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ELECTRODYNAMIC METHOD FOR BENEFICIATING SYLVINITE ORE

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This invention relates to a method of recovering potassium chloride from potash-bearing ores. More particularly, it relates to an electrodynamic method of separation of sylvinite into its components, sylvite and halite.

Potassium chloride-bearing ores are found in the United States primarily in the Carlsbad section of New Mexico. Recovery of potassium chloride from these ores has heretofore been accomplished by preparing a potassium chloride saturated solution from an ore such as sylvinite and selectively crystallizing out potassium chloride, or by the flotation of solid potassium chloride from slurries of comminuted sylvinite ore suspended in saturated brines. These processes involve the handling of large quantities of materials in relatively dilute solution and in slurry form. Following such treatments the products must be recovered from solution or segregated from slurries by concentration and/or filtration methods. Such methods of operation add materially to the expense of producing potassium chloride products of commerce.

It is an object, therefore, of this invention to overcome the shortcomings and disadvantages of the processes heretofore in use.

It is a further object to accomplish improved separation of sylvinite into its components.

It is still another object to provide a method wherein components of sylvinite ore are selectively rendered responsive to an electrodynamic separation.

It is still another object to provide a more economical method of recovering potassium chloride from sylvinite ore.

These and other objects will become more apparent from the following description.

For the method of this invention, it is desirable that sylvinite ore be comminuted to economical liberation of the particles. The comminuted ore is then treated with a combination of agents which selectively render one component of the ore a better conductor; i. e., selectively changes the conductivity characteristic of one component of the ore such as potassium chloride with respect to the remainder of the ore. The comminuted and surface-conditioned ore is then electrostatically separated by passage through ionized and nonionized electrostatic fields in series as by contact with a relatively high speed rotating drum or roll electrode, the charging of the particles being effected by ionizing discharge in the vicinity of the rotating drum.

In carrying out this method, sylvinite ore is broken up, for example, in a jaw crusher and then comminuted by suitable methods such as thermal comminution or by standard grinding equipment such as a hammer mill. The comminuted ore is reduced to economic liberation size of less than about 8 mesh. Preferably a granular material is produced having particles of size in the range between about 14 mesh and about 200 mesh.

Surface-conditioning of the ore, rendering one component thereof selectively a better electrical conductor than the other, is effected preferably by dry reagentizing. By "dry reagentizing" is meant that the granular sylvinite ore is maintained in an unagglomerated condition, as by agitating, while bringing the surface of the particles first into contact with a long chain aliphatic amine in the vapor form, and then spraying the granular sylvinite with an alkyl monohydric secondary alcohol under conditions

whereby substantially no potassium chloride is dissolved and the surfaces of the particles rapidly attain a dry, nontacky condition. By "long chain aliphatic amine" is meant amines having alkyl groups averaging from about 8 to about 18 carbon atoms per molecule, such as octadecylamine, hexadecylamine, and tallow oil amines such as are sold under the trade name Armac T.

In the preferred embodiment of the invention, an amine such as tallow oil amines sold under the broad name Armac T is heated to a temperature of about 250° F., and the vapors evolved conducted to a tumbling or agitating chamber containing hot granular ore where the vapors are caused to rise through the bed of granular material until a total of about 0.2 and about 0.5 pound per ton of ore is used, and preferably about 0.3 pound per ton of ore is used.

At the time of surface-conditioning, the granular ore generally is maintained at a temperature in the range between about 225° F. and about 300° F., and preferably at a temperature in the range of 240° F. and about 260° F.

Following the amine treatment, the granular material is sprayed with the alkyl monohydric secondary alcohol. Alcohols useful for this purpose are those having between about 6 and about 12 carbon atoms per molecule and having between about 4 and about 8 carbons in the branched chain alkyl groups, such as 4-methyl-pentanol-2, and the like. 4-methyl-pentanol-2 is utilized in varying amounts, but in general the amount ranges between about 0.4 pound and about 1.0 pound per ton of ore and preferably about 0.6 pound and about 0.9 pound per ton of ore.

The hot reagentized ore rapidly dries, following the spraying with alcohol, and is then separated electrostatically by means taking advantage of the differences in conductivity of halite and sylvite. This reagentized ore is fed by a guiding trough which confines the spread of the ore layer onto the surface of a rotatable cylindrical drum, usually about three to six inches in diameter, and rotating at speeds in the range between about 250 and about 1500 R. P. M. In order to effect charging of the particles, a suitable ionizing zone is disposed close to the depositing point of the ore particles on the drum. The dense uniform ionizing zone may be produced by disposing a series of sharply tipped wires, or other means disposing sharp points in the direction of the drum, and connecting such means as one electrode to a source of high voltage electricity, the electrode being at a high difference of potential from the rotating roll. When on the drum, the charged particles are passed through a nonionizing electrostatic field produced between nondischarging electrodes and the drum. This rotating drum is provided with a highly conductive outer surface in order that electrical charges acquired by particles rendered conductive may be rapidly dissipated.

The nonionizing electrostatic field also is maintained at a high voltage gradient with substantially negligible current. Its general direction with respect to the surface of the drum is the same as that of the ionized field resulting in electrostatic forces acting on one portion of the ore. These forces act in a direction tending to hold the ore particles on or repel them from the drum surface. Charged particles tend to lose their charges by conduction to the drum whether highly conductive or not. Thus, the slower the rate of conduction, the longer the electrostatic force tends to hold such particles on the drum surface. Eventually, a point is reached where centrifugal or gravitational forces, or both, cause the particles to leave the drum. The nonconductors generally leave the drum last and therefore a good separation of particles is effected.

Separation may also be made with a nonionized electrostatic field maintained between two fixed plate-like electrodes. Material instead of being fed into contact with these electrodes as is done with the drum type separators,

is generally passed as free falling bodies between the electrodes.

The dual electrostatic fields, nonionizing field, and ionizing field, may be of the same or different field strengths. The field strength or gradient of the nonionizing field may vary from 1,000 to about 5,000 volts per inch of distance between electrodes, if separating materials of relatively fine particle size, and from 5,000 to 15,000 volts per inch for beneficiation of coarser particles. In general, it is preferred to handle material having an over-all particle size in the range of −14 mesh to about +200 mesh as a unit and pass such material through fields having a gradient in the range of 10,000 to 15,000 volts per inch. In general, it is preferred to operate with a total impressed difference of potential upon the electrodes in the range of about 30,000 volts to about 60,000 volts. This voltage should be maintained at a high direct voltage potential substantially free of alternating current components; i. e., filtered D. C. current should be low in so-called A. C. ripple. A steady supply of D. C. voltage may also be obtained without expensive filtering apparatus by the use of such equipment as a rectified radio frequency power supply. The invention will be more fully illustrated by the following examples:

Example I

Sylvinite ore from the Carlsbad area of New Mexico was comminuted and then sized to produce a feed having a particle size in the range of −14 and +200 mesh. This comminuted ore was accumulated as a mass of considerable depth in a tank and heated to about 250° F. The hot ore was maintained in an agitated condition by stirring and vapors of amine in the form of tallow oil amines were passed through the ore bed until about 0.3 pound per ton of ore had been used. The hot ore was then sprayed with 4-methyl-pentanol-2 until about 0.8 pound per ton of ore had been added and evenly distributed. The ore was then separated on a corona discharge-type electrodynamic separator, at a rate of 100 pounds per hour per foot wherein the nonionizing field is at a gradient of approximately 12,000 volts per inch, the total impressed voltage being about 60,000 volts.

Results obtained were as follows:

Material	Percent KCl	Percent Wt.
Feed	43	100
Pinned	56.5	7.7
Free	33.0	13.5
Middling	43.5	78.8

By "pinned" is meant material adhering to the drum electrode, and by "free material" is meant that portion which is most strongly repelled.

Example II

Sylvinite ore treated as in Example I with vapors of tallow oil amines and with 4-methyl-pentanol-2 was introduced at the rate of 100 pounds per hour per foot of electrode between ionizing wire electrodes of 0.01 inch in diameter spaced three inches apart and giving a corona discharge. The ore particles then fall as free falling bodies between three foot long plate electrodes maintained at a potential gradient difference of approximately 12,000 volts per inch, the total impressed voltage being about 60,000 volts.

The results were as follows:

Material	Percent KCl	Percent By Weight
Feed	47.9	100
Concentrate	56.7	49
Middlings	42.7	37.9
Tailings	29.4	13.1

This application is a continuation-in-part of copending application Serial No. 255,337, filed November 7, 1951, and now abandoned, entitled "Electrodynamic Method for Beneficiating Sylvinite Ore," by James E. Lawver.

Having thus fully described and illustrated the character of the invention, what is desired to be secured and claimed by Letters Patent is:

1. The method of beneficiating sylvinite ore which comprises treating comminuted sylvinite with a long chain fatty acid amine and with a branched chain alkyl monohydric alcohol to selectively change the conductivity characteristic of potassium chloride with respect to the remainder of the ore, passing treated particles of the ore through an ionized electrostatic field to induce charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

2. The method of beneficiating sylvinite ore which comprises treating comminuted sylvinite with a long chain aliphatic amine and with a branched chain alkyl monohydric alcohol to selectively change the conductivity characteristic of potassium chloride with respect to the remainder of the ore, passing treated particles of the ore through an ionized electrostatic field to induce charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

3. The method of beneficiating sylvinite ore which comprises treating comminuted sylvinite with a long chain aliphatic amine having alkyl groups averaging between 8 and 18 carbon atoms per molecule and with a branched chain alkyl monohydric alcohol having 6 and 12 carbon atoms per molecule to selectively change the conductivity characteristic of one component of the ore, passing treated particles of the ore through an ionized electrostatic field to induce charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

4. The method of beneficiating sylvinite ore which comprises treating comminuted sylvinite with a long chain aliphatic amine and with a branched chain alkyl monohydric secondary alcohol of 6 to 12 carbon atoms per molecule and having about 4 to about 8 carbon atoms per branched chain alkyl groups to selectively change the conductivity characteristic of potassium chloride with respect to the remainder of the ore, passing treated particles of the ore through an ionized electrostatic field to induce charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

5. The method of beneficiating sylvinite ore which comprises treating comminuted sylvinite with tallow oil amines having alkyl groups averaging between 12 and 18 carbon atoms per molecule and with methyl amyl alcohol to selectively change the conductivity characteristic of potassium chloride with respect to the remainder of the ore, passing treated particles of the ore through an ionized electrostatic field to induce charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

6. The method of beneficiating sylvinite ore which comprises heating the comminuted ore to a temperature in the range of about 225° F. to about 300° F., passing vapors of a long chain fatty acid amine through the hot ore, after the amine treatment spraying the ore with a branched chain monohydric secondary alcohol, passing the treated ore when dry through an ionized electrostatic field to induce charging of the particles, and subjecting the charged particles to the separation action of a nonionizing electrostatic field.

7. The method of beneficiating sylvinite ore which comprises heating the comminuted ore to a temperature in the range of about 225° F. to about 300° F., passing vapors of a long chain fatty acid amine through the hot ore until an amount of an amine in the range of about 0.2 to about 0.5 pound per ton of ore has been accumulated on the surface of said comminuted ore, after

the amine treatment spraying the ore with a branched chain monohydric secondary alcohol until amounts in the range of about 0.4 to about 1.0 pound per ton of ore have been deposited thereon, passing the treated particles through an ionized electrostatic field to induce the charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

8. The method of beneficiating sylvinite ore which comprises heating the comminuted ore to a temperature in the range of about 225° F. to about 300° F., passing vapors of a long chain fatty acid amine through the hot ore until an amount of an amine in the range of about 0.2 to about 0.5 pound per ton of ore has been accumulated on the surface of said comminuted ore, after the amine treatment spraying the ore with a branched chain monohydric secondary alcohol until amounts in the range of about 0.6 to about 0.9 pound per ton of ore have been deposited thereon, passing the treated particles through an ionized electrostatic field to induce the charging of the particles, and subjecting the charged particles to the separation action of a nonionized electrostatic field.

9. The method of beneficiating sylvinite ore which comprises heating the comminuted ore to a temperature in the range of about 225° F. to about 300° F., passing vapors of a long chain fatty acid amine through the hot ore, after the amine treatment spraying the ore with a branched chain monohydric secondary alcohol, passing the treated ore through an electrostatic field maintained at a high difference of potential, the particles being in contact with the moving element forming one extremity of said field, maintaining an ionized field in the vicinity of the point of contact of treated ore particles with said moving element, and individually collecting the repelled portion of said ore and the attracted portion of said ore.

10. The method of beneficiating sylvinite ore which comprises heating the comminuted ore to a temperature in the range of about 225° F. to about 300° F., passing vapors of a long chain fatty acid amine through the hot ore, after the amine treatment spraying the ore with a branched chain monohydric secondary alcohol, passing the treated ore through an ionized electrostatic field having a moving element as the outer extremity of said field and maintained at a field gradient in the range between about 10,000 volts and about 20,000 volts per inch, and subjecting the particles charged in said ionized field to the separation action of a nonionized electrostatic field maintained between said moving element and a companion moving element and having a field gradient in the range between about 5,000 and about 15,000 volts per inch of distance separating the rotating electrodes.

11. The method of beneficiating sylvinite ore which comprises treating comminuted sylvinite ore with a long chain fatty acid amine and with a branched chain alkyl monohydric alcohol to selectively change the conductivity characteristic of potassium chloride with respect to the remainder of the ore, passing treated particles of the ore through an ionized electrostatic field to induce charging of particles, and passing the charged particles as free falling bodies through a nonionized electrostatic field.

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