed of the outcoming gas being shown by the bubbles in the sulphuric acid drying tube); the flow of water through the pump is gradually increased, until a vacuum of about 700 mm. is created; then boiling water is poured into the beaker in which the flask containing the coal is standing, while to the beaker in which the lime tube is situated, a boiling aqueous solution of either sodium chloride or calcium chloride is added, care being taken that the corks of the tube are not wetted with the solution. The reactions taking place are as follows:—

Under the reduction of pressure and at a temperature of the boiling water surrounding the flask containing the coal, the water in the coal, together with volatile matter varying with the nature of the coal, distils off and passes into the lime tube where, in accordance with the following equation—

$$(CaO + H_2O = Ca,OH)_2,$$

the water originally in the coal is chemically retained, while the other volatile matter from the coal, owing to the absence of any chemical affinity for the lime, and the higher temperature of the lime tube (due to its being surrounded by a boiling aqueous solution of sodium chloride or calcium chloride), passes through to the sulphuric acid drying tube, where some of it is retained, discoloring the sulphuric acid, while other portions pass through to the pump.

At the end of about half an hour, the whole of the water having passed from the coal to the lime tube, the tap adjoining the vacuum pump is turned off, the beaker of boiling water surrounding the coal flask is removed, and the air gradually let back through the sulphuric acid drying tube into the apparatus; then the apparatus is taken to pieces, the lime tube washed, wiped, placed in a desiccator to cool, then weighed, the increase in weight noted (this increase is solely due to water from the coal) and the percentage of water in the coal calculated.

In the new method the two errors due to oxidation no longer exist, because the water is distilled from the coal in the absence of air, and consequently no oxidation can take place; with regard to the error due to volatilization of matter in the coal, something more must be said, for the volatilization still takes place, but since the temperature of the quicklime tube is higher than the coal itself, no condensation can take place in this tube unless chemical action takes place.

When determining the percentage of moisture in an anthracite, it was found that the increase in weight of the drying tube was greater than the loss in weight of the anthracite in the coal flask, by an amount far greater than would be accounted for the fact that the aqueous vapour in the air originally in the apparatus would be absorbed by the drying tube; naturally it was at first supposed that there must be some leak in the apparatus between the coal flask and the drying tube, but this, on performing a blank experiment, was not found to be the case.

The experiment was repeated, using anthracite in the coal flask, and it was found that while the increase in weight of the drying tube was equal to 2.78 per cent. of the anthracite employed, the decrease in the weight of the anthracite in the flask was equal to 2.52 per cent. This curious fact having been undoubtedly established, the author sought for some explanation of it, and could but conclude that when the water left the coal under the influence of the reduced pressure and heat, it left it in the physical condition of charcoal, capable, like charcoal, of absorbing many times its own volume of gas.

PRODUCTION POWER PLANTS.

The United States Bureau of Mines has published a study of the producer-gas plants using anthracite. Such a plant has large conservation and commercial possibilities. Government experiments for eight years have demonstrated not only a very low fuel consumption per horse-power hour, but also the possibility of utilizing commercially low grades of bituminous, lignite and peat.

There are in present use engines with aggregate capacity of 200,000 horse-power deriving this power from producer gas. Engines with power from blast furnace and coke oven gas aggregate 350,000 horse-power. The latter type is largely in steel works, the power being used for mills and furnaces.

There are producer-gas plants in 46 states, the District of Columbia and Alaska. From 1909 to 1912 such plants increased from 474 to 722, or 52 per cent. Horse-power increases from 11,250 to 187,140, or 68 per cent. Plants using anthracite increased from 415 to 610 and their power from 48,100 to 89,470; those using bituminous from 37 to 77 and power from 54,150 to 86,605; those using lignite from 23 to 32 and power from 9,000 to 10,230.

The producer-gas power plant has proved economical in obtaining power and in using fuels such as peat and lignite. Texas in 1912 had 28 producer-gas power plants, of which three used bituminous coal, six used anthracite and 19 used lignite.