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Technological Parameters of the Process of Producing Metallized Iron Concentrates from Poor Raw Material

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Abstract: *In article the possibility of receiving the metallized concentrates from ferriferous ores with the low content of iron, for the purpose of preparation them to metallurgical processing is considered. It is shown that the following factors have significant effect on effectiveness of process of receiving the metallized concentrates: composition of ore, physical and chemical properties of ore, possibility of receiving pellets, type and consumption of reducer, etc.*

Keywords: *low-quality raw materials, enrichment, receiving ore and coal pellets, roasting, metallization, restoration, pyrometallurgy, magnetic separation, production became.*

I. INTRODUCTION

Iron ore fields of Uzbekistan belong to the category poor and complete iron-titanium, iron-titanium - vanadium ores of which it is characteristic extremely thin germinations of ore and nonmetallic minerals. At their enrichment it is not reached satisfactory division of ore and nonmetallic minerals even at very thin by crushing of ores. As a result of it the poor iron concentrates with the increased content of dead rock turns out. Besides, in the presence of a chemical bond between oxides of iron and dead rock, a considerable part of the connected metal is lost with tails, extraction of a valuable component in a concentrate at the same time remains low.

So for example, ores of the Tebinbulak field are densely - interspersed and massive. The main ore mineral – titanomagnetit, consisting of magnetite with thin lamellar of ilmenite. There is to a hematite also.

II. RELETED WORK

The Temirkan field is characterized by existence hematite, mixed hematite - magnetite and magnetite – hematite ores. Sueren-ata field is characterized hydrothermal sedimentary hematite-limestone type of ores. Are available also skarno-magnetite type of ores. [1] Application to such ores roasting - magnetic enrichments in most cases do not yield positive results. So, when roasting - magnetic enrichment the iron of the ores presented substantially by thin-pocket breeds of complex structure, iron content in a concentrate usually we do not exceed 53-55%, and concentration it in tails makes not less than 22-24%. It is explained to the main reviews by presence at these ores of significant amounts of iron-silicate minerals: the nontrolit, chlorite and the shamozit gaining magnetic properties in the course of roasting and passing at separation into a magnetic concentrate. [2.3] For implementation of high-temperature recovery roasting of ores to a metal state various methods are offered and tested in laboratory and semi-industrial scale. Use as reducer of steam coal or a coke trifle is provided in them.

Among them:

1. Roasting of ore in the rotating furnaces in poured ore coal - the flux layer known as RN process [4. 5];
2. High-temperature (1150-1350 ^{0}C) roasting the ore-coal of pellets in the oxidizing or neutral atmosphere on the conveyor indurating machine in the ring rotating furnace or periodically acting to a retort [6]. After thin crushing of pellets and the subsequent magnetic separation the concentrate with the high content of metal iron (75-85%) and extent of metallization can be received (Fe_{met} / Fe_{total}) • 100 about 80-95%.

III. OBJECTS AND METHODS OF RESEARCH

At the department of Metallurgy in Tashkent state technical university the technology at which direct enrichment of ore is combined by one of classical methods with high-temperature (1150-1350^{0}C) restoration the churlish of industrial products to metal iron is developed. Parts of iron separate dead rock and are allocated from difficult chemical compounds with difficult and reparable titanium dioxides, manganese, vanadium and chrome. Further parts coagulate getting the form rounded crushing that allows to take easier them at the subsequent a product and its magnetic separation in weaker magnetic field.

In the republic three fields of similar ores are known. Considering that two of them rather small (Sueren-ata and Temirkan), not our look it is expedient to conduct researches for mix of all types of ores. It is unlikely expediently on each field to develop separate technologies and to build the industrial company. With such sight of logistics it can economic be expedient.

Average test of ore had the following mineralogical structure; % (weight): 34,85 hematite, 26,00 magnetites, 0,33 sulfides, 38,82 dead rocks. In most cases residues of magnetite remained c only in the central part, especially large ore particles.

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Sometimes in hematite grains of magnetite with a diameter of 0,02-0,30 mm are observed, however considerably very thin germinations of hematite on magnetite meet more often. Dead rock consists of a small amount of quartz, chalcedony and mainly of a jasper – very thin mix of chalcedony with hematite.

Besides, in the ore particles which are located in the mass of quartz, chalcedony or jasper numerous inclusions of dead rock are found. The amount of these inclusions is often extremely small (from 0,01 to 0,02 mm) that does not allow to separate completely dead rock from ore mineral even at very thin to crushing and predetermines poor quality of a concentrate.

Trial experiments on magnetic separation of shredded ore showed expediency of application of the combined magnetic and gravitational scheme of enrichment at which receiving rich magnetic concentration fineness of 10-0 mm and thinner (1-0 mm) a hematite concentrate is possible. This concentrate can life is successfully allocated at gravitational enrichment the re-milling of tails and an industrial product of magnetic separation. Fe received according to this scheme industrial products from 30-34% which enrichment was in the classical ways not effective re-milling and directed to pyrometallurgical enrichment. As high-temperature roasting of ore - coal pellets is labor-consuming and expensive operations, the scheme of preliminary enrichment of ore is developed so that on this operation less amount of material arrived perhaps (an exit of industrial products from 34,74% of Fe made 18,11%).

The technology of receiving crude ore and coal pellets from the thin-milled of the materials supporting not less than 70-90% of fraction of-0,074 mm practically remains such those, as well as for ore granules, and can be realized on applied in the presents time granule - that will be coordinated with results of work. In view of high capillary moisture capacity of thin-milling fuel in comparison with a concentrate, the humidity of furnace charge for receiving ore and coal granules needs to be maintained 2-4% above, than by production of ore pellets. Crude ore–coal pellets from 20% of fuel (powder of the Angren coal) with a diameter about 10 mm of discharging before destruction loading of 0.8 kg, and after the drying – 1,0 – 1,2 kg / a pellet.

We conducted researches on definition of influence of temperature of roasting on some technological indicators of process of enrichment and a metalizing of iron ore pellets. Results of a research are given not by fig. 1-3. Experiments are given under following conditions: time of roasting of-15 minutes, diameter of a pellet about-10 mm, composition of furnace charge: 80% poor iron-ore and 20% of fuel. On rice 1. changes of content of iron in a concentrate depending on roasting temperature are presented.

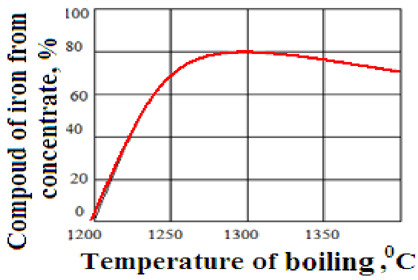

Fig. 1. Influence of temperature of roasting on iron content in a concentrate.

From fig. 1 it is visible that with increase in temperature of roasting iron content grows in a concentrate. It the phenomena can be explained as follows. For course of chemical or structural changes in a firm phase there has to be a movement of atoms. Various mechanisms of this phenomenon are possible. Transition of atoms from normal knots of a lattice in a nearby vacancy can be one of them. Vacancies exist in each crystal at all temperatures other than absolute zero. Speed with which diffusion of atoms in this case proceeds depends on ease of movement of atoms from normal knot in vacant and on concentration of vacancies. Movement of atoms in any direction is equivalent to wandering of vacancies in the antiput direction. Therefore in a similar case it is possible to speak about diffusion of vacancies.

One of options of this process is the so-called "relay" mechanism at which atom, being in an interstice, passes into normal knot, pushing out the atom which was earlier there in new between-packs. The valid mechanism of process in this system is defined by the relative size of energy, required for course of this process. Diffusive processes, as a rule, in many respects determine speed chemical reaction and agglomeration of particles.

The size of energy necessary for this purpose is called energy of activation of process, and the temperature dependence can be presented by expression:

$$D = D_0 \cdot \exp(-E/RT)$$

where E-the seeming energy of activation of diffusion.

Coefficient size diffusion and its change with growth of temperature increases and by that, reactions of restoration of oxides of iron accelerate.

Process of restoration of iron of oxides, according to Baykov's principle about the sequence of transformations, proceeds in steps by transition from the highest oxides to low according to the scheme [10] $Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow FeO \rightarrow Fe$ (higher than 570 ^{0}C) or $Fe_2O_3 \rightarrow Fe_3O_4 \rightarrow Fe$ (it is lower than 570 ^{0}C).

At the same time according to the chart Fe-O in a system there are not only lowest oxides and metal, but also solid solutions. Restoration of oxides of iron solid carbon perhaps on the following reaction;

$$3Fe_2O_3 + C = 2Fe_3O_4 + CO \quad -129{,}07 \text{ MDj}$$
$$Fe_3O_4 + C = 3FeO + CO \quad -187{,}28 \text{ MDj}$$
$$FeO + C = Fe + CO \quad -152{,}67 \text{ MDj}$$

For the last reaction,

$$\lg K_p = -7730/T + 7{,}84$$

Total negative thermal effect 4240 kJ/kg of iron.

At negative thermal effect of chemical reaction, according to Le-Chatelie's principle, increase in temperature shifts balance of reaction of restoration of iron from left to right, i.e. towards formation of metal.

Important indicator of concentrating process is extraction of a valuable component in a concentrate. On rice 2 results of researches on definition of this indicator depending on roasting temperature are put.

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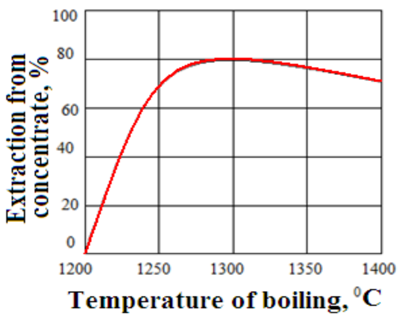


From data in fig. 2 it is visible that with temperature increase extent of extraction in a concentrate increases. It is a consequence of the fact that at high temperatures recovery processes proceed more intensively. However, extent of extraction remains quite low and it leads to the fact that a considerable part of iron is lost with enrichment tails. It can be explained with the fact that at heat treatment of the crushed iron ore materials the agglomeration phenomena are observed. It especially becomes more active if the porous pressed body is exposed to processing. Thus, agglomeration is shown at heat treatment as separate particles (for example, at restoration or roasting of concentrates in the boiling layer), and granules (crude pellets, briquettes).

The initial porous body is the system remote from a condition of thermodynamic balance at the same time in many parameters. It is caused by a big free surface of separate particles, existence of microdistortions of type of shift of atoms from regular provisions in a lattice, nonequilibrium defects of type of dislocations, excess vacancies, etc. At multicomponent structure of the disperse environment the unevenness of a system is caused also by the field of a gradient of concentration. At agglomeration, being irreversible process, there is both reduction superficial an energy of particles, and "curing" of separate defects, alignment of concentration. Solid-phase agglomeration influences process of restoration when processing ore and coal pellets. At restoration in the mine furnace this process is of great importance because the top limit of temperatures of restoration by a possibility of agglomeration of pellets in clusters with violation of the mode of process.

IV. RESULTS OF THE RESEARCH

Processing of iron ore materials during thermal recovery have, in comparison with clean to the phenomena, feature components from which first of all it is necessary to select:

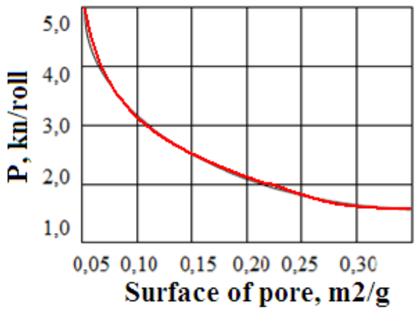
a) existence of bigger number of components (oxides of iron, silicon, aluminum, calcium, magnesium and so forth)

b) noticeable amount of the gases which are formed during process.

c) course of oxidation-reduction and solid-phase reactions (between magnetite and silicon dioxide, lime and hematite and other),

d) possibility of formation of a quantity of a liquid phase of variable structure and properties.

These features do not give the chance to use without changes of pattern of agglomeration, found, mainly, for metal powders. For example, iron ore material is the system remote from a thermodynamic equilibrium state in many parameters. As recovery processing is followed by chemical reactions, reduction free system energy as a result of course of reactions is characterized by more powerful flows of substance, than other processes. In other words, approach of a system to balance in one parameter can be energetically justified and in that case when it is followed by temporary remoteness from balance in other parameters. Practically it can be expressed in other process of change of porosity of granules, grains size, etc. Generally the pellet can be considered as a porous polycrystal with an extensive network of interpartial borders. The more area between grain of borders, the dense and strong pellet. Proceeding from it, objective criterion of behavior of iron ore particles when heating is the total area of interpartial contacts or the return value - the total area of contacts of a particle time which expresses a total or specific surface of a time. We conducted researches on determination of dependence of strength properties in pellets cold statuses from a specific surface of a time. The specific surface of a time was determined by a widespread pycnometric method. Results of researches are presented in fig. 3



From data in fig. 3 it is visible that with increase in a specific surface of a time durability of pellets significantly falls. Especially it is important to consider it when loading material in the mine furnace, as at the same time pellets can collapse that reduces gas permeability of furnace charge, increases dust-remove and the recoverability of oxides owing to change of aerodynamic conditions in the furnace decreases. Also furnace charge agglomeration since significantly are at a loss recoverability owing to decrease in a reactionary surface and formation of hardly reparable connections has an adverse effect.

V. CONCLUSION

From the conducted researches it is possible to draw a conclusion that successful operation of mine furnaces at work on the metallized raw materials is possible only when determining optimum parameters on enrichment raw materials and its metallizations. At the same time a materia has to have the sufficient hardness and recoverability.

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