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COKING HIGH VOLATILE COAL

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The general object of the present invention is to provide a simple and effective method of producing a relatively strong and dense coke from coal having a volatile content of from forty to sixty percent, which is too high to permit its conversion into such coke by the customary methods used in the production of metallurgical coke.

At the present time, practically all of the metallurgical coke used in the world is made in by-product coke ovens of the horizontal regenerative type, and is made from a coal, or a coal mixture, having a volatile content which is seldom higher than thirty-five percent and usually is about twenty-five to thirty percent, and which is heated to a final temperature of the order of 1800° F. or higher. The volatile content percentages stated herein, are based on coal free from its actual moisture and ash contents.

My present invention was especially devised for, and is well adapted for use in coking so-called Illinois coals, having a volatile content in the neighborhood of forty-five percent, of which great quantities are available in this country for mining at a relatively low cost. When such a coal is treated in a byproduct coke oven of standard type, in accordance with the standard procedure followed in the production of metallurgical coke, the solid residue remaining after forty-five percent or so of the weight of the charge has passed away from the ovens in gas or vapor form, is in the form of coke, which is too porous and friable for practical use.

I have discovered, however, that a relatively strong and dense coke can be made from Illinois and analogous high volatile coals by a process comprising the following steps. The formation of a moist carbonaceous mass having a water content of from ten to fourteen percent and which in most cases is preferably about twelve percent of the weight of the coal including its ash content, and a carbonaceous content consisting wholly of light volatile coal in a finely subdivided state or, and preferably in many cases, of such finely divided high volatile coal in admixture with from two to five percent by volume coke in a subdivided state; the stamping or compression of the moist mass into compressed bodies adapted for insertion in coking chambers, and of such density that the weight of the non-volatile portion including the ash, of each body is approximately as great as that of a similar volume of metallurgical coke; the insertion of the compressed bodies in coking chambers and the heating of the coking chambers to temperatures similar to or slightly higher than the oven temperatures used in the standard production of metallurgical coke. In order that the charge may be heated to a suitably high temperature and with desirable rapidity, the coking chamber may advantageously be relatively narrow and in some cases the oven width may well be about thirteen inches.

In producing metallurgical coke from a good coking coal, in an oven charged through openings in its top wall, the dry coal density of the coal charge in the oven will normally be about .75 and with a normal average volatile content, the coke produced will weigh about thirty-five pounds per cubic foot of charge, and in proceeding in accordance with the present invention, I consider it ordinarily desirable to so compress the coking charges, that the coke produced will weigh from thirty-three to thirty-eight pounds per cubic foot of charge. In general, the weight of a charge produced in accordance with the present invention will be greater when the ash content of the coal is relatively high than when it is relatively low. For example, a charge of such composition that a portion thereof which when coked will contain seven pounds of ash will also contain twenty-eight pounds of carbon and will have given off twenty-seven and four-tenths pounds of distillation products in the coking operation, may well be compressed in accordance with the present invention to a dry coal density of 1, so that the compressed charge will weigh sixty-two and four-tenths pounds per cubic foot, and the coke formed with then weigh thirty-five pounds per cubic foot. Such coke may be expected to have a density and mechanical strength approximately the same as that of good metallurgical coke. It is practically feasible, when conditions make it desirable, to compress the coal to a density appreciably higher than unity, for example to a density of 1.05.

In the preferred practical mode of carrying out the invention, I first break the coal into such relatively coarse particles that, after being cleaned by any usual or suitable washing process, the coal mass will hold the ten to fourteen percent moisture content needed in the compressed charge forming cake or body. After washing or otherwise wetting the coarsely subdivided coal, I subject it to a breaker or grinding action to subdivide the coal so finely that about eighty percent of it will pass a wire mesh screen, i. e. a screen having eighty-one openings per square inch and adapted to pass particles about two millimeters in diameter. I next compress the

moist coal into a cake or body suitable for charging, and of the desired density, or, and preferably in most cases prior to the formation of the compressed coke, I intimately mix with the finely subdivided coal from two to five percent of coke. The latter may be coke breeze and in any event should be fine enough so that substantially all of it will pass a thirty mesh screen, i. e. a screen having nine hundred openings per square inch, and advantageously, in some cases, the coke should be fine enough so that substantially all of it will pass a forty mesh screen, i. e. a screen having sixteen hundred openings per square inch.

Finally the compressed cake or body or coal and coke is charged into a coking chamber or retort, and therein subjected to coking temperatures of the order of, but preferably slightly higher than those ordinarily employed in the so-called high temperature carbonization of coal to produce metallurgical coke. In such high temperature carbonization, the final coke temperature is of the order of 1800° F. whereas in the so-called low temperature carbonization of coal, the final coke, or "char," temperature is of the order of 1000° F. Ordinarily each compressed cake is made of proper size to form the entire charge of a coking chamber. However, in some cases, it may be desirable to compress the coal into briquette-like bodies and to form each oven charge of a stack of said bodies.

The compression of the charge may be effected by the use of charge stamping, or compressing, apparatus of various known forms of apparatus heretofore devised for use in forming compressed coal cakes to be charged into coking chambers, provided such apparatus has, or is given sufficient strength and power to effect the compression required for the purposes of the present invention, which is appreciably higher than heretofore customary in forming compressed coal charges. For the purposes of the present invention, the dry coal density of the compressed charge will normally be appreciably above .95 and usually will be 1 or greater, whereas heretofore, the dry coal density of stamped coal charges has ordinarily been below .95, and usually about .9.

Heretofore it has been assumed that a stamped or compressed oven coal charge should not have a height greater than about seven times the thickness of the charge. This has tended to the use of wider ovens with stamped coal charges than would otherwise be desirable. The greater density of a coal charge cake formed in accordance with the present invention, results in increased strength of the cake and permits the height to width ratio to be substantially greater than 7 to 1. In some cases the compressed charge bodies may be strengthened and their coking properties improved, by adding pitch to the coal either by mixing it in finely ground form with the coal, or by spraying liquid pitch onto the coal and then subjecting the coal to a mixing action prior to the cake forming operation.

A coal charge formed, compressed and coked in accordance with the present invention, does not swell, and ordinarily does not deform during the coking operation so that the taper in the oven chamber width, which is characteristic of the standard type ovens, is not needed, but on the contrary, is undesirable in the practice of my invention.

The coking portion of my improved process may well be carried out in regenerative coke ovens differing from those of standard type only in the omission of oven taper, and the large volume of distillation gases evolved may be subjected to the full byproduct recovery treatment customary in standard byproduct metallurgical coke oven plants. A practical economical advantage of my invention, however, is that it is practically possible, where a relatively low plant investment is desirable and there is no renumerative market for the distillation gases evolved, to coke the compressed charges in a coke oven battery without regenerators, and to dispense with byproduct apparatus. Even where low plant cost is especially important, however, I consider it ordinarily desirable to provide the relatively inexpensive equipment required for the recovery of tar from the distillation gases.

In such a low cost plant, the distillation gases may be used, partly in heating the coke oven battery and partly in firing steam generating boilers included in the plant for power purposes, and waste heat boilers may also be heated, or other industrial heating purposes served, by the waste heating gases passing away from the coke oven battery.

The fact that the compressed coal charges do not swell or deform during the coking operation, permits the walls between the heating flues and the coking chambers to be reduced in thickness without making the heating walls undesirably weak, and thereby permits the rate of heat transfer to the charge and the final coking temperature to be higher than is customary in the production of metallurgical coke with the same flue temperatures customarily employed in the manufacture of metallurgical, and also making up for some of the loss in thermal efficiency theoretically resulting from the non-use of regenerators. In my copending application for patent, Serial No. 330,049, filed April 17, 1940, I have disclosed and claimed a relatively simple and inexpensive waste heat coke oven especially devised and adapted for use in the practice of my improved process, but further references thereto are unnecessary in view of the fact that the present invention can be carried out in coke ovens of other types and forms.

The dimensions of an oven coal charge prepared and coked in accordance with the present invention may vary quite widely but by way of illustration, I note that in the practice of the present invention use may be made of a coke oven in which the coking chambers are 33½ feet long, 8 feet high, and 13 inches wide, and is intended to receive a compressed coal charge 7½ feet high, and 1 foot thick, and in which, the liner bricks forming the walls between the coking chambers and combustion flues have a thickness of 3 inches, instead of the thickness of 4½–6 inches customary in standard design coke ovens used in the manufacture of metallurgical coke.

By proceeding in accordance with the present invention, it is possible to produce from high volatile coal a coke strong enough to withstand handling and transportation, with little if any greater formation of breeze, than is produced in a similar handling and transportation of ordinary metallurgical coke. The coke produced by my process forms an excellent fuel, and because of its density and strength burns on a grate or in a fuel bed about as does ordinary metallurgical coke, and is a satisfactory substitute for the latter for domestic purposes and for many industrial purposes. The addition to the high volatile coal of from two to five percent of suitably sub-

divided coke adds to the mechanical strength of and improves the coke produced.

This application is a continuation in part of my prior patent application Serial No. 330,048, filed April 17, 1940.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The method of producing a coke similar in density and strength to metallurgical coke, from coal having a volatile content substantially higher than thirty-five percent, which consists in forming a moist mass having a moisture content of ten to fourteen percent and a solid content consisting wholly or mainly of the first mentioned coal in such a finely divided state that about eighty per cent will pass through a screen adapted to pass particles about two millimeters in diameter, compressing said mass into a body having a non-volatile content of from thirty-three to thirty-eight pounds per cubic foot, and coking said body in a coking chamber in which said body is subjected to carbonization temperatures of the order of or about 1800° F.

2. A method as specified in claim 1, in which the high volatile coal is mixed with from two to five percent of coke subdivided so finely that substantially all of it will pass a thirty mesh per inch screen.

3. A method as specified in claim 1, in which heat is conducted to the coking chamber through refractory material flue walls which are about three inches thick, and in which the flue temperatures are at least as high as the flue temperatures employed in the production of metallurgical coke in coking chambers having walls of not less than four and a half inches thick and in which the coke is heated to a temperature as high at 1800° F.

4. The method of producing a relatively strong and dense coke from coal having a volatile content of forty or more percent, which consists in subdividing the coal so that about eighty per cent will pass through a screen adjusted to pass particles about two millimeters in diameter moistening the coal, compressing the moist coal into a body having a non-volatile content weight of from thirty-three to thirty-eight pounds per cubic foot, and then coking said body in a retort in which said body is subjected to carbonization temperatures of the order of 1800° F.

5. The method of producing a relatively strong and dense coke from coal having a volatile content of forty or more percent, which consists in subdividing the coal so that about eighty per cent will pass through a screen adapted to pass particles about two millimeters in diameter moistening the coal and mixing therewith from two to five percent of subdivided coke, compressing the moist coal and subdivided coke into a body having a non-volatile content weight of from thirty-three to thirty-eight pounds per cubic foot, and then coking said body in a retort in which said body is subjected to carbonization temperatures of the order of 1800° F.

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