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COMPLETE SPECIFICATION

Fluid for Gravity Separation and a process of Separation of Ores

We, KNAPSACK-GRIESHEIM AKTIENGESELLSCHAFT FÜR STICKSTOFFDÜNGER UND AUTOGENTECHNIK, a German company, of Knapsack Bezirk Köln, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

For the gravity separation of mixtures the individual constituents of which have various specific gravities, there have been used fluids which are prepared by the addition of finely divided solid gravity-substances to water or saline solutions. The specific gravity of these fluids can be increased by using solid materials of a high specific gravity. As materials of this kind, some of which may be used according to the present invention, there are known, for example: amidosulphonate of lead, fluorspar (fluorite) and hematite, iron oxide, heavy spar (barite), ferrosilicon, pyrolusite (manganese dioxide), roasted pyrites, floating agents capable of being magnetically influenced, hammer scale, sea-sand, clay, loam, and aluminium silicate.

The materials to be separated, for example ores and gangue, are separated in the aforementioned fluid for gravity separation, and in this case the part of lower specific gravity floats on top, whereas the heavier part sinks to the bottom of the fluid. According to the kind and quantity of the finely divided gravity-substance, the specific gravity of the separating fluid may be adjusted to different levels. The highest specific gravities are attained with pulverized galena and pulverized ferrosilicon. If the silicon content of the latter is not above a certain limit and if the ferrosilicon powder is still magnetic, it has the further advantage that it can be readily recovered from the flowing-off water, whereas, if galena is used, a flotation step has to be carried out.

When the gravity separation process is carried out in practice, the fluid for this separation is undesirably laden with very fine solid particles and the viscosity of the fluid gradually becomes so high that floating or sinking of the ores can no longer take place. These very fine particles originate from the dressed ores and also from the gravity substance itself which owing to the vigorous movement of the fluid undergo heavy abrasion. If ferrosilicon is used the rubbing off due to abrasion is very small owing to the hardness of the product, but it is nevertheless appreciable and undesirable.

The ferrosilicon powder has, hitherto, been obtained in the usual way from large pieces by a coarse crushing and a subsequent fine crushing, for example in ball mills. The particles must have a diameter not larger than 200 μ. Microscopic examination shows that these particles possess sharp edges and points. Just at these parts the abrasion is, of course, the greatest. If corrosive material is used which affects the pH value of the fluid, corrosion begins first at these sharp parts, and this is extremely detrimental for the entire process.

The present invention comprises a new fluid composition of matter for gravity separation of ores and a new process of concentrating ores by means of said fluid composition.

The present invention is based on the observation that solid, finely subdivided, heavy particles, such as for example ferrosilicon powder, do not show the afore-named drawbacks, if they have a hard, round and smooth surface produced by spraying from a melt.

According to the present invention a fluid composition of matter for gravity separation of ores comprises water and finely divided solid magnetic constituents, preferably ferrosilicon, in the form of hard, round particles having a smooth surface produced by spraying from a melt.

When fluid compositions of matter for gravity separation of ores are used containing particles of a rounded form according to the

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present invention, rubbings of these particles are essentially less than in the case of particles having sharp edges and points. It is not absolutely necessary that the particles be present in the form of balls; they may also be used in a globular, elongated, or drop-shaped form. When said particles are prepared according to the specified methods, most of them are obtained in a globular form of varying shape. The roundedness or the mathematical boundary of a spherical surface is, however, not the only characteristic of the present invention. In addition, there is the feature that the particles are distinguished by a particularly smooth surface, contrary to a surface showing sharp edges and points as is produced, for example by grinding ferrosilicon lumps. The smooth surface may, for instance, be produced as follows: the liquefied material is disintegrated to form very fine particles and suddenly quenched to cause it to solidify. The individual particles tend to form a very small surface, and a round shape and a smooth surface are formed.

Contrary to powders obtained by grinding, powders used according to the invention have the advantage, that they are resistant to corrosion and in particular when using them as materials for gravity separation of ores. No reaction takes place with the water used for the preparation of the fluids, or with the oxygen dissolved therein. The resistance to corrosion of the material may, in some cases, also be due to its chemical composition; the nature of the surface is, however, the essential feature. Hence it results, that in intimate contact with water even the finest portions of smooth ferrosilicon powder according to the invention do not develop hydrogen. If the same powder of smooth round particles is crushed in an agate dish, without coming into contact with another metal, noticeable evolution of hydrogen sets in even after only one day's contact with water. Such a crushed powder whose surface is, of course, no longer smooth, shows formation of rust when it is frequently wetted with water and allowed to stand for some time. During industrial use, said rust, which can readily be removed by rubbing, causes a loss of gravity material, for example of ferrosilicon, which amounts to about 16 per cent of the total loss of ferrosilicon, according to the statements found in the relevant literature.

A further advantage consists in the following: owing to the absence of any corrosion, the addition of lime is no longer necessary. Hitherto an amount of 10 per cent (calculated upon the powdered gravity-substance) for increasing the pH value has been added to the aqueous suspension in order to prevent corrosion.

Moreover, the adherence losses are smaller than with edged material. These losses are caused as follows: in spite of an intensive rinsing off, a certain portion of the gravity-substance adheres to the ore to be dressed. If the gravity-substance has a smooth surface, according to the present invention, the adherence is smaller than with a material having a rough surface. Investigations have shown that, on using a round and smooth material for gravity separation of ores according to the present invention, in particular ferrosilicon, for carrying out the gravity separation, these losses are 60 per cent lower when treating, for example, siderite; 49 per cent lower when treating quartz having a relatively rough surface; 21 per cent lower when treating the usual gravelstone (pebbles); and 23 per cent lower when treating chamotte fractions having a rough surface; than with ground ferrosilicon powder of the hitherto used kind.

Moreover, the viscosity of the fluid to be used for gravity separation of ores containing the material according to the present invention is smaller than with ground material. The specific gravity of the fluid may be increased to 3.5 and the fluid does not become unduly viscous. 45 Per cent by volume of solid material is then contained in the suspension, a value which could not be attained with other solid substances. Owing to the high specific gravity it is possible to dress ores which hitherto could not be separated with ferrosilicon as a gravity material.

The whole surface of these round particles of ferrosilicon looks as if polished when examined under the microscope. It might have been assumed that owing to their round shape and smooth surface the particles would rapidly sink in the fluid. Investigations have, however, proved surprisingly that within the range of granulation below about 200 μ the velocity of deposition of these round particles is substantially equal to that of "edged" ferrosilicon grains obtained by grinding. Only with granules above about 200 μ can a more rapid sinking of the round grains be noticed. It is advantageous to keep the portion of small particles having a diameter of less than about 20 to 30 μ as small as possible. A small portion of particles of a diameter of less than 20 μ, however, is not detrimental.

These examples show the advantages of the present invention over the hitherto known processes which operate with compositions of matter having a rough surface.

On using the hitherto customary ground, "edged" powder for gravity separation, the individual particles undergo, it is true, a certain grinding off, but such round and at the same time smooth surfaces as characterize the material used according to the present invention are never attained. By the grinding off of the edged particles fine dust is formed which, as is known, is detrimental because the viscosity of the fluids is increased thereby and an undesirable, fine solid material is thus added to the fluids to be used for gravity

separation of ores. These drawbacks are likewise avoided if the smooth bodies according to the present invention are applied.

Finally, the preparation of round particles may be considerably more economical compared with the high costs necessary e.g. for crushing the hard and tough ferrosilicon to obtain an edged powder.

Instead of ferrosilicon it is possible to use ferrosilicon alloys, for example alloys having a content of anticorrosive additional substances, such as copper, aluminium or other materials.

Ferrosilicon produced in an electric melting furnace has, in this respect, been found of advantage. Probably owing to the strongly reducing power of the electric furnace and by its high operating temperature, a ferrosilicon thus produced is even less liable to corrosion and, therefore, does not require any anticorrosive additional products. Moreover, ferrosilicon may be used which is obtained as an undesirable by-product during the manufacture of calcium carbide and which is separately tapped from the calcium carbide furnace. It is, however, also possible to tap the ferrosilicon together with the calcium carbide, and to obtain it during the gasification of the calcium carbide with water.

It may be advisable that the content of silicon in the ferrosilicon amounts to not less than about 11 per cent. If the content of silicon is smaller than about 11 per cent, the risk of corrosion increases. If, after the dressing, it is intended to recover the ferrosilicon by means of the magnetic separation process, it is advisable to use a ferrosilicon having a content of not more than about 22 per cent of silicon, since with a higher silicon content the material is no longer sufficiently magnetic. Ferrosilicon containing about 11 to about 22 per cent of silicon has a particularly high toughness and a low brittleness: it can, therefore, be ground only with difficulty. For this reason the use of a ferrosilicon having a round, smooth surface and which is obtainable from the spraying of molten metal is especially advantageous. The costs of preparation from the melt are essentially lower than the costs of grinding.

The present invention is not limited to ferrosilicon. Other solid magnetic substances, which can be shaped according to known methods to form compact, hard, heavy, round or spherical particles, may also be used. They, too, have the advantage that they are less ground off and hardly undergo any corrosion so that practically no loss arises. They possess a higher specific gravity, a lower viscosity of the fluid to be used for gravity separation of ores being thus attained. Materials of said kind are, for example: metal alloys, and magnetic iron oxides. These materials may be transformed, by spraying in the molten state, into round smooth particles. If it is required owing to the specific gravity of the ore to be dressed or if certain tailings have to be separated, any usual alloy may be used, such as refined steel of the type of stainless steel.

The smooth, round particles to be used as gravity-substances in fluids for gravity separation of ores may be separated and recovered by means of generally known processes. The recovery of the gravity-substance from the concentrate by means of magnetism, is particularly advantageous, gravity substances being used according to the present invention which are magnetic, such as ferrosilicon having at most 22% silicon content (since above this limit the magnetic properties become inappreciable).

The process of the present invention allows of dressing, for example, the following ores: Iron-ores, lead ores, zinc ores and copper ores; furthermore all the minerals whose specific gravity and that of their tailings are suitable, i.e. the specific gravity of the minerals and of the tailings thereof must be sufficient apart, so that the minerals sink down in the liquid, whereas the tailings float; this is the case for most of the important minerals in the density of the fluid has been adjusted to 1.5—3.7. On dressing coal whose specific gravity is relatively low, the procedure is, for example vice versa, the light coal floats on top of the fluid and the impurities of a heavy specific gravity sink down.

Up-to-now experts have, in general, been of the opinion, that only a well crushable material is suitable as a gravity substance to be used for gravity separation of ores. It therefore, was surprising and could not be foreseen that materials which can be ground only with difficulty, are likewise especially suitable as additional substances to fluids for gravity separation of ores.

What we claim is:—

1. A fluid composition of matter for gravity separation of ores, said composition comprising water and finely divided solid magnetic constituents, in the form of hard, round particles having a smooth surface produced by spraying from a melt.

2. A fluid composition of matter for gravity separation of ores as claimed in claim 1 wherein the particles consist of ferrosilicon.

3. A fluid composition of matter for gravity separation of ores as claimed in claim 1 or 2 wherein the particles have a diameter of at most about 200 μ.

4. A process for the separation of ores by treating the comminuted ores with a fluid composition of matter for gravity separation of ores, said composition comprising water and finely divided solid magnetic constituents, wherein said constituents are used in the form of hard round particles having a smooth surface produced by spraying from a melt.

5. A process as claimed in claim 4 wherein the particles used consist of ferrosilicon.

6. A process as claimed in claims 4 or 5

separation of ores. These drawbacks are likewise avoided if the smooth bodies according to the present invention are applied.

Finally, the preparation of round particles may be considerably more economical compared with the high costs necessary e.g. for crushing the hard and tough ferrosilicon to obtain an edged powder.

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The smooth, round particles to be used as gravity-substances in fluids for gravity separation of ores may be separated and recovered by means of generally known processes. The recovery of the gravity-substance from the concentrate by means of magnetism, is particularly advantageous, gravity substances being used according to the present invention which are magnetic, such as ferrosilicon having at most 22% silicon content (since above this limit the magnetic properties become inappreciable).

The process of the present invention allows of dressing, for example, the following ores: Iron-ores, lead ores, zinc ores and copper ores; furthermore all the minerals whose specific gravity and that of their tailings are suitable, i.e. the specific gravity of the minerals and of the tailings thereof must be sufficient apart, so that the minerals sink down in the liquid, whereas the tailings float; this is the case for most of the important minerals in the density of the fluid has been adjusted to 1.5—3.7. On dressing coal whose specific gravity is relatively low, the procedure is, for example vice versa, the light coal floats on top of the fluid and the impurities of a heavy specific gravity sink down.

Up-to-now experts have, in general, been of the opinion, that only a well crushable material is suitable as a gravity substance to be used for gravity separation of ores. It therefore, was surprising and could not be foreseen that materials which can be ground only with difficulty, are likewise especially suitable as additional substances to fluids for gravity separation of ores.

What we claim is:—

1. A fluid composition of matter for gravity separation of ores, said composition comprising water and finely divided solid magnetic constituents, in the form of hard, round particles having a smooth surface produced by spraying from a melt.

2. A fluid composition of matter for gravity separation of ores as claimed in claim 1 wherein the particles consist of ferrosilicon.

3. A fluid composition of matter for gravity separation of ores as claimed in claim 1 or 2 wherein the particles have a diameter of at most about 200 μ.

4. A process for the separation of ores by treating the comminuted ores with a fluid composition of matter for gravity separation of ores, said composition comprising water and finely divided solid magnetic constituents, wherein said constituents are used in the form of hard round particles having a smooth surface produced by spraying from a melt.

5. A process as claimed in claim 4 wherein the particles used consist of ferrosilicon.

6. A process as claimed in claims 4 or 5

wherein the particles have a diameter of at most about 200 μ.

7. A process as claimed in claim 4 or 5 wherein after the separation the particles contained in the fluid composition of matter for gravity separation of ores are recovered by magnetic means.

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