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PROCESS OF PRODUCING IRON-COKE BODIES

Werner Peters, Wattenscheid, Heinrich Echterhoff, and Heribert Bertling, Essen, Germany, assignors to Bergwerksverbond G.m.b.H., Essen, Germany

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ABSTRACT OF THE DISCLOSURE

Production of ore-coke bodies characterized by high strength characteristics and high contents of reduced material by mixing finely divided ore and coking coal, adding water to the resultant mixture and forming pellets therefrom, coking the pellets by contacting the same with an inert solid carrier heated to the coking temperature and cooling the coked pellets.

This invention relates to iron-coke bodies of increased strength characteristics. More particularly this invention relates to the treatment of iron ore and coke in a way that renders the resulting bodies highly resistant to compression and abrasion.

In the processing or recovery of ores, most of the ores are brought into a finely divided form. In this form, the ores cannot be satisfactorily worked in blast oven or electrometallurgical processes. In order to improve their workability, these finely divided materials have been pretreated to form agglomerates of the fines as by sintering or pelletizing. In more recent times, it has been proposed to pretreat the fines so as to obtain the same in the form of shaped ore-coke bodies.

The ore-coke bodies produced in the known manner of coking from mixtures of ore and coke briquetted with pitch have poor strength characteristics unless they are briquetted with a large amount of pitch. Their content of reduced material is as a result however very low, amounting to about 20 to 40 weight percent. As a result the manufacture of ore-coke bodies is relatively rarely undertaken.

It is a major object of the present invention to provide a novel method of treating mixtures of ore and coal to provide a shaped body of high strength characteristics without the attendant disadvantages of the art.

It is a further object of the present invention to provide a novel method of treating mixtures of ore and coal to provide a shaped body of high strength characteristics and having a high content of reduced metal.

Other objects and advantages of the invention will appear from the following description.

In accordance with the invention it has now been found that ore-coke bodies characterized by high strength characteristics and having a high content of reduced material, at least 40% of the original metal present in the ore being in reduced form, are obtained by preparing pellets from finely divided ore in admixture with a coking coal by spraying such mixture with water, coking the green pellets in a finely divided heat carrier and cooling the coked pellets or bodies.

The ore-coke bodies thus obtained have a resistance to compression of over 100 kp. and a resistance to abrasion of only about 10%, as measure in a Micum drum.

The process of the invention has the additional advantages over the conventional procedures that the comparatively high costs of preparing briquettes is lowered and the coking time decreased through the use of heated carriers down to 5 to 90 minutes. Further in accordance with the invention the heat produced in the cooling of the ore-coke bodies using an inert gas stream can be recovered for further use in the process or for another unrelated use.

The ores with which the present invention is used include all finely divided ores and ore concentrates. Illustrative of the ores which can be used herein are iron ore, chrome ore, copper ore, nickle ore, tin ore, and lead ore.

As coking coal there is suitable any and all coals having a content of volatile components amounting to between 17 and 40%, and a swelling index falling between 1.5 and 9 to preferably of between 3 and 7.

In order to improve the coking, pitch or bitumen in minor amounts can be added to the mixtures.

The relationship of the ore to the coal in the mixture can vary broadly. The least amount of coal that can be used is that amount required for the reduction of the ore i.e., at least the stoichiometric amount required to reduce the ore. A greater quantity of coal in excess of that amount assures the completeness of the reduction. The ratio of ore to the coal preferably amounts to from 80:40 to 20:60.

In order to improve the durability and solidity of the green pellets it is advantageous to add small amounts of a binding agent as for instance bitumen or pitch to the mixtures. The binding agent is most advantageously used in amounts of 2–20% and preferably is used in amounts of from 5–12%. In addition inorganic binding agents such as bentonite can be used. Preferably these are employed in an amount of 0.1–5% and most preferably 0.2–1.0%. The particle size of the mixture of ore and coal should be less than 1 mm. and preferably less than 0.5 mm. Most preferably 40–60% of the mixture should have a particle size of less than 0.06 mm. It is even more desirable to have 20–70% of the mixture have a particle size of less than 0.06 mm.

The coking of the pellets can take place in a reactor with the filling material in a quiescent or agitated condition. As heat carrier, there may be utilized any finely divided inert material which is not decomposed at temperatures up to 1400° C. Such materials include fine coke or sand.

In order to obtain a rapid heating up of the green pellets, the ratio of pellets to heated carrier material cannot be too large. Advantageously an amount of heated carrier of about 20 to 40 fold that of the pellets is used. This results in that the green pellets are coked in a short time and the desired ore-coke bodies obtained.

The temperature required for the coking at the very least is 900° C. and preferably is from 1000–1200° C. This is an additional advantage over the art where temperatures in the range of 1500° C. have been required.

As the possibility exists that with too rapid heating of the green pellets to the coking temperature, the steam formed from the water contained in the innermost portions of the pellet may rupture the same, it is advisable to carry out the heating to coking temperature in two stages. In the first stage the pellets are heated to from 500–700° C. and then in a second stage heating to the final temperature required for coking. The two stage heating can be carried out in a single reactor or in two separate reactors. In the latter case, care should be taken that the heated pellets do not cool down too much.

In order to recover the heat freed in the cooling of the ore-coke bodies following the separation of the heated carrier material, the ore-coke bodies can be cooled with a circulating gas stream which can be utilized to provide heat for the process as, for instance, to heat up the carrier material, or otherwise.

Typical practice of the invention is exemplified in the following examples in which the details are given by way of illustration, and are not to be construed as limiting the invention.

Example 1

130 parts by weight of a chrome ore concentrate, 50 parts by weight of a long flame gas coal (37% volatile components, water and ash free) and 12 parts by weight of a solid pitch having a grain size <1 mm. were mixed together and the mixture fed in continuous fashion into a pelletizer tray. 27 parts by weight of water were sprayed onto the batch present on the rotating tray. The molded bodies or pellets thereby formed were then delivered into a furnace having a height of 10 meters where they were heated in admixture with coke fines preheated to 1200° C.; passage through the oven taking place in 45 minutes. In this manner an about 25 fold amount of coke fines were applied and the pellets entirely embedded therein. At the foot of the oven the pellets were separated from coke fines and cooled in a circulating gas stream.

The coked pellets have a high content of reduced ore, from 40–90% of the metal present being in reduced form. The coke content of the pellets lies between 5–80% and preferably 5–40%.

The size of the pellets amounts to from 5–40 mm. and preferably from 10–25 mm.

The recovered ore-coke bodies had a resistance to compression of at the least 100 kp. and generally of at least 120 kp. and a resistance to abrasion of 10% measured in a Micum drum. This type of apparatus has been described in copending U.S. application Ser. No. 486,205.

Example 2

120 parts by weight of iron ore in a mixture with 79 parts by weight of a bituminous rich coal (24% volatile components, water and ash-free) and 0.6 part by weight of bentonite were introduced into a pelletizing plate. 32 parts by weight of water were then sprayed onto the pellets. The green pellets were charged into a furnace which had been filled with sand heated to 700° C. The pellets left the oven after 40 minutes, were separated from the sand and passed into a second oven into which simultaneously there were introduced a 30 mold amount of sand heated to 1300° C. The pellets passed through the second oven in 30 minutes and following separation of the sand were cooled in a circulating gas stream.

The ore-coke bodies thereby produced had a resistance to compression of 95 kp. and a resistance to abrasion of 11% measured in a Micum drum.

85% of the original content of iron in the iron ore was reduced to metallic iron.

Example 3

80 parts by weight of an iron ore concentrate, 120 parts by weight of a bituminous rich coil (26% volatile components, water and ash free) and 0.6 part by weight of bentonite were mixed together. 31 parts by weight of water were sprayed onto the mixture present on a pelletizing tray. The green pellets were charged into a furnace together with sand heated to 650° C. The time of stay in the oven amounted to about 60 minutes. After the sand had been separated from the pellets, the pellets were introduced into a second oven together with sand heated to 1250° C. The pellets passed through the second oven in about 20 minutes and were cooled following removal of sand.

The recovered iron-coke pellets had a resistance to compression of 125 kp. and a resistance to abrasion of 10% measured in a Micum drum.

95% of the original content of iron in the iron ore has been reduced to metallic iron.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. Process of producing ore-coke bodies having high strength characteristics and high contents of reduced material which comprises mixing finely divided ore and coking coal, adding water to the mixture and forming pellets therefrom, coking the pellets by contacting the same with an inert solid carrier heated to the coking temperature and cooling the coked pellets.

2. Process according to claim 1 wherein said ore is a member selected from the group consisting of chrome, copper, nickel, tin, lead and iron ores and chrome, copper, nickel, tin, lead and iron concentrates.

3. Process according to claim 1 wherein said carrier material is a member selected from the group consisting of sand and coke fines.

4. Process according to claim 1 wherein said mixture additionally contains a minor amount of a member selected from the group consisting of bitumen, pitch and mixtures thereof.

5. Process according to claim 1 wherein said mixture additionally contains a minor amount of an inorganic binding agent.

6. Process according to claim 1 wherein said coking is carried out at a temperature of from 1000 to 1400° C.

7. Process according to claim 1 wherein said coking is carried out in two stages, in the first stage by heating to 500 to 700° C. and in the second stage by heating to 1000 to 1400° C.

8. Process according to claim 1 wherein said coking is effected in from 5 to 90 minutes.

9. Process according to claim 1 wherein said carrier is employed in an amount 20 to 40 times that of the pellets.

References Cited

UNITED STATES PATENTS

1,193,680	8/1916	Fulton	75—4
1,523,044	1/1925	Broek et al.	75—4
2,420,376	5/1947	Johansson	75—5
2,863,758	12/1958	Crane et al.	75—4
2,986,457	5/1961	Jones	75—37

L. DEWAYNE RUTLEDGE, *Primary Examiner.*

E. L. WEISE, *Assistant Examiner.*

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