UNITED STATES PATENT OFFICE.

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COKING OF COAL.

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(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that I, STEWART ROY ILLINGWORTH, a subject of the King of Great Britain, residing at 6 Llantwit Road, Treforest, in the county of Glamorgan, Wales, have invented new and useful Improvements in the Coking of Coal, (for which I have made application in Great Britain on Feb. 28, 1920, Patent Number 164,104, accepted May 30, 1921), of which the following is a specification.

This invention relates to improvements in the coking of coal and has for its object to provide a better and more uniform quality of coke.

In the production of coke as at present practised, bituminous coal containing 17 to 35% of matter volatile at 900° C. is required and moreover the coke produced is not of average uniform quality and is in some cases of a type not wholly suitable for metallurgical purposes.

In the production of gas bituminous coal containing 30 to 40% of products volatile at 900° C. is required.

I have ascertained that all coals other than dry steam and anthracite, namely all coals containing more than 12 to 14% of volatile matter at 900° C., can be treated to produce coke provided such coal contain resinic material in sufficient amount. Coal suitable for treatment may be divided into types according to the amounts and stability of that portion of the coal which is decomposed below 500° C., that portion principally consisting in resinic, cellulosic and humic substances, and I have ascertained that both the cellulosic and resinic substances can be classed according to the temperatures at which they decompose.

Resinic substances are those portions of a coal or coal residue soluble in boiling pyridine and also soluble in chloroform.

β-cellulosic substances are those portions of a coal or coal residue soluble in pyridine but not in chloroform.

Humic substances are those portions of a coal soluble in caustic soda or caustic potash solution of about 5% strength.

We therefore classify coals as follows:—

Type I in which the humic, cellulosic and resinic substances decompose at or below 300° C.

Type II at or below 350° C.

Type III at or below 400° C.

Type IV at or below 450° C.

The best types of coking coal contain relatively small amounts of type II, large amounts of type III and smaller amounts of type IV, and gas coals contain these types but the amount of type II is greater than in the coking coals, and the more volatile gas coals contain considerable amounts of type I. If therefore gas coals are heated out of contact with air to 350° C., coals of the type I and II will be eliminated leaving a residue containing types III and IV, such residue being suitable for coke production.

The rate at which the substances above mentioned decompose when they have attained a certain temerature which is above their minimum temperature of decomposition depends upon the number of degrees which this temperature is above the minimum temperature; the amount decomposed will depend upon the time that the substances are maintained at this temperature.

The temperature and period of heating of coals can be therefore so adjusted as to eliminate from them the types of lesser stability in order to produce the types of greater stability, the temperature and duration of heating depending upon the nature of the coal used and the characteristics desired in the product.

According to this invention coal is heated out of contact with air so as to destroy as far as possible the β cellulosic and a part of the resinic substances contained in the coal but at the same time not sufficient to destroy all the resinic substances. The resinic substances are destroyed at a slower rate than the non-resinic substances and the quantity of the resinic substances (about 11% resinic and 29% β cellulosic) must not be reduced below 5% by weight of the product. It is preferred to conduct the process at a temperature below the minimum temperature at which the coal forms a coherent mass, usually below 400° C., so that a non-coherent product is produced which can be charged directly into the oven for carbonization at 900° to 1000° C. If a higher temperature than 400° C. is used it may be necessary to crush the product before coking.

As an example we may take coal of 40%

volatile which is a non-coking coal as it sinters or agglomerates on carbonization into patches, and heat this coal to 350° C. The product obtained is a coal suitable for gas manufacture giving an ordinary type of gas coke. The same coal heated to 400° C. for such a time that 6% of resinic matter was left in the product gave a dense coke suitable for metallurgical purposes.

Coke production is due to the coal first becoming plastic and subsequently undergoing decomposition. The porosity of the coke is determined by the amount of volatile matter evolved when the coal is in its most viscous state. An improvement in the quality of the coke results by eliminating the β cellulosic matters from coals containing resinic and β cellulosic matters before coking and thus decreasing the volatile matter evolved when the coal is in its most viscous state.

Every coal is characterized by a definite minimum temperature at which coke formation commences this temperature being above the temperature of the initial thermal decomposition of the coal. We are therefore able to select the temperature of initial heating of the coal so that the coal does not coke in the course of the preliminary treatment. Further, by adjustment of temperature we are able fractionally to decompose the resinic bodies without the production of coke even though the final temperature reaches 1000° C. For example the coal may be heated for a period at 300° C. followed by periods at 350° and 400° C., the durations of the periods being dependent upon the kind of coal. Thus a coal which would coke at 400° C. may be preheated without the product being coked and then by raising the temperature the product which contains the required quantity, preferably 10% of resinic matter is coked.

As an example, a coal forming a hard coke and giving 30% of volatile at 900° C., was found to form coke structure at 360° to 380° C. This coal was heated to 300° C. for 2½ hours out of contact with air and on the ash free dry basis lost 2.5% of weight and no coke or sintered product was formed. The temperature was then raised to 350° C. and the coal heated for 4 hours at this temperature, the further loss of weight was equal to 7% of the ash free basis. No coke or sinter was formed.

The temperature was raised to 400° C. and the coal heated for 2 hours at this temperature with further loss of 2%. No coke or sinter was formed. The product was of the same appearance as the original coal, but had no coking properties at any temperature above 400° C., and not even when heated rapidly to 900° C. Thus coking coals by utilization of successive stages of heating can be fully carbonized i. e. all volatile matter expelled, yet no coke be formed. The successive times of heating depend upon the nature of the coal.

In the present process it is possible to so preheat coals that in the preheating no coke formation results, and further the preheating in this manner can be arrested at any desired stage according to the nature of the product sought. The times of heating also depend upon the nature of the apparatus used; mechanical agitation of the coal will permit of a more rapid treatment, by virtue of a more rapid attainment of the desired temperature by the coal, and further if the change at one temperature is not wholly complete, the tendency of coke structure to develop at the next temperature considered will be prevented by the movement of the coal mass.

The preheating may be conducted in a separate furnace, the material being transferred to an oven or furnace for carbonization, or the preliminary heating may be conducted in an oven which is heated to a temperature usually below 400° C. and subsequently to the higher carbonization temperature.

The heated gases evolved from a charge undergoing carbonization may be used for the preliminary heating, the gases being cooled to the required temperature and then passed through the charge of coal.

What I claim is:—

1. In the art of coking coal the improvement which comprises submitting the coal out of contact with air to a temperature and for a time sufficient to destroy a portion of the non-coke producing substances in the coal, but to leave 5% by weight of the resinic substances in the product.

2. In the art of coking coal the improvement which comprises heating the coal for definite periods out of contact with air, such heating being sufficient to destroy a portion of the non-coke producing substances in the coal but to leave 5% by weight of the resinic substances in the product.

3. In the art of coking coal the improvement which comprises submitting the coal out of contact with air to a temperature below 400° C. and for a time sufficient to destroy a substantial portion of the non-coke producing substances in the coal but to leave 5% by weight of the resinic substances in the product.

4. In the art of coking coal the improvement which comprises heating the coal out of contact with air for definite periods at increasing temperatures in order to destroy a substantial portion of the non-coke producing substance in the coal but to leave 5% by weight of the resinic substances in the product.

5. In the art of coking coal the improvement which comprises heating the coal out of contact with air, to a temperature of

not substantially above 400° C. the temperature being so selected for the particular coal as to leave in the coal not substantially less than 5% of substances soluble in boiling pyridine and in chloroform, while destroying the bulk of the substances in the coal which are soluble in caustic alkalies, whereby a coal having good coking properties is produced.

In testimony that I claim the foregoing as my invention I have signed my name this seventh day of February, 1921.

STEWART ROY ILLINGWORTH.