

ALIEN PROPERTY CUSTODIAN

PROCESSES FOR THE TREATMENT OF SILICEOUS IRON-CONTAINING MATERIALS

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It is known that the iron oxide in iron ores can be reduced to magnetite by roasting in the presence of reducing coal gas and can then be enriched to a certain extent by magnetic separation. If, however, there is any stronger combination between iron oxide and silicic acid a concentration of the iron content cannot be obtained in this way because the reduced iron oxide remains coalesced with the silicic acid.

It has now been found that this difficulty can be obviated and the iron oxide can be loosened from the silicic acid to a much greater extent by subjecting the material containing iron and silicic acid, in particular of ores which have a low content of iron and a high content of silicic acid, to a special treatment. This treatment consists in maintaining a mixture of the starting material which contains iron and silicic acid, preferably in a state of fine subdivision, with mineral coal, brown coal, peat, bituminous shale or like carbonaceous combustible material at an elevated temperature which preferably does not exceed 600° C. while avoiding access of air or oxygen until carbonisation of the carbon-containing admixtures has occurred, after which the iron compounds can be separated, for example by a magnetic separator, from the residue which remains.

This loosening of the iron oxide from the silicic acid which is effected by the treatment of the present invention is due to the intense reactivity of the vapours from the carbonisation which, shortly after being released, have the tendency to decompose or crack at the elevated temperature. If therefore these vapours come into contact with metal compounds which contain oxygen, such as iron oxide, they remove oxygen from them by means of unsaturated hydroxyl groups with the formation of water. Since this formation of water proceeds within the molecular association at a temperature considerably above the boiling point of water, an excess pressure is probably produced in the molecular structure owing to the pressure of the steam which results in a thorough loosening. After this loosening has occurred the reduced iron oxide can be separated by mechanical means from the silicic acid.

The process in accordance with the present invention has great economical advantages in that, on the one hand, the loosening of the iron oxide from the silicic acid already takes place at the relatively low carbonising temperature of the admixed carbonaceous material, which in general lies between about 300 and 600° C., and, on the

other hand, in that valuable carbonisation products can be obtained in the same operation.

The course of the reactions which take place in the process of the present invention can be favoured and the reaction promoted by conducting through the material being treated or through the furnace containing said material a combustible gas or other washing gas. A preferred gas is pure nitrogen which contains no considerable proportions of carbon dioxide and oxygen, such as obtained for example in the Linde process for producing oxygen and does not contain more than 1% of oxygen.

Again special advantages from the point of view of heat economy can be obtained by subjecting the siliceous iron starting material before its admixture with the carbonaceous carbonisable materials to a preheating, for example by means of heating or furnace gases and then mixing them in this preheated condition with the carbonaceous carbonisable substances which may in some cases likewise be preheated. By using siliceous iron-containing starting materials which have in this way been highly heated as heat carriers, the carbonisation temperature of the admixed carbon-containing materials can be reached, so that the indirect supply of heat can be considerably reduced and the carbonisation in indirectly heated carbonising furnaces in the absence of air is considerably facilitated.

If it is desired to obviate the necessity, after separation of the iron compounds, for isolating for economical reasons the carbonisation products from the silicic acid or of working the coke and siliceous reaction mixture to form a useful product, the process can be carried out in such a way, in accordance with a particularly advantageous modification of the invention, that the siliceous iron-containing starting materials are treated, preferably in a fine state of sub-division, at an elevated temperature which preferably does not exceed 600° with the vapours which are split off when mineral coal, brown coal, peat, bituminous shale and the like is carbonised, any direct mixing with the carbonisable materials being dispensed with. If the process is carried out in this way and the siliceous iron-containing starting material is treated, not in mixture with coal or the like, but only with the vapours from the carbonisation thereof, a product is obtained in which reduced iron compounds with silicic acid are present in loosened form and from which the iron compounds can be separated, for example by magnetic separation or with the aid of solvents, the extent of this separation being con-

siderable and far greater than was formerly possible.

In particular, when the process of the invention is carried out in this manner, the treatment may be undertaken in a furnace to which the iron-containing materials and the substances to be carbonised are supplied separately, preferably in counter-current. This can be carried out by passing the finely pulverised iron-containing substance on the one hand and the substances to be carbonised on the other hand in layers which are separated, for example by a wire network or separate supports, together through a carbonising furnace in such a way that the vapours from the carbonisation, as they are split off from the carbonaceous material come directly into contact with the iron-containing layer to be treated. By using the counterflow principle a large output of treated ore or the like can be obtained in uniform stages of treatment with a small charge of carbonaceous material.

According to a further modification of the invention, the operation is carried out in two furnaces which are in direct communication the one with the other, in one of which the carbonisation is carried out and in the other of which the iron-containing material is heated to the carbonisation temperature and is brought into intimate contact with the hot vapours discharged from the first furnace. In this case also reduction of the iron oxygen compounds and loosening of the iron from the gangue is obtained. After the treated material has cooled, the iron fraction which has been loosened or become magnetic can be separated in this case also from the silicic acid by a magnetic separator. Likewise the iron which has been freed from the silicic acid can be extracted from the loosened material by dissolving it out chemically.

It has further been found that it is advantageous in all cases to subject the material to be treated, before the separation of the iron compounds from the silicic acid, to a disintegrating process preferably to fine grinding as the separation is considerable facilitated by this means.

The processes of treatment of the present invention can be used for all siliceous iron ores, minerals, sands and other materials, as well as for bauxite and the residues which accumulate in the recovery of alumina therefrom, and also for pyrites, for example such as is obtained in addition to heavy spar at Meggen in Westphalia and other similar materials.

For carrying out the process of the present invention all carbonisable materials which on carbonisation evolve vapours or gases similar to those evolved by brown coal and mineral coal,

such as for example various kinds of peat, bituminous shales, oil distillation residues and the like, can be used.

The consumption of carbonisable material in the process according to the present invention can be very considerably restricted while nevertheless maintaining favourable operating conditions. On the other hand, there are scarcely any losses of importance because the decomposed or cracked carbonisation product breaks up into lower benzines which can be recovered by condensation, while the carbonisation gas which is formed in large quantity can be utilised for heating the carbonisation furnace or the heater for the ore.

The iron ore concentrate which is accumulated in the form of a fine powder by the process of the present invention can either be melted out directly in a suitable furnace or after being briquetted can be introduced in a normal blast furnace.

Example 1

In a horizontal carbonisation furnace having a grate system of the Bartling-Honigmann type, the grate is sub-divided in such a way that coal and iron ore can be supplied to separate adjacent grate plates. The charging of the oven is carried out in such a way that 1000 kg of coal and 3000 kg of finely ground ore are passed together through the carbonisation zone. During this the grates are shaken so that an alteration of the position of the carbonisation material and also of the ore and therefore of its surface of contact with the gases continuously takes place. From the ore which has been pre-treated in this manner and is poor in iron and rich in silicic acid an iron concentrate which is suitable for being smelted can be recovered, after cooling, for example by magnetic separation.

Example 2

In a vertical carbonisation furnace which is externally heated, for example a furnace of the Borsig-Geisen type a carbonisable brown coal is carbonised. The hot vapours produced are drawn off and are conducted directly to a furnace for heating the ore which is of similar construction to known ore roasting furnaces and in which the ore is pre-heated to a temperature of about 500° C. and is kept in continuous movement by rotating the charge. This treatment loosens the finely disintegrated iron ore and the reduced iron oxide becomes more easily mechanically separable from the associated silicic acid. In some cases separation can be facilitated by grinding the treated material.

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