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GRAPHITE CONTAINING METALLURGICAL COKE AND PROCESS FOR ITS MANUFACTURE

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The present invention relates to the manufacture of coke and more particularly relates to coke compositions of caking coals and graphite and the process of coking such composition.

The primary object of the invention is to provide a metallurgical coke comprising a blend of caking coals and graphite, which coke serves as an excellent cupola fuel and at the same time gives positive increases in metallurgical carbon to help solve carbon control problems.

It is well known in the foundry industry that natural, amorphous graphite serves as a positive source of metallurgical carbon, and further that small amounts of graphite promote fluidity of the metal and reduce chill and hardness in grey iron castings when used as a ladle inoculant. An important object of the invention is to provide a method of blending caking coals and natural amorphous graphite in the manufacture of a graphitic coke which combines the aforementioned desirable effects of graphite addition by actually retaining a mist of graphitic carbon within the coke structure. This affords perfect graphitic carbon distribution throughout the coke splits and bed thereby giving the maximum graphitic effect, the graphite being released at the crucial moment in the furnace melting zone where it is in intimate contact with the metal.

A further object of the invention is in the production of a graphitic coke with small cellular structure and thick walls, plus low porosity, the coke being strong, hard, possessing high apparent and true specific gravity with a relatively low volatile moisture and ash as well as low reactivity.

Graphite, aside from being the most soluble form of carbon known is not "wetted" by molten slag and while being an excellent refractory, it is also rather inert chemically, necessitating heating to a higher temperature than coke carbon in order for it to burn readily. Because of these factors coupled with its high density and low volatile content, the added graphite keeps the coke surfaces clean and at a low reactivity. Because of the high marking power and self-lubricating action of graphite, it is an important object of the invention in the blending of the graphite with the coal to blend these ingredients in such a manner that the graphite is smeared over the entire coal surfaces whereby the graphitic property is transferred very effectively to the entire coke mass as it is made in the oven.

Further objects of the invention reside in the provision of a metallurgical coke which increases the cupola melting rate, enables savings in the metallic charge materials to the cupola, and enables the use of less coke.

The foregoing objects and others that will become apparent as the description proceeds are realized by preparing a coke from a caking coal and natural amorphous graphite, the graphite being preferably of the Mexican variety, and constituting 4–20% by weight of the coal before coking.

The best suited caking coals for use in the production

of the graphitic coke of the present invention have been found to be those in the following range:

Moisture	Up to 2.40%.
Volatile matter	20–27%.
Fixed carbon	62–74%.
Ash	6–14%.
Sulfur	Less than 1%.

To the coal is added prior to coking in a beehive oven, 4–20% graphite.

Because beehive coke has always been considered to be of a rather graphitic nature, the coking of the mixture is preferably carried out in a beehive oven, although there is no apparent reason to assume any change in result would occur if the coking were carried out in by-product or other ovens.

To obtain optimum results in the preparation of the coke, both the caking coal and graphite are first blended then pulverized to pass through a screen of 3/8" mesh or less, the more complete the pulverization, the better the final product. The pulverization of the coal and the graphite is conveniently carried out by passing the mixture through a double roll crusher.

The pulverized coal and graphite mass is then ready for coking. When the graphite addition is under 10%, exceedingly good metallurgical cokes suitable for cupola charges are provided, the preferable percentage of graphite addition in the formation of such cokes being approximately 4%. However, when the graphite addition is over 10%, it is necessary to add approximately 2% silicon to obtain a coke that approaches the required toughness, hardness and other desirable properties.

The thoroughly mixed mass of caking coal and graphite is then coked in a beehive oven for from 72 to 96 hours at temperatures ranging approximately from 1900 to 2400°, the preferable average temperature being in the neighborhood of 2000° F.

As noted previously, the preferable coke for cupola charges has been found to be that wherein the graphite addition is approximately 4% by weight of the coal before coking. The final product after coking contains about 7% graphite, is strong and hard, possesses a high apparent and true specific gravity with a relatively low volatile moisture and ash, low porosity and low reactivity.

Typical results of the 7% final product graphitic coke on the shatter and screen tests are given below.

	Per cent
Shatter test:	
Retained on 2" screen	90.63
Passing 2" screen, retained on 1½" screen	3.48
Passing 1½" screen, retained on 1" screen	2.41
Passing 1" screen, retained on ½" screen	1.34
Passing ½" screen	2.14
Screen test:	
Retained on 4" screen	72.17
Retained on 3" screen	24.35
Retained on 2" screen	1.83
Retained on 1" screen	.52
Retained on ½" screen	.08
Passing ½" screen	1.05

The indicated values for the specific gravity and porosity of the 7% graphite coke are as follows:

True specific gravity	1.968
Apparent specific gravity	.8336
Porosity, per cent	57.64

These results are compatible with those of conventional metallurgical cokes utilized in cupola charges.

Typical analyses of the graphitic cokes prepared in accordance with the invention are given in the following examples:

Example 1

Analysis of coke containing 4% graphite addition prior to coking:

	Per cent
Fixed carbon	89.24
Ash	10.32
Volatile matter	.44
Sulfur	.59

Example 2

Analysis of coke to which 10% graphite has been added before coking:

	Per cent
Fixed carbon	89.23
Ash	10.31
Volatile matter	.46
Sulfur	.65

Example 3

Analysis of coke to which 15% graphite has been added before coking:

	Per cent
Fixed carbon	88.66
Ash	10.79
Volatile matter	.55
Sulfur	.58

Example 4

Analysis of coke to which 20% graphite has been added prior to coking:

	Per cent
Fixed carbon	88.49
Ash	11.10
Volatile matter	.41
Sulfur	.67

In an actual foundry operation testing the graphitic coke against ordinary foundry cokes, the superiority of the graphitic coke was clearly established. The same cupola furnace was used for each of the heats set forth in the chart below. In heats I and II, the initial carbon content of the metal was 3.33% and the silicon was 1.18%. In the third heat, the first seven charges were identical to those in heats I and II; however, charges 8 through 10 contained only 2.90% carbon and 1.18% silicon.

	I Foundry Coke	II 4% Graphitic Coke	III Foundry Coke and 4% Graphitic Coke
Number of charges	11	11	11.
Total amount of each charge, lbs.	4,000	4,000	4,000.
Composition of each charge:			
High silicon pig iron	1,000	1,000	1,000 (charges 1–7). Mixed 1,400 (charges 8–11).
Low silicon pig iron	500	500	500 (charges 1–7).
Scrap wheels	1,300	1,300	1,300 (charges 1–7). 1,400 (charges 8–11).
Home scrap	850	850	850 (charges 1–7). 300 (charges 8–11).
Steel scrap	350	350	350 (charges 1–7). 900 (charges 8–11).
Coke bed, lbs	3,025	2,500	3,025 (foundry).
Coke splits (each)	550	450	(1–7 splits) 550 foundry. (8–10 splits) 450 graphitic.
Total coke	8,525	7,000	8,225.
Melting rate (tons per hour).	10.5	14.5	15.6.
Average initial carbon in charges, percent.	3.33	3.33	3.33 (charges 1–7). 2.90 (charges 8–11).
Average initial silicon in charges, percent.	1.18	1.18	1.18.
Average carbon at spout, percent.	3.58	3.73	3.62.
Average silicon at spout, percent.	.92	.93	.93.

From the chart, it can be seen that the utilization of the graphite coke, alone or in combination with conventional foundry coke in cupola furnaces is very effective, increasing the carbon pick-up of the metal, decreasing the amount of coke necessary, increasing the melting rate, enabling the use of less costly charge materials and less coke.

The figures set forth in the foregoing chart are not generic to all cupola furnaces since with so many variables involved, considerable care must be taken in making adjustments to the use of the graphitic coke in melting practice. The end result should be a lower bed, a higher blast pressure, a more efficient coke ratio, and a higher scrap content to produce the same carbon level with metal at the desired temperature and fluidity.

What is claimed as new is as follows:

1. In the manufacture of coke, the process of mixing natural amorphous graphite and caking coal, then coking the mixture.

2. In the manufacture of coke, the process of mixing natural amorphous graphite with caking coal, the graphite being 4–20% by weight of the coal, then coking the mixture.

3. In the manufacture of coke, the process of mixing natural amorphous graphite and caking coal, then coking the mixture in a beehive oven for from 72–96 hours.

4. In the manufacture of coke, the process of mixing natural amorphous graphite and caking coal, then coking the mixture in a beehive oven for from 72–96 hours, at temperatures below 2400° F.

5. The process of manufacturing metallurgical coke which comprises pulverizing caking coal to pass through a ⅜ inch mesh screen, adding natural, amorphous graphite to the pulverized coal in the ratio of approximately 4–20 parts by weight graphite to approximately 100 parts coal, thoroughly blending the mixture of graphite and coal into a substantially homogeneous mass, then coking the mass in a beehive oven for 72–96 hours.

6. The process of producing a graphitic coke which comprises pulverizing caking coal, adding graphite to the coal, thoroughly mixing the mass of graphite and coal distributing the graphite evenly throughout the mass, then coking the mass.

7. The process of claim 6 wherein the mass is coked in a beehive oven for at least 72 hours.

8. The process of manufacturing metallurgical coke which comprises pulverizing caking coal to pass through a ⅜ inch mesh screen, adding natural, amorphous graphite to the pulverized coal in the ratio of approximately 4 parts by weight graphite to approximately 100 parts coal, thoroughly blending the mixture of graphite and coal into a substantially homogeneous mass, then coking the mass in a beehive oven for 72–96 hours.

9. A coke composition comprising a blend of caking coal and natural amorphous graphite.

10. A coke composition comprising a blend of caking coal and natural amorphous graphite, the graphite consisting of from 4–20% by weight graphite to coal prior to coking.

11. A coke composition comprising by weight approximately 93% coal and 7% natural amorphous graphite.

12. A coke composition comprising by weight approximately 93% coal and 7% natural amorphous graphite of the Mexican variety.

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