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PRODUCTION OF SMOKELESS FUELS AND COKE.

No Drawing. Application filed July 31, 1922. Serial No. 578,814.

To all whom it may concern:

Be it known that I, STEWART ROY ILLINGWORTH, a subject of the King of Great Britain, residing at Brynfedwen, Radyr, in the county of Glamorgan, Wales, have invented new and useful Improvements in the Production of Smokeless Fuels and Coke, of which the following is a specification.

This invention relates to the production of smokeless fuels and coke by blending two coals or blending a coal from common or semi-coke or the products resulting from the process described in the specification of my former Patent No. 1,422,269 of July 11, 1922, or with iron or other ores.

In this connection the resinic content and the volatile content of the coals has to be considered. The resinic substances may be defined as those portions of coal soluble in boiling phenol or boiling pyridine and also soluble in chloroform. The resinic matter in a coal acts as a binder of the fixed carbon or residues of components of the coal which is formed on thermal decomposition. The fixed carbon from the resinic matter is a measure of its binding power. The amount of such fixed carbon varies with the carbon-hydrogen ratio—if this be below 14 the amount of fixed carbon is less than 20%; moreover coals of higher C-H ratio than this give less fixed carbon, and in the case of the lignitous non-coking type of coal of a C-H ratio under 15—16, the resinic matter is nearly always volatile below 350° C. This type of resinic matter is of little value as regards coke producing properties.

According to this invention the resinic content of the blend of the coals is not less than 5% but preferably not less than 8%. The same applies when a coal is blended with other carbonaceous material namely with coke, semi-coke or ore. In such blends the coals do not expand on carbonization and can be freely discharged from the retort oven or carbonizing chamber. The rate of rise of temperature through the horizontal cross section of the mass under carbonization, known as the temperature gradient, should be borne in mind as the slow heating of a coal results in the slow destruction of the resinic matter and when the resinic content is low it may result in the non-coking of the coal. A rapid rise of temperature throughout the mass ensures the mass reaching the stage of greater plasticity due to the liquature of the resinic content and the maximum shrinkage of the mass ensues. It is recommended that the blend be charged into retorts maintained at a temperature of 50–100° C. above that at which the resinic matter of the coal is destroyed. Any higher temperature can be utilized according to the nature of the products desired.

If it be desired to produce liquid bye products the carbonization is conducted at temperatures below 600° C. for above this temperature the bye products become a mixture of aromatic, olefinic and saturated non-aromatic compounds until at about 750° to 800° C. they are practically all of an aromatic nature.

According to this invention also when it is especially desired to increase the contraction of the blends of two coals when carbonized the effective volatile matter, namely the volatile matter evolved over a range of 350°–400° C., should be low, that is below 7.5%. In this connection it may be stated that high volatile lignitous non-coking coals which contain a large amount of oxygen commence to decompose at low temperature. Thus a coal with a C-H ratio 14 lost at 325° C. 5% of its volatile content as determined at 900° C. and there remained in the product an amount of substance decomposable between 300° and 400° C. but the volatile matter evolved between these temperatures was 8%, no resinic matter being left in the product. Such a coal blended with a coal containing over 8% resinic matter decomposable above 350° C. would produce a dense hard fuel which has contracted during carbonization. It is evident that in the process of carbonization the easily decomposable constituents in a non-coking coal pass away from the blend prior to the stage at which a structure of a resultant coke is formed by the decomposition of the more stable resinic matter.

When non-coking coals are used in which the thermal stability of the more easily decomposable constituents is of the same order as that of coking coal used in the blend the contraction of the charge is less marked. Hence in these cases a coking coal should be used, the resinic content of which is of greater thermal stability than that of the substances in the non-coking coal. The resinic matter in coals may be reduced by oxidation or the coals can be heated to a

temperature of 500° C. to eliminate the volatile matter and destroy all resinic matter. These coals can be blended with coking coals in order to reduce the resinic content of the blend.

A rough guide to the proper blend for coking at 500° C. is to determine the coking index of the blend by mixing the blend ground to 60 mesh with varying proportions of Calais sand which passes 60 mesh and remains on an 80 mesh sieve. 5 grams of the mixture of blend and sand is heated to 900° C. for ten minutes. The resultant mass is placed on a glass plate and a 500 grams weight placed on the mass. The strength of the mass will vary with the relative amounts of blend of coal to sand. That mixture which just supports the 500 grams weight is taken as the limiting one; the number of grams of sand to one gram of blend of coals denotes the coking index.

Blended coals may be treated according to the process described in my application filed August 29, 1921, Serial No. 496743, that is, the blend may be first preheated and then heated to a temperature required for the formation of coke structure, usually 500° C. or a temperature of 50°–100° C. above that of the minimum temperature at which the resinic matter in the content is destroyed. The product may subsequently without cooling be carbonized at any higher temperature up to say 900° C. to 1,000° C. according to the nature of the product required.

The advantage of blending is enhanced if the retort or oven tapers outwards in the direction of discharge. Thus a vertical retort charged from the top and tapering $\frac{1}{4}$ inch per linear foot downwards ensures freedom of discharge from the bottom of the retort.

The following examples further explain the process. In these examples the coals are such that all would pass through $\frac{1}{8}$ inch screen. It has been found that the fineness of the coals influenced the result and that the smaller the size below 10 mesh the greater the resinic content needed in the blend to give good results. The oxidation of coals influences the results; it is well known that in certain cases the coking qualities of a coal are destroyed by oxidation; it is now known that after a certain degree of oxidation has taken place coals which normally produce a porous coke do then give a coke of denser nature. The coals used were not coals that had become considerably oxidized.

Example I.—A bituminous coal evolving 31% (ash free dry) volatile matter at 900° C. and 15% (ash free dry) volatile matter at 400° C. and having a resinic content greater than 21% was blended with an anthracite coal evolving 10.7% (ash free dry) volatile substances at 900° C. and 0.5% (ash free dry) volatile substances at 400° C. and having no resinic content. The most satisfactory blend was bituminous coal 45% anthracite 55% the amount of volatile substances evolved by the blend at 400° C. being 6.75%.

Example II.—The bituminous coal of example I was carbonized at 500° C.; the product evolved 10% volatile matter at 900° C. and 0.75% at 500° C. and no volatile at lower temperatures. This product was mixed with the virgin coal in the following proportions: virgin coal 45%, product 55%. A dense hard fuel resulted when the blend was carbonized at 500° C.

Example III.—A semi-bituminous coal evolving 20.15% of volatile substances at 900° C. and 7.8% of volatile substances at 400° C. and having a resinic content of 11% was mixed with the anthracite coal of example I as follows: semi-bituminous 80%, anthracite 20%. The blend when carbonized at 500° C. gave a dense hard homogeneous fuel and a similar result was obtained when equal quantities of the semi-bituminous and anthracite coal were used.

Example IV.—A semi-bituminous coal evolving 17% of volatile substances at 900° C. and 2.5% of volatile substances at 400° C. and having a resinic content of 9.5% was mixed with 20% of the above mentioned anthracite coal. On carbonization a homogeneous fuel resulted.

In the claims the term "coke" is used to include a semi-coke or smokeless fuel.

What I claim is:—

1. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight, to a temperature not exceeding 500° C.

2. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight, to a temperature of from 50° to 100° C. above the minimum temperature at which the resinic matter in the blend is destroyed.

3. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight, and that a total volatile matter given off from the blend at 350° to 400° C. does not exceed 7.5% to a temperature not exceeding 500° C.

4. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight, and that a total volatile matter given off from the blend at 350° to 400° C. does not exceed 7.5%, to a temperature of from 50° to 100° above the minimum temperature at which the resinic matter in the blend is destroyed.

5. The manufacture of coke by heating a

blend of coal with other carbonaceous material such that the resinic content of the blend is not less than 5% but preferably not less than 8% of its weight to a temperature not exceeding 500° C.

6. The manufacture of coke by heating a blend of coal with other carbonaceous material such that the resinic content of the blend is not less than 5% but preferably not less than 8% of its weight to a temperature of from 50° to 100° above the minimum temperature at which the resinic matter in the blend is destroyed.

7. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight to a temperature not exceeding 500° C. and heating the product to a temperature higher than the temperature to which it has already been submitted.

8. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight, to a temperature of from 50° to 100° above the minimum temperature at which the resinic matter in the blend is destroyed, and heating the product to a temperature higher than the temperature to which it has already been submitted.

9. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight and that a total volatile matter given off from the blend at 350° to 400° C. does not exceed 7.5% to a temperature not exceeding 500° C., and heating the product to a temperature higher than the temperature to which it has already been submitted.

10. The manufacture of coke by heating a blend of two coals, which is such that its resinic content is not less than 5% but preferably not less than 8% of its weight, and that a total volatile matter given off from the blend at 350° to 400° C. does not exceed 7.5% to a temperature of from 50° to 100° C. above the minimum temperature at which the resinic matter in the blend is destroyed, and heating the product to a temperature higher than the temperature to which it has already been submitted.

11. The manufacture of coke by heating a blend of coal with other carbonaceous material such that the resinic content of the blend is not less than 5% but preferably not less than 8% of its weight to a temperature not exceeding 500° C. and heating the product to a temperature higher than the temperature to which it has already been submitted.

12. The manufacture of coke by heating a blend of coal with other carbonaceous material such that the resinic content of the blend is not less than 5% but preferably not less than 8% of its weight to a temperature of from 50° to 100° C. above the minimum temperature at which the resinic matter in the blend is destroyed, and heating the product to a temperature higher than the temperature to which it has already been submitted.

In testimony that I claim the foregoing as my invention I have signed my name this 18th day of July, 1922.

STEWART ROY ILLINGWORTH.