Oxide-bearing iron ore processing to produce pigments for paint-and-varnish industry

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Iron oxides are among the most common colour pigments in the world. The world production of iron oxide pigments accounts for 600,000. tonnes a year and considerably exceeds other sorts of colour pigment making, with red iron oxide pigments being in much greater demand than yellow ones [1].

At present almost all iron oxide pigment production plants are located in the near abroad. Ukrainian enterprises greatly reduced their production due to ecological hazards of the out-of-date technologies. The Yaroslavl' plant principally meets only its own maintenance needs. Russia has almost no iron oxide pigments while all the elaborated and approved varieties of composition of paint materials include these very iron oxide pigments [2].

Nowadays the paint-and-varnish industry predominantly uses substitute goods instead of iron oxide pigments. The substitute goods are mostly metallurgical production waste, the latter being bright brown or red-brown in colour due to the presence of iron oxide pigments. The use of substitute goods instead of pigments has resulted in the paint materials quality decline, service life and storage time decrease. Such paint materials rapidly lose their protective properties and even hasten corrosion of the products or installations treated by them.

Thus, ecologically safe technology development for pigment ore production appears to be actual.

The research work on pigment ore production for the paint-and-varnish industry has been carried out at the department of mineral dressing of Saint Petersburg State Mining Institute. The work is aimed at technology planning of colour-bearing (pigment) ore recovery for the paint-and-varnish industry. The assumed capacity is 10,000–30,000 tonnes of pigment a year.

Samples of martite-hydrohematite ore have been analyzed. The ore was characterized by variable grading. The maximum prills were no more than 200 mm in size. Martite and martitized magnetite prevailed in the sample. Around 5 % of the debris included hydrogetite, lepidocrocite, and aggregates of hydrogetite and hematite. Sulphides were a very rare case.

Initially, an attempt to produce the pigment by a "dry" method was made, viz. the use of dry crushing, reduction, dry magnetic separation, roasting. The "dry" scheme seemed logical because the prepared pigment required roasting. However, the experiments have shown that when the time needed for applying this method increased fines yield (–50 μm) reached as much as 60–65 % and did not go up any longer because the powder tended to roll down into ultimate particles of different size. Apart from this, the original ore often has a high water content which hinders dry crushing.

Further investigations were conducted by a "wet" method. The processes of crushing, grinding, classification, magnetic separation, gravity dressing, and electric separation were studied.

It develops that dry ore (with water content less than 7–8 %) is readily crushed in conventional crushers (jaw-, cone-, cylinder crushers, etc.). Significant difficulties relevant to crushing since the material gets sticky results from moisture increase. Wet crushing in the cylinder crusher, particularly in that of the cone inertial type completely solves the problems.

Magnetic separation in a weak magnetic field is aimed at removal of magnetic minerals (martite, where clots are abundant,etc.) as potentially deleterious impurities. Depending on the contents and impregnation of different minerals, a one-, two-, and more stage magnetic separation has been tested. Let us note that the magnetic fraction can be used as a raw material for iron production.

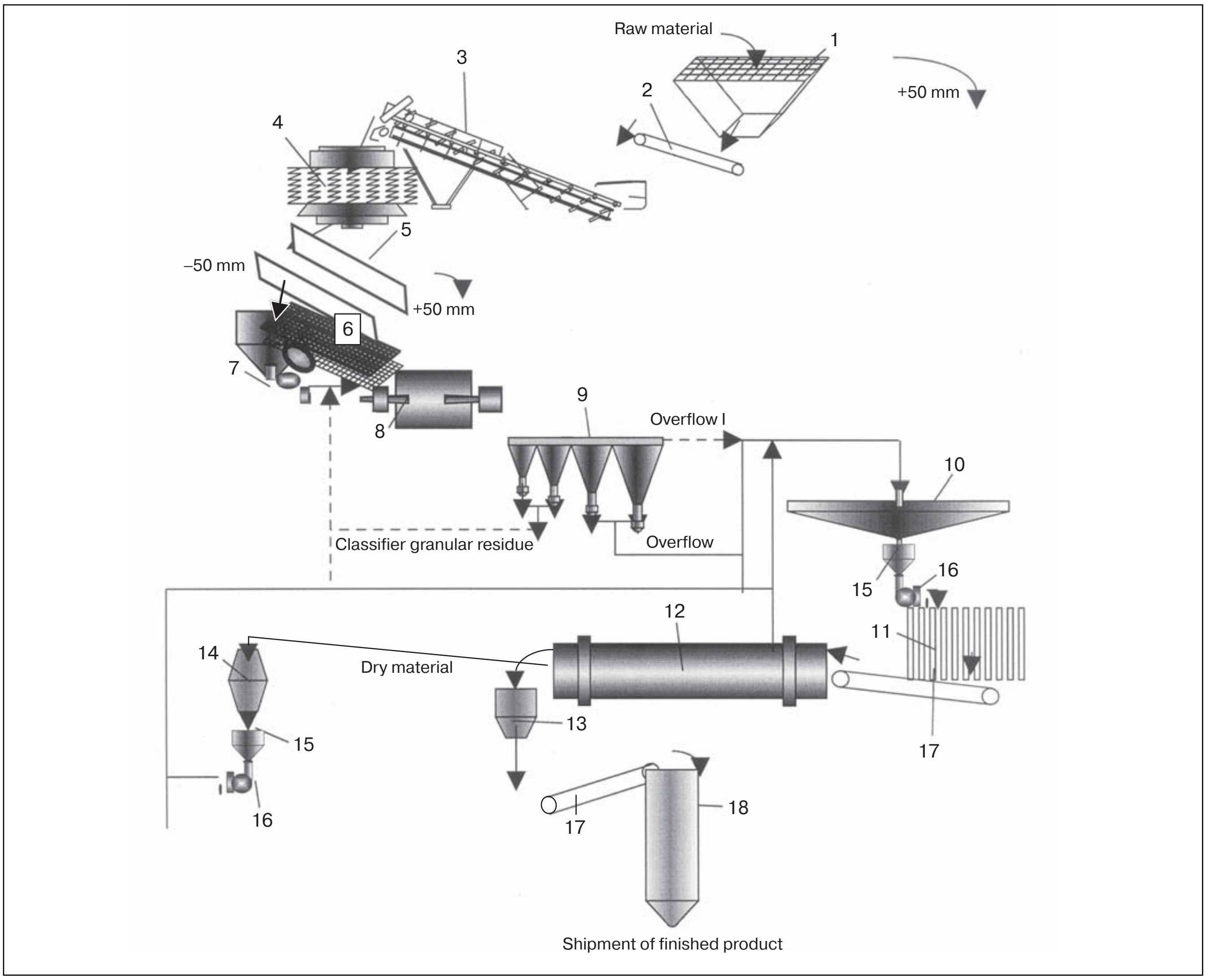
The classification of the ore crushed in the ball crusher in the hydrocyclone, mechanical and hydraulic classifying screen has shown a possibility of the material fineness-based clean-cut separation. Since the underflow consists primarily of mafic (deleterious) minerals, the classification also serves as a dressing process.

The table concentration experiments have shown that magnetic iron has an irregular distribution within the products, i. e. the sinking fraction chiefly contains mafic minerals. Concentration by jigging and concentration in screw-shaped sluice boxes and spiral separators bring results similar to those of table concentration (strong magnetic iron mainly gets into the sinking fraction). Concentration of classification and separation products has shown that the sample material is condensed satisfactorily, especially with the use of flocculating agents.

So, the following scheme of pigmental ore production (Figure) can be recommended, viz. raw ore enters the bunker (1) after sieving of class +50 mm with a grate or a bar screen. Class +50 mm is used as a raw material for metallurgical production. Then, by means of the feeding mechanism (2) and belt conveyor (3) the ore is discharged into the cone inertial crusher (4) operating in "wet" conditions. The crushed ore enters the vibration screen (5) for removal of class +5 mm, which is used as a raw material for metallurgical production. Class +5 mm accumulates in the bunker (6). From the bunker the material is pumped into the ball crusher (8), and the crushed material is discharged into the multichamber hydraulic classifier (9), e. g. of grade KG-4R.

The multichambered hydraulic classifier makes it possible to obtain several classes of material fineness, the production of several pigment grades being feasible. Classes of different fineness can be grouped in any order, too.

The classifier overflows enter the thickener (10), granular residue of which is filtered by the press filter (11); the



The apparatus chain scheme (description is presented in the text)

thickener overflows are used as recycled water. The press filter cake gets dry in the cylinder drier (12). The dry product is reground in the grinding mill, if necessary (13). Fume-laden gas, leaving the cylinder drier, is scrubbed by the wet dust collector (14), with the water returning to the thickener.

Also, if required, the hydraulic classifier granular residue can returned to the grinding mill for regrinding, and, consequently, for gain in the pigment grade yield.

In case of increasing in the contaminating impurity content, the scheme gets complicated by a number of supplementary dressing operations. In this instance, the scheme includes crushing in the crusher to the finess of –5 mm, separation (magnetic or by jigging), grinding in the ball crusher in the closed cycle with the hydrocyclone, thickening (by the circular thickener), filtration, drying and roasting [3].

In case of further ore composition degradation, the classification can be applied after grinding with removal of the granular residue from the scheme, followed by overflow magnetic separation, secondary grinding, subsequent magnetic separation, etc.

Such a scheme is rather flexible and can readily respond to the changing ore composition.

Besides, gravitational and magnetic separation was preliminarily tested (ore particles were separated simultaneously under the influence of gravitational and magnetic fields; and, considering the fact that magnetite separated from pigment minerals is denser, harder-grained and more magnetic, the separation being rather effective) [4].

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