It will thus be seen that while the calorific power of hydrogen is more than four times that of carbon, part for part hydrogen will reduce three times as much lead as carbon. As a set-off against this enormous source of error the whole of the oxygen contained in the coal in a free state will have to be satisfied with sufficient hydrogen to form water, before any lead becomes reduced.

Comparing sulphur to carbon it will be seen that the discrepancy is not so great, but a high percentage of sulphur will give by this method a calorific power higher than the truth.

The other method of taking the calorific power consists of first making an analysis of the coal, and then giving each component part its calorific power and adding the whole together : the whole of the oxygen is satisfied with sufficient hydrogen to form water, and the calorific power of the surplus hydrogen only estimated.

The calorific power of a fuel taken by this method is open to the following sources of error: (1) In the combustion of the coal, iron pyrites is converted into ferric oxide and the sulphur into sulphurous anhydride; in the presence of lime or other base this latter would remain behind with the ashes, and its calorific power would escape calculation. (2) The hydrogen in the water of combination which always exists in fireclay (a very usual constituent of coal ash) would be calculated as hydrogen (3) In the event of a coal containing a carbonate—and many coals contain carbonate of lime, while some of our Nova Scotia coals contain carbonate of iron—the carbonic acid would be evolved in the combustion and be calculated as carbon. In general practice it is found that the calculated calorific power is greater than that obtained by the calorimetric method, while that obtained by the Berthier method is less.

The following (taken from the report on coals suited to the steam navy by De la Bache and Playfair) are the evaporative powers obtained by calculations and the actual practical results obtained in boilers of a few British coals :---

Locality.	Calculated Evaporative power of 1 lb. coal.	Practical Result of 1 lb. Coal.
Ebbn Vale.	15.635 lbs. water.	10.21 lbs. water.
Mynydd Newydd.	14 904 '' ''	9 52 '' ''
Porthmawr.	12.811 '' ''	7.53 '' ''
Elgin Wallsend.	13.422 '' ''	8.46 '' ''

Of course in actual practice a certain amount of the coal escapes complete combustion, which accounts to a great extent for the wide difference between theory and practice, and then a by no means inconsiderable amount of heat is lost up the chimney stack and by radiation.

Turning to the sulphur contained in coal, its mode of combination is a matter of no small importance. It may appropriately be described as volatile sulphur, fixed sulphur and sulphur in ash

The first form is principally a matter of consideration for the gas manufacturer, as in the destructive distillation of coal, it will be evolved as either hydrogen sulphide or one of the sulphides of carbon. The fixed sulphur, or the sulphur contained in the coke, usually exists as a sulphide of iron, and is a matter of consideration to the iron manufacturer. The sulphur contained in the ash probably originally existed in the coal as a sulphate of sulphide of one of the alkalis or alkaline earths, or it may in the process of burning be taken from the sulphide of iron by an alkali or alkaline earth present in the coal. This last form of sulphur is not detrimental to the coal, whatever may be the use to which it is put. For steam and household purposes both the volatile and fixed sulphur are equally noxious.

Ashes of Coal The consumer too often contents hunself with a knowledge of the proportion of ash in a coal, while he utterly disregards its composition.

Much iron pyrites is very injurious to steam coal, for in the reduc-

ing atmosphere of the grate in which the coal is burned, the iron pyrites does not become oxidized, but remains in the ash, and falling to t bottom of the grate in a semi-liquid form, it comes in contact with the fire bars. Here it cuts off a considerable amount of the draught and stops its cooling effect on the fire bars, and they becoming heated are rapidly eaten away by the corrosive action of the sulphide. Similarly, when the composition of the ash is such that it sinters together, a clinker is formed on the fire bars, cutting off to a large extent the cooling effect of the draught, and consequently fire bars become heated and readily oxidized. It is exceedingly unusual to get an ash which is sufficiently fusible to run between the bars of the grate, unless it be mainly a sulphide of iron, which as we have already stated, is injurious to the fire bars. It is therefore advisable to try and select a coal with a difficultly fusible ash. Such an ash should be high in silica and may contain from 15 to 25 per cent. of alumina. It should be low in oxide of iron and very low in lime, magnesia and the fixed alkalics.

Many other forms of ash are of course equally infusible, for instance an ash mainly composed of an alkaline earth.

Provided the ash does not clinker, a comparatively high ash is rather beneficial in a steam coal than otherwise, for it holds the fire together and prevents it from too rapidly collapsing.

The physical as well as the chemical properties of a coal are a matter of considerable importance. Two coals may be obtained of approximately the same quantities of volatile matter, fixed carbon and ash, yet the one will coke and the other will not. The length and character of the flame is a matter of no small importance, as is also the character of the coke.

Samples—The samples received from the various mines were for the most part in fairly small pieces and showed no signs of unfair picking.

In taking the samples for analyses the whole box was turned out, the larger pieces broken, the whole carefully mixed together. From this a sample of about 10 lbs. was taken and crushed through a 4 mesh sieve. This was again carefully mixed and a sample of one pound taken and ground through a 60 mesh sieve, and from this the analyses were made.

METHODS OF ANALYSES.

Moisture—The powdered coal was heated in an oil oven at a temperature of 110° until the weight was constant and the loss taken as moisture.

Volatile Matter—The coal was heated in a closed crucible in a muffle in a reducing atmosphere, at a temperature below the melting point of gold and above the melting point of silver. The loss in weight, less the moisture, was taken as the volatile matter.

Fixed Carbon—The coke obtained from the previous experiment was heated in a muffle in an oxidizing atmosphere until oxidation was complete. The loss in weight gave the fixed carbon, while the residue gave the ash.

Sulphur—This was estimated by two and sometimes three different methods, all of which gave equally good results. For quickness the method in which the coal is mixed with about four times its weight of pure sodic carbonate, heated at first gently, and finally strongly, for fully an hour, the mass is turned into a crucible and digested with bromine water, then filtered, and the filtrate acidulated with hydrochloric acid, and the sulphur precipitated with baric chloride.

The second method was similar, only a mixture of two parts of pure magnesia and one part of sodic carbonate was used, instead of the sodic carbonate alone.

The third method, and one which gives very accurate results, consisted of heating the coal in a current of oxygen and passing the products of combustion through bromine water and hydrochloric acid and precipitating the sulphur as barium sulphate.