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3,432,030

PROCESS FOR TREATING MINERALS

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No Drawing, Filed Oct. 15, 1965, Ser. No. 496,692
U.S. Cl. 209—5
Int. Cl. B03d 3/06; B03b 1/04

15 Claims

ABSTRACT OF THE DISCLOSURE

Process for beneficiating a mineral matter. The process involves extracting the mineral matter, which has been conditioned with specific conditioning agents, with a water insoluble, nonionizable organic liquid. The process enables the removal of discoloring impurities, particularly titanium dioxide, from mineral matter of any particle size.

The present invention relates to a process for beneficiating minerals and ores by separating and concentrating such mixtures into components by a selective extraction process. More particularly the present invention concerns a concentration process whereby discoloring mineral components are removed from aluminosilicious components such as kaolin clay; or valuable mineral or ore components such as iron oxide (Fe_2O_3) are separated from silicious components as silicon dioxide.

Impurities are invariably associated in nature with minerals and ores. Illustrative of such minerals is kaolin clay which occurs as a fine-grained mineral made up of particles chiefly 5 microns in size and smaller. Typically, kaolin clays are composed of a substantial portion of the desired kaolinite and may additionally have varying amounts of such clay minerals as nacrite, halloysite, endellite, dickite, montmorillonite, attapulgite and illite.

Kaolin clay as mined is impure, being mechanically associated with varying amounts of other clay minerals together with accessory minerals such as mica, quartz, feldspar, cristobalite, ilmenite, zircon, anatase, rutile and iron oxides. A pure kaolinite crystal is a hydrous aluminosilicate comprised of the elements hydrogen, oxygen, aluminum and silicon. In addition to those elements, it is said that about two dozen other elements may be detected in kaolin clay by chemical analysis. These additional elements include carbon, magnesium, calcium, sodium, potassium, iron and titanium. Since pure kaolinite is colorless, the commonly observed discoloration of kaolin clay must be attributed to impurity elements that are found either in an inorganic or organic form in the clay. These very finely divided discoloring impurities greatly detract from the value and usefulness of the clay for many applications, as for instance in the making of high quality paper, where a very white pigment is required.

Titanium dioxide (TiO_2), usually in the form of anatase and rutile, is recognized to be an extremely important discoloring impurity in kaolin; presumably this is because iron is incorporated into the crystalline lattice of the anatase and rutile to give a highly colored pigment, since pure anatase or rutile is ordinarily a very white substance. As little as 1% iron, or less, as impurity in anatase or rutile, will suffice to render it highly colored; the high refractive index of TiO_2 making it especially potent as a discolorant. As used in the application, the term "titanium dioxide" refers to the impure form of anatase and rutile.

Processes for separating and concentrating ores and minerals into components have included two general approaches; direct chemical attack on one or more components of the minerals and ores leading to their removal as new chemical compounds, or physical processes that

achieve selective separation of one or more of the components from the minerals and ores.

Direct chemical attack has not proven always to be completely effective and economically feasible. For example, while titanium oxide may be dissolved and substantially removed from kaolin clay by resorting to hot, strong acids, the kaolinite itself is thereby attacked, and its structure destroyed, thus degrading many of its valuable properties. With conventional bleaching processes employing weakly acidic, strongly reducing conditions, the gain in brightness of kaolin clay is limited, since the TiO_2 content of the clay remains unaffected.

Various methods of physically separating and concentrating minerals and ores are known in the art. A prerequisite to all such methods is that the feed material be crushed or ground to a degree of fineness such that mechanical interlocking between the various mineral components present has been substantially eliminated. Component separation of the minerals and ores can then be performed by a particle size classification step in those cases where the particles of the component minerals differ sufficiently in size. Kaoline clays, for example, are commonly subjected to a particle size classification step during processing in order to recover a fine kaolin fraction of better brightness and color; the coarse fraction resulting from this separation contains most of the sand and mica originally present. However, with domestic sedimentary kaolin clays, such as with the Georgia kaolins, it usually happens that while the fine kaoline fractions recovered from a particle size classification process have a better color, they also have an increased content of discoloring TiO_2 impurity, since titanium discoloring impurity mineral components in domestic sedimentary kaolin clays have an effective particle size distribution that overlaps the desirable clay size ranges. This seeming contradiction in brightness is explained by the fact that the brightness of a kaolin clay is powerfully controlled by its particle size as well as by its impurity content; the improved brightness of the fractionated kaolin clay is presumably caused by the much greater light-scattering and reflecting ability of the finer kaolinite particles that thus more than compensates for the presence of increased amounts of impurity. The increase in brightness, however, that can be achieved by reducing the particle size of the clay is inherently limited by the physical fact that particles smaller than about one-half the wavelength of visible light no longer scatter or reflect the light as effectively. Hence brightness is lost on reduction of particle size below about 0.2 micron.

A widely used method for accomplishing the physical separation of mineral and ore mixtures is the froth flotation technique. Herein a mineral mixture, crushed and ground, where necessary, to a size range generally between 40 and 200 mesh (ca. 400 to 74 microns), is made into an aqueous dispersion. The resulting aqueous mineral pulp is conditioned for flotation by agitation with a reagent capable of selectively coating, or oiling, a particular component of the feed, rendering that component non-wettable by water. Frothing is then produced by the admission of air to the agitated pulp; the collector-coated component of the feed, by attachment to the air bubbles, is carried into the froth, which is continuously removed; resulting in a froth product containing a large percentage of the oiled component of the feed, and a machine discharge product that is a concentrate of the non-oiled, water-wettable feed component.

It is essential in the froth flotation process that the component particles of the mineral and ore mixtures being treated have a size within a range bounded by an upper limit, above which the gravitational force acting on an oiled particle exceeds the strength of adhesion of the