

It should also be noted that a very high rate is paid for the electric energy, as this is obtained from the municipal supply and is generated by steam. In Canada, utilizing water power, the current could easily be supplied at 0.2d. per kw.hr. corresponding to a charge of £6 per horse-power year based on 300 days a year continuous full load; consequently, in using the above figures as a base to figure out cost of production in Canada it must be borne in mind that although the cost of labor would be undoubtedly higher, the cost of electric energy would be only one-third and the total cost, as shown by the above figures, would be in the neighborhood of £2 os. od. per ton.

If a new iron works were planned in Canada electric reducing and refining should be used throughout and it is certain that with judicious arrangements adapted to the special requirements of the country such an undertaking would pay handsomely and the quality obtained would be so high that it would exclude the importation of a good many standard products of iron and steel.

Anybody interested in these matters need only look up the government's statistics on import to compile a very long list of raw material and half finished goods which could and should be made in the country.

THE OXIDATION OF COAL AND OF THE PROCESS OF COMBUSTION.*

By Horace C. Porter.

IT is well known from the work of several investigators in European laboratories and from earlier work at the Bureau of Mines that all coals unite with oxygen more or less at ordinary temperatures. The action is at ordinary temperatures largely a simple addition, very little gaseous products of combustion being produced. There is, however, a development of heat by the simple addition of oxygen, and this heat development is the primary cause of spontaneous combustion.

As the temperature rises, the oxidation reactions increase rapidly in rate, and the simple-addition reaction becomes complicated with the development of water and oxides of carbon as products of the oxidation and with the production of water and of methane and other gases by destructive distillation.

Under whatever conditions coal burns, as for example on the fuel bed of a boiler furnace or in suspension as dust in the air of a mine, the earlier stages of oxidation proceeding at the lower temperatures have important bearing on the ease of ignition of the fuel and the degree of inflammability of its dust. In order to throw more light on the nature of the combustion reactions at successive stages and to determine how the various kinds of coal differ in their rates of reaction with oxygen, a laboratory study has been made of the oxidation of coal, at temperatures ranging from 80 deg. to 300 deg. C.

A series of experiments has been run with samples of different coals placed in atmospheres of pure oxygen at a pressure reduced so as to equal the average partial pressure of the oxygen in air. The rate of absorption of oxygen by the coal was determined by admitting pure oxygen at

such a rate as to maintain constant pressure in the apparatus. Large differences in rate were found between different kinds of coal, and the comparative oxidation rates thus found conform in general to the known comparative degrees of inflammability of these coals.

At temperatures above 200 deg. C. the production of CO₂ and other gases causes a considerable error in an experimental method which does not remove these gases as they are formed. A rapid-stream method was, therefore, devised in which weighed samples of dry coal were heated at definite temperatures in a rapid stream of dry air for one hour, the change in weight of the coal being accurately determined as well as the amounts of H₂O, CO₂ and CO produced. From these data the total oxygen used and the oxygen fixed were calculated.

It was shown that the oxidation of coal consists in the earlier stages of the formation of an unknown complex of the coal substance with oxygen, and the more or less gradual dissociation of this complex as the temperature rises into water, CO₂ and CO. Below 200 deg. water is the chief product of this dissociation, the proportion of CO₂ in the products increasing as the temperature rises. Carbon monoxide is a primary product of the oxidation of coal at temperatures between 100 deg. and 300 deg. C. and possibly also outside of this range. Triangular diagrams representing the relationship of the three products H₂O, CO₂ and CO at different temperatures show interesting tendencies, e.g., toward constancy in ratio between CO₂ and CO within a certain temperature range.

The production of water by oxidation of coal at 100 deg. C. or lower is of interest in connection with the devising of methods for accurate moisture determination in coal. The direct production of CO at moderate temperatures is of interest in connection with mining operations and the storage of coal.

Returns made to the Bureau of Mines show that the metal output of Ontario for the first quarter of 1913 was as shown in the accompanying table:—

Product.	Unit.	Quantity.
Gold	Oz.	50,637
Silver	Oz.	7,264,559
Copper	Tons.	3,075
Nickel	Tons.	6,311
Iron ore	Tons.	15,389
Pig iron	Tons.	181,042
Cobalt and nickel oxides	Lb.	280,096

The principal gold producers are the Hollinger and Dome; but the McEnany and MacIntyre also contributed, as well as the Cordova in Hastings County, and the Canadian Exploration Company at Long Lake. The Foster-Tough mine at the new camp of Kirkland Lake is turning out some rich ore. The quantity of ore milled in all was 69,905 tons, the average yield of gold being thus a little under $\frac{3}{4}$ oz. per ton. The production of silver was nearly equal to that for the corresponding period of last year, being only some 74,485 oz. less. The mines of Cobalt proper furnished 7,253,595 oz.; South Lorrain, 198,381 oz.; Gowganda, 54,350 oz., and from gold bullion, 10,964 oz. Shipments amounted to 7,053 tons ore, 2,130 tons concentrates, and 1,926,160 oz. of bullion. Silver refineries in Ontario recovered 2,754,292 ounces. The Sudbury mines yielded 1,589 tons more of nickel and 538 tons more of copper than during the first three months of 1912. The producing companies are the Canadian Copper Company and the Mond Nickel Company, but a third company, which acquired the holdings of the Dominion Nickel-Copper Company, is actively preparing for production.

*An address delivered at the annual meeting of the American Chemical Society, Rochester, N.Y., Sept. 9-12, published by permission of the Director of the Bureau of Mines.