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[54] **TWO-STAGE ELECTROSTATIC SEPARATION OF PARTICULATE MATERIAL**
12 Claims, 1 Drawing Fig.

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[50] **Field of Search** ..... 209/127-—131, 9

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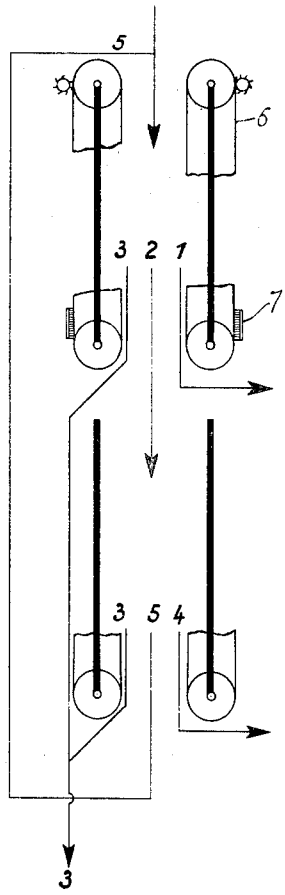
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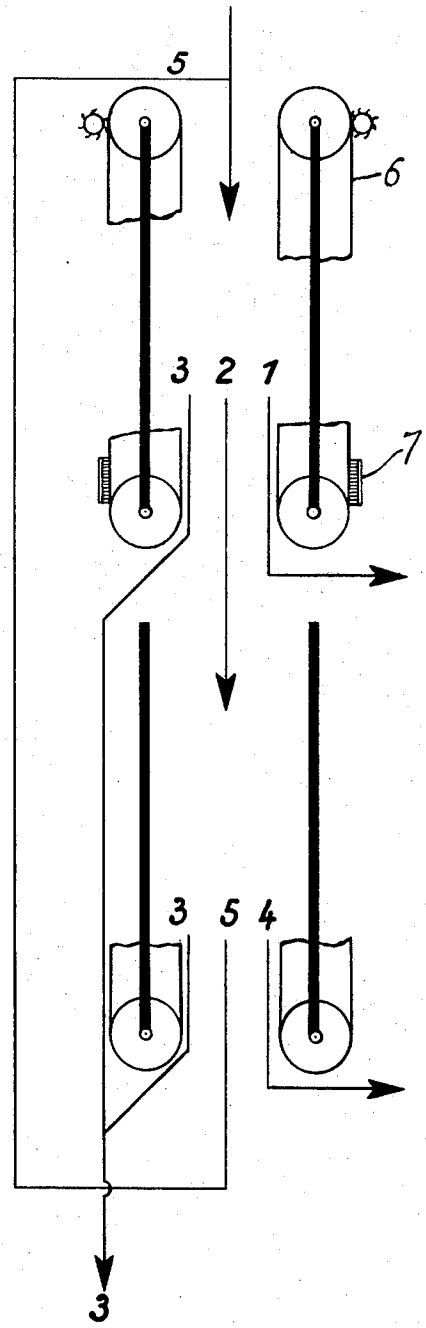
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ABSTRACT: Separation of potassium oxide containing salts into various size fractions by passing a mass containing particulate and powder fractions between two electrodes of an electrostatic precipitator; maintaining the voltage across the electrodes such that the mass separates into portions, that part adheres to the positive electrode, part stays adjacent the positive electrode, part stays adjacent the negative electrode, and part passes intermediate the two electrodes; and recovering the individual parts separate from each other.





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TWO-STAGE ELECTROSTATIC SEPARATION OF PARTICULATE MATERIAL

CROSS-REFERENCES TO RELATED APPLICATIONS

This is a continuation-in-part of our copending application, Ser. No. 592,863 now abandoned, filed on Nov. 8,1966 under the title "Method and Apparatus for Electrostatic Separation of Particulate Material."

BACKGROUND OF THE INVENTION

The present invention relates to a method for the electrostatic separation of particulate material and, more specifically, the invention is concerned with a method for the electrostatic treatment of crude potassium salts in particulate form and including a fraction of very small, dustlike particles.

The separation of sylvite from dust-containing crude potassium salts is connected with very considerable difficulties which it was not possible up to now to overcome in a satisfactory manner. These difficulties arise primarily due to the fact that the dustlike fraction of the crude potassium salts will be unselectively charged in an electrostatic field and, consequently, the dustlike particles which will be collected together with the coarser particles of higher potassium content and since these dustlike particles at least partially have a relatively low potassium content, their presence will reduce the K_2O concentration in the separated particulate fraction of higher K_2O content. The dustlike fraction is primarily selectively charged. It appears to be unselectively charged because its constituent particles will readily agglomerate, in which condition the selective charge exchange is nullified with resultant adverse influencing of the k_2O content of the concentrates and the residues. This occurs particularly if the crude material includes dustlike fraction in a quantity of 25 percent or more. If a crude salt is electrostatically processed in accordance with the approach known from the prior art and without prior separation of the dustlike fraction, a large quantity of the dustlike fraction will enter the concentration stage, together with the preconcentrate, and will be returned from the concentration stage to the preconcentration stage together with the middlings. This quantity of dustlike fraction, that is the quantity contained in the middlings, will inevitably cause the maximum permissible quantity of up to 25 percent in the finished product to be exceeded.

Throughout the description and claims the potassium content will be referred to as K_2O as an indication of the equivalent amount of the potassium salts which are actually present.

A further difficulty in the concentration of sylvite from dust-containing particulate crude potassium salts is caused by the firm adherence of the dustlike particles at the electrodes of the electrostatic separator, whereby again the electrostatic separation of the coarser constituents of the particulate mass of crude potassium salts into fractions of higher and lower K_2O content will be impaired.

In view of the foregoing, it has been proposed to separate dustlike particles from the particulate mass of crude potassium salts by mechanical means such as screening, prior to the electrostatic dressing of the particulate mass. However, such prescreening requires a separate installation and is a relatively expensive procedure and, furthermore, results in the separation of the dustlike particles in a form in which same are substantially without commercial value so that the thus separated mass of dustlike particles has to be further processed, for instance concentrated by dissolution in hot water followed by crystallization.

The direct electrostatic separation of a mass consisting essentially only of dustlike particles into fractions of higher and lower K_2O content is not possible in a technically satisfactory manner, due to the lack of selectivity of the dustlike particles with respect to the acceptance of electrostatic charges by the same.

By producing a concentrate in conventional manner, by electrostatic separation which may be carried out as a single step or as a two-step electrostatic separation, it is possible, for instance, to separate hard salt into the following fractions:

Pre-concentrate, Percent K_2O	Concentrate, Percent K_2O	Residue, Percent K_2O
36–38	48–52	1.9–2.0
36–40	48–50	1.8–2.0

However, such results are only intermittently obtained since upon changes in the grain composition of the crude potassium salt, particulately upon fluctuation in the proportion of dustlike particles therein, the result is greatly impaired due to the fact that unselectively separated dustlike particles continue to circulate with the middlings throughout the process. Thus, in actual industrial operation, for instance, separated fractions of the following K_2O concentrations are obtained:

Pre-concentrate, Percent K_2O	Concentrate, Percent K_2O	Residue, Percent K_2O
30–36	46–50	2.5–3.0
32–34	46–48	2.2–2.6

The above examples will serve to show that it is not possible by using the above-described conventional processes to work in a technically satisfactory manner with crude potassium salts which contain a significant proportion of dustlike particles, particularly hard salt.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to overcome the above-discussed difficulties and disadvantages.

It is a further object of the present invention to provide a method which will permit the working-up of crude potassium salts containing a significant proportion of dustlike particles so as to obtain a separated concentrated fraction of relatively high K_2O content and a residue of relatively very low K_2O content.

It is a further object of the present invention to provide a method for the electrostatic separation of dust-containing crude potassium salts into fractions of higher and lower K_2O concentration which can be carried out in a simple and particularly effective manner.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention contemplates a method of electrostatically separating a particulate mass of crude potassium salts, including a dustlike fraction and coarser particles of varying K_2O content, into the dustlike fraction and into a plurality of fractions of progressively lower K_2O concentration and substantially free of dustlike particles, comprising the steps of passing a stream of the mass through an electrostatic field formed between electrodes of opposite polarity, the electrodes, respectively, exerting different degrees of attraction with respect to the dustlike particles and the coarser particles of higher and lower K_2O content of the stream, so as to separate the mass into the dustlike fraction and into a stream of coarser particles having a progressively lower K_2O concentration in the direction from one of the electrodes to the other, and separately recovering the dustlike fraction, and the portions of the stream of highest, lowest and intermediate K_2O concentration.

The present invention also provides in a device for the electrostatic separation of particulate material into fractions of particles having, respectively, different electrostatic characteristics with respect to attraction of the same by electrodes of opposite polarity, in combination, a pair of elongated electrode means including electrodes of opposite polarity, respectively, the electrode means being arranged spaced from each other and forming between themselves a substantially vertical

path for the downward passage of a stream of particulate material therethrough, at least one of the electrode means including endless belt means rotating about the electrode of the one electrode means and in part forming the path so that particles which are strongly attracted by the one electrode will be caused to adhere to the moving belt means, brush means operatively associated with the moving belt means at a portion thereof spaced from the path for separating adhering particles from the belt means, and guide means located in the vicinity of the lower end of the path for preventing contact between the downwardly passing stream and the separated particles, and for recovering of the latter.

According to the present invention, it is possible to work up dustlike particles-containing crude potassium salts in a manner which permits separation of the dustlike fraction in the form of a commercially valuable product containing about 40 percent K_2O.

Whereas according to the conventional methods of separating and concentrating crude potassium salts in an electrostatic separator three fractions are produced, namely a preconcentrate, middlings and residue, the present invention provides for the additional separation of a further concentrated fraction, namely a dustlike fraction consisting of very small particles, generally having a size of less than 0.15 mm. and containing about 40 percent K_2O.

This additional separation of the dustlike fraction having a particle size of below about 0.1 or 1.15 mm. is carried out simultaneously with the separation of the coarser particles of the crude salt into preconcentrate, middlings and residue. Thereby the further advantage is achieved that the separated fractions of coarser particles will be substantially free of dustlike particles.

Preferably, the method of the present invention is carried out in an electrostatic separating device in which the crude salt particles pass under the force of gravity downwardly through an electrostatic field produced by two spaced electrodes which define the path through which the stream of particulate potassium salt moves in a downward direction. The crude potassium salt is preferably preconditioned in conventional manner prior to being introduced into the electrostatic separator, for instance by treatment with straight-chain lower fatty acids. According to the present invention, means are provided for dislodging dustlike particles which under the force of the electrostatic field attach themselves to an electrode, and for separately recovering the thus-dislodged dustlike particles.

It has been found, surprisingly, that the dustlike fraction will adhere to the electrodes at a certain specifically defined field strength, while the coarser particulate fraction will freely travel over the electrodes. This makes it possible to brush the adhering dustlike fraction off the electrodes and to separate it from the final product through the use of a separating trap which is adjustable for particle separation.

Only after this was understood did it become possible to develop the present approach to the processing in electrostatic separators, particularly free-fall separators, of crude potassium salts containing dustlike fraction. For example, to separate the dustlike fraction below approximately 0.15 mm. grain size when raw salts are conditioned with a 10—15 percent water solution of Na-salts of fatty acids, a field strength of 3.5—4.5 kv./cm., preferably 4.0—4.5 kv./cm., is necessary.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a schematic elevational view in the nature of flow diagram, of a two-step electrostatic separation process according to the present invention. **1** represents the dust concentrate, **2** are the resultant middlings introduced into the second separator, **3** the residue, **4** the coarse preconcentrate, **5** the middlings from the second separator to be recycled, **6** represents the endless belt electrode, and **7** the brush means

DESCRIPTION OF THE PREFERRED EMBODIMENTS

By proceeding in accordance with the present invention of electrostatic separations it is possible, for instance, from a hard salt containing 19.2 percent sylvite, 35.4 percent kieserite, 0.9 percent carnallite, 0.34 percent anhydrite, 1.64 percent insolubles and 0.23 percent moisture, and having the following grain size distribution:

Millimeters:	Percent
Greater than 1	0.8
0.75–1	9.2
0.5–0.75	20.4
0.3–0.5	19.8
0.2–0.3	10.6
0.1–0.2	15.6
0.06–0.1	9.8
Smaller than 0.06	13.8

to obtain the following four fractions:

(4) Preconcentrate percent K_2O	Concentrate, percent K_2O	(1) Dust Concentrate, percent K_2O	(3) Residue, percent K_2O
46–48	58–60	38–40	1.8–2.0
47–49	58–60	38–40	1.6–2.0

The sieve analyses of the products obtained are as follows.

	(1) Dust fraction	(4) Dust-free preconcentrate	Concentrate
Millimeters:			
Greater than 1.0		0.4	0.1
0.75–1.0		3.5	1.2
0.5–0.75		18.3	16.0
0.3–0.5	1.3	31.7	43.0
0.2–0.3	3.3	20.2	20.3
0.1–0.2	21.0	20.6	16.9
0.06–0.1	27.0	4.1	2.3
Smaller than 0.06	47.4	1.2	0.2

It is thus possible to obtain from about 20 tons of the above-described crude potassium salt in the first electrostatic separation about 2 tons of a dustlike concentrate **1** of commercially marketable quality. The dust-concentrate **1** may be sold and used as such, for instance in the production of mixed or potassium fertilizers, or it may be further worked up, in a manner known per se, to form a granulated and commercially valuable product.

It will also be seen from the example given above that, by proceeding in accordance with the present invention, it is possible in the postseparation to further work up the concentrate **4** obtained in the first separation, so as to arrive in the postseparation a concentrate which has a K_2O content which is by 10 percent higher than that which could be obtained without the separation of dustlike particles in the prior art electrostatic separation processes.

The possibility, according to the present invention, to obtain in a simple and effective manner a commercial product having a K_2O content of between 58 and 60 percent is of very great practical significance.

Thus, the method of the present invention permits to obtain from a crude potassium salt including dustlike particles between two-thirds and three-fourths of the potassium, calculated as K_2O in the form of a concentrated product containing

between 58 and 60 percent K_2O, and between one-third and one-fourth as a product containing between 38 and 40 percent K_2O.

It is also possible to utilize the dust concentrate 1 which is obtained in the separation of hard salt and which contains between 38 and 40 percent K_2O and about 5 percent MgO for producing a granulated magnesium-containing product which is commercially sold under the designation "granulated potassium with MgO."

According to the invention, the dustlike particles 1 are separated and withdrawn in the first electrostatic separation device. The middlings 2 containing K_2O are introduced into a second electrostatic separator wherein at the positive electrode a practically dust-free concentrate 4 will be separated. The middlings 5 of the second separation are preferably ground and then recycled for reintroduction into the first electrostatic separating device, together with additional preconditioned crude salt.

The residue 3 which accrues at the zones of the negative electrode in the first and second separating device, is withdrawn in conventional manner.

The process of the present invention thus provides for the separation of a dust concentrate 1 from the fraction of coarser salt particles 4.

By proceeding in this manner, and introducing 20 tons per hour of crude salt into the illustrated electrostatic separator, it is possible to recover 2 tons per hour of a dust concentrate 1 containing 40.5 percent K_2O and about 5 tons per hour of a coarse preconcentrate 4 containing between 44 and 46 percent K_2O. The dust concentrate 1 contains the dustlike particles of sylvite having a size of less than 0.15 mm. and the coarse concentrate 4 contains the coarser sylvite particles having a particle size of 0.15—1.0 mm., which are then subjected to a second electrostatic separation in order to obtain a product of up to about 60 percent K_2O as described further above.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What we claim as new and desire to be secured by Letters Patent is:

1. A process for the continuous electrostatic separation of ground potassium raw salts containing finely divided particles and being conditioned with a 10—15 percent aqueous solution of Na-salts of straight-chain, lower fatty acids comprising the steps of (a) establishing between successive areas of two endless traveling surfaces of opposite polarity a first electrostatic field having a strength of at least 3.5 and at most 4.5 kv./cm.; (b) feeding in a predetermine direction through said electrostatic field a stream of said potassium raw salts including particles having a grain size smaller than 0.15 mm. and particles having a grain size larger than 0.15 mm. and containing a predetermined percentage range of K_2O whereby a dust concentrate consisting of particles having a grain size up to about 0.15 mm. and containing between substantially 38—42 percent K_2O adheres to the positive one of said electrodes, while a dust-free potassium oxide-rich preconcentrate having a grain size greater than 0.15 mm. and containing 40—46 percent K_2O flows freely towards and past said positive electrode, and a potassium-poor residue flows to the negative one of said electrodes with a middling fraction passing intermediate both of said electrodes; (c) brushing said dust concentrate off and recovering it from said positive electrode; passing said middling fraction through a second similar electrostatic field between two additional electrodes of opposite polarity whereby an additional dust-free preconcentrate containing K_2O and having a grain size above about 0.15 mm. is separated from said middling fraction and freely passes over the positive additional electrode, while a residue poor in K_2O freely passes over the negative additional electrode with a residual dust-free fraction passing freely between both of said additional electrodes; and (d) recirculating said residual middling fraction to said first electrostatic field, together with new raw salts.

2. A process as defined in claim 1, wherein said stream is passed through said fields in downward direction.

3. A process as defined in claim 1, wherein said raw salts are hartsalz.

4. A process as defined in claim 1, wherein the step of brushing said dust separately off said positive electrode comprises subjecting said positive electrode to a brushing with a stationary brush.

5. A process as defined in claim 1; and further comprising the steps of separately subjecting said additional preconcentrate to further separation into portions of higher and lower K_2O concentration until a portion is obtained having a K_2O concentration of between about 58 and 60 percent.

6. A process as defined in claim 1, wherein the steps of establishing said electrostatic fields comprise establishing at least said first electrostatic field at a field strength of between substantially 4.0 and 4.5 kv./cm.

7. A process as defined in claim 6, wherein the steps of establishing said electrostatic fields comprise establishing said second electrostatic field also at a field strength of between substantially 4.0 and 4.5 kv./cm.

8. A process for the continuous electrostatic separation, by means of continuous electrode surfaces of an endless, conductive, moving belt, of ground potassium raw salts containing finely divided particles and being conditioned with a 10—15 percent aqueous solution of sodium salts of straight chain, lower fatty acids, comprising the steps of establishing between two electrodes of opposite polarity in an electrostatic separator an electrostatic field having a strength of at least 3.5 and at most 4.5 kv./cm.; feeding in a predetermined direction through said electrostatic field a stream of said potassium raw salts including particles having a grain size smaller than 0.15 mm. and particles having a grain size larger than 0.15 mm. and containing a predetermined percentage range of K_2O, whereby a dust concentrate consisting of particles having a grain size up to about 0.15 mm. and containing between substantially 38—42 percent K_2O adheres to the positive one of said electrodes, while a dust-free potassium oxide-rich preconcentrate having a grain size greater than 0.15 mm. and containing 40—46 percent K_2O flows freely toward and past said positive electrode, and a potassium-poor residue flows to the negative one of said electrodes with a middling fraction passing intermediate both of said electrodes; brushing said dust concentrate off and recovering it from said positive electrode; and returning said middling fraction upstream of said electrostatic field for renewed passage therethrough with fresh raw salts.

9. A process as defined in claim 8, wherein the step of establishing said electrostatic field comprises establishing said field at a field strength of between substantially 4.0 and 4.5 kv./cm.

10. A process as defined in claim 9, wherein said stream is passed through said field in downward direction.

11. A process as defined in claim 9, wherein said raw salts are hartsalz.

12. A process as defined in claim 9; and further comprising the step of subjecting said preconcentrate to further electrostatic separation into portions of higher and lower K_2O concentration until a portion is obtained having a K_2O concentration of between about 58 and 60 percent.