

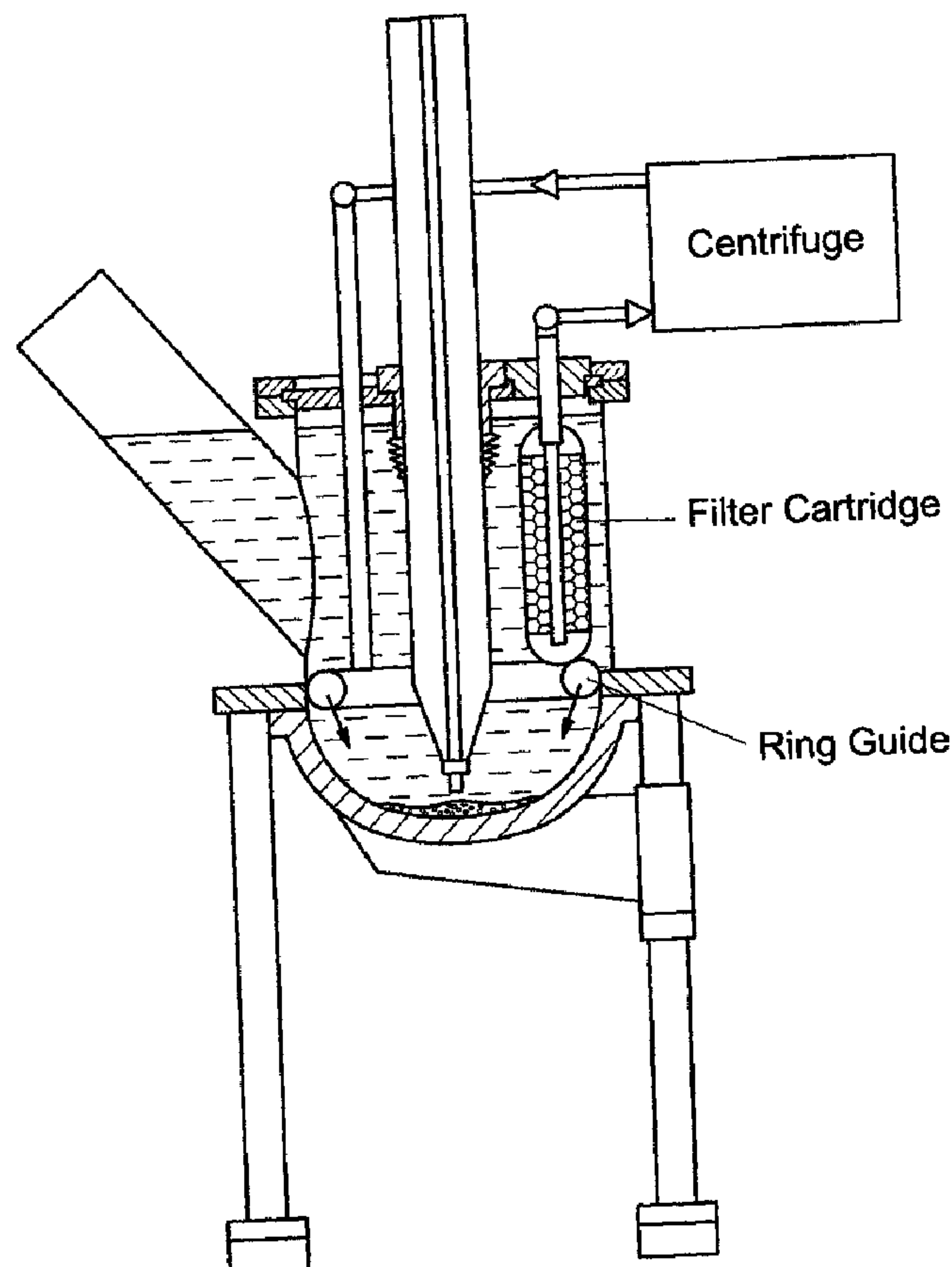


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(54) Title: METHOD FOR OPERATING A FRAGMENTATION SYSTEM AND SYSTEM THEREFOR



(57) Abrégé/Abstract:

The invention relates to a method for operating an electrodynamic fragmentation system. The fragmentation product arranged in the process fluid is permanently suspended and forms a suspension with the process fluid. The portion of the processed



(57) **Abrégé(suite)/Abstract(continued):**

fragmentation product which attains the target particle size or smaller is discharged from the reaction vessel and the fragmentation product exceeding the target particle size is supplied to the reaction area. The fragmentation system comprises a chargeable electric energy store, a pair of electrodes connected thereto, and both ends thereof are arranged at a distance from each other in the process fluid contained in the reaction vessel. The fragmented product is separated in a solid and liquid manner in a separator in the electrode intermediate chamber until it reaches the target particle size and is smaller than the target particle size and the prepared process fluid is guided back into the reaction vessel.

ABSTRACT

The invention relates to a method for operating an electrodynamic fragmentation system. The fragmentation product arranged in the process fluid is permanently suspended and forms a suspension with the process fluid. The portion of the processed fragmentation product which attains the target particle size or smaller is discharged from the reaction vessel and the fragmentation product exceeding the target particle size is supplied to the reaction area. The fragmentation system comprises a chargeable electric energy store, a pair of electrodes connected thereto, and both ends thereof are arranged at a distance from each other in the process fluid contained in the reaction vessel. The fragmented product is separated in a solid and liquid manner in a separator in the electrode intermediate chamber until it reaches the target particle size and is smaller than the target particle size and the prepared process fluid is guided back into the reaction vessel.

25213-90

Method for Operating a Fragmentation System and System Therefor

The present invention relates to a system for operating a fragmentation system for more effectively grinding fragmentation product of mineral and/or brittle materials to a particle size of < 5 mm, and a fragmentation system that can be operated using this method.

The technical principle of the fragmentation system is based on the FRANKA technology (FRANKA = Fragmentieranlage Karlsruhe), as described in DE 195 34 232, published on March 20, 1997. The fragmentation system comprises an electrical energy store that is discharged in pulses within a reaction vessel, onto the fragmentation product in a process liquid between two electrode ends that are spaced apart opposite each other – the reaction zone.

When being ground in the fragmentation system, the fragmentation product that is present in the process liquid between the two electrode ends is reduced by electrical discharge and the resulting shock waves. These mineral and/or brittle materials can be uniform, such as stone or rock, or glass, or conglomerate, for example stone and concrete. The target particle sizes are < 5 mm, preferably < 2 mm. Fragmented particles that are smaller than this particle size are drawn out of the process area through filter cartridges. See, for example, during gravel or sand production or when grinding colour solids, in general materials that do not consist of composites. Fragmentation products such as those that are generated when a building is demolished are fed into the process area continuously, based on the fragmentation product that is drawn off.

The fragmentation system comprises an electrical energy store that is discharged in pulses onto a load by way of a spark gap. The load is the process liquid in the area between the electrodes, and the fragmentation product that is contained within it. The two electrodes are positioned with their ends completely submerged in this, spaced apart by a predetermined distance that can be adjusted. The process liquid is usually contained in the reaction vessel, into which the fragmentation product is dumped and the fragmented product from and below the predetermined threshold for the particle size is removed.

25213-90

Up to now, it has been assumed that because of the discharges between the ends of the two electrodes – in most instances the high-voltage electrodes and the bottom or part thereof – the material to be crushed is sufficiently and repeatedly agitated during the pulse discharges. However, tests
5 have shown that the agitation is largely incomplete.

This leads to the underlying objective of the present invention, namely, to fragment the material that is to be fragmented and which is introduced into the space between the electrodes more effectively by keeping it suspended, so as to save processing time and energy.

10 According to the present invention, there is provided a method for operating a fragmentation system for the grinding of mineral and/or brittle materials to particle sizes of < 5 mm, said fragmentation system comprising an electrical energy store that is discharged by pulses in a reaction vessel onto the fragmentation material in a process liquid, between the ends of two electrodes that
15 are spaced apart to provide a reaction zone, wherein the fragmentation product that is in the process liquid is kept continuously in suspension, thereby forming a suspension with the process liquid; the fragmentation product that is processed from this suspension and which is of the target particle size or below the target particle size is extracted from the reaction vessel; and the fragmentation product
20 that is larger than the target particle size, these being the coarse fractions, are returned to the reaction zone.

The present method involves the agitation of the fragmentation product in the space between the electrode ends that is filled with process liquid, and of the fragmentation product that is deposited on the bottom of the reaction
25 vessel. The fragmentation product that is in the process liquid is kept constantly suspended, thereby forming a suspension with the process liquid. The portion of the fragmentation product that has reached the required particle size, or is smaller than that, is removed from the reaction vessel. The fragmentation product that exceeds the target particle size, which is to say the coarse portions, is routed back
30 into the reaction zone.

25213-90

Also according to the present invention, there is provided a fragmentation system for carrying out the method, comprising: a chargeable electrical energy store, a pair of electrodes connected thereto, the ends of said electrodes being spaced apart opposite each other in process liquid contained within a reaction vessel, one of the two said electrodes being at reference potential and the other being a high-voltage electrode and acted upon by high voltage pulses from the energy store through an output switch, wherein a device that keeps the fragmentation product that has been introduced into the process liquid in suspension is built onto or into the reaction vessel; a device that removes the fractions of the fragmentation product that are at and smaller than the target particle size from the suspension, routes them to a device for solid-liquid separation, and returns the fragmentation fractions that are larger than the target particle size is built onto or into the reaction vessel; and at least one return line for the process liquid opens out into the reaction vessel.

Attached to or within the reaction vessel is a device that keeps the fragmentation product that has been introduced into the process liquid in suspension since no air, relative dielectric constant ϵ_r approaching 1, or no gas, similarly ϵ_r , may be introduced into the process area. Furthermore, attached to or within the reaction vessel there is a device that routes that portion of the fragmentation product that is of the target particle size or below this out of the suspension, and returns those portions of the fragmentation product that are greater than the target particle size to the reaction vessel. To this end, at least one return line for the process liquid opens out into the reaction vessel.

Some embodiments may include additional measures by which the fractionating process can be carried out advantageously. For example, in some embodiments, the fragmentation product that is in the process liquid with the reaction vessel is kept in suspension hydrodynamically or mechanically. Thus, hydrodynamic measures such as flow or mechanical measures such as stirring or paddling are suitable for keeping the fragmentation product suspended effectively. The strength and direction of flow, and the rate of stirring and paddling can be controlled and adjusted so as to optimize the fragmentation.

25213-90

In some embodiments, the portion of the processed fragmentation product that has reached the approximate target particle size within the reaction vessel or is smaller than this is removed by reverse-flow classification and then subjected to solid-liquid separation, and the coarse fractions that are greater than
5 the particle size are returned to the reaction vessel. In this embodiment, upstream (reverse flow) classification is used to remove the fragmentation product portion. The coarse portion that exceeds the target particle size is returned to the reaction vessel in a solid-liquid separation.

In some embodiments, the portion of the processed fragmentation
10 product in the reaction vessel that has reached the target particle size or is smaller than this is extracted by hydrocloning and then subjected to solid-liquid separation, and the coarse fractions that exceed the target particle size are returned to the reaction vessel. Thus, in some implementations, separation is effected by hydrocloning.

15 In some embodiments, the portion of the processed fragmentation product in the reaction vessel that has reached the target particle size or is smaller than this is extracted by a filter that is submerged in the process liquid and the coarse fractions that exceed the particle size are returned to the reaction zone from the surface of the filter. In some embodiments, filters such as basket filters
20 or cartridge filters that are submerged in the process liquid in the reactor are used for this separation.

Some embodiments of the fragmentation system may be provided with one or more of the following advantageous features.

For example, maintenance of the suspension is important for the
25 economical, long-term operation of the fragmentation system. In some embodiments, the device that maintains the suspension conducts the fragmentation product that is in the process liquid and guides the suspension through the suspension zone without the formation of dead zones. In this implementation, the device used for maintaining the suspension must be so set up
30 and adjusted that the fragmentation product in the process liquid is held in suspension without the formation of dead zones.

25213-90

In some embodiments, the device that directs the fragmentation fractions that are at or smaller than the target particle size out of the suspension is the process vessel, which is configured as a reverse-flow classifier. In this implementation, an upstream (reverse flow) classifier is set up for separating the
5 fractions. In some embodiments, the device that directs the fragmentation fractions that are at or smaller than the target particle size out of the suspension is the process vessel, which is configured as a hydrocyclone. In this implementation, an alternative solution is that the device for separating the fractions is a hydrocyclone.

10 In some embodiments, the device that directs the fragmentation fractions that are at or smaller than the target particle size out of the suspension is at least a filter that takes particle size into account. Such devices may include filters in the form of baskets or cartridges that are known from screening technology. Because of the shock wave effect that results from the electrical
15 discharge, the distance to the space between the electrodes is adjusted so as to provide for effective cleaning and prevent damage. The intensity decreases as $1/r^2$ from the source of the shock wave.

In some embodiments, the process liquid for the solid to liquid separation is returned to the reaction vessel through one or a plurality of jets in such
20 a way that the process material is kept as completely as possible in suspension within the reaction zone. In some implementations, influx nozzles through which the process liquid that is recovered during the separation of the solids and liquid is introduced or flows back into the reaction vessel maintain the suspension.

As a result of these measures, fine fractions of the pulverized
25 product can be kept suspended in the process liquid during fragmentation and returned continuously into the area of the electrical discharge. The extraction filter cartridge(s) is/are so located that it is highly probable that the fragmented material will encounter it/them and the particles that are small enough will be extracted. During every discharge, fragments that are too large and are adhering to the
30 screen of the screen of the extraction filter cartridge will be shaken off by the shock wave generated by the discharge channel(s).

25213-90

The method and an exemplary fragmentation system will be described below on the basis of the drawing appended hereto. One embodiment is shown, namely the "Ring Guide" embodiment in which the fragmentation product is kept in suspension hydrodynamically. According to preliminary testing,
5 this is a solution that is favourable from the standpoint of flow dynamics.

Additional solutions include a directional tube or bundle of tubes. In any case, when the system is being designed and built, it must be ensured that dead-flow zones, within which fine fractions can collect and be deposited, are avoided.

10 Of the fragmentation system, only the reaction vessel itself is shown in the drawing. The electrical part, the charging apparatus, the energy store, and the spark gaps are devices that are known from – inter alia – the above cited sources. The energy store is mainly a bank of condensers that is discharged with interposed spark gaps onto the load within the space between the electrodes in
15 the reaction vessel by auto-flashover. In systems of the FRANKA type, the electrical part is a Marx generator, which is charged and discharged in the manner known from electrical high-power/high-voltage pulse technology.

Figure 1 shows the barrel-shaped reaction vessel that rests on supports. The high-voltage electrode, which is insulated as far as its unattached end area, extends through the cover and into the interior of the reaction vessel. The high-voltage electrode is not secured rigidly in the cover, so that the surge and shockwave effect that results from the electrical discharge cannot be transferred. The exposed metal end area is completely immersed in the process liquid (in this case, water) contained within the reaction vessel. The insulation itself extends deep into the water. No leakage paths can be allowed to form on it in the course of long-term operation. In this case, the opposite (counter) electrode is the dished bottom of the reaction vessel itself. This can be the whole of the bottom or only the central part thereof. In each case, the counter electrode is connected to a fixed potential, the reference potential, in the general ground potential. Fragmentation product is shown deposited centrally on the ground potential. Starting from the tip of the high-voltage electrode, the discharge channel is intended to be formed through the fragmentation product to the ground potential electrode, or is intended to form a cone-shaped area of discharge channels from the face of the high-voltage electrode to the central area of the bottom.

The water supply line passes through the cover of the reaction vessel and the return line for the water that contains the fragmentation product passes through the cover from the filter cartridge. In order to optimize the fragmentation process, the strength of the flow that brings about the agitation and, at its beginning, its direction are controlled. This device for generating flow and agitation of the fragmentation product surrounds the high-voltage electrode coaxially. The supply line feeds into the coaxially installed ring guide. The ring guide is installed on the wall of the vessel so as to be electrically safe and resistant to shock waves for an acceptable outlay.

The exit direction of the jets can be controlled, so that agitation of the fragmentation product that is optimal for the process can be set up or adjusted. The strength of the flow is adjusted with a pump that forces the clean process liquid into the ring guide. The jets direct the flows along the bottom to the centre of the bottom. The fragmentation product

that is deposited or being deposited there settles is continuously agitated and held in suspension. Areas in which there is no flow are prevented in the overall volume of water.

The filter cartridge is immersed completely in the water. The mesh size of the screen that surrounds the filter cartridge determines the maximum size of the particles that are removed. The suspension that passes through the filter cartridge is separated into its liquid fraction, process water, and its solid fractions in the centrifuge that is shown on the right-hand side of the drawing. The water is returned to the reaction vessel through the feed line to the ring guide, if necessary supplemented with fresh water.

New material that is to be fragmented is added by way of the fitting that extends from the left-hand side of the reaction vessel in the drawing.

Depending on the size of the reaction vessel, maintenance and repair operations are greatly simplified if the bottom of the reaction vessel can be unscrewed and swung out of the way on the arm that can rotate around the support that is shown on the right-hand side in the drawing.

25213-90

CLAIMS:

1. A method for operating a fragmentation system for the grinding of mineral and/or brittle materials to particle sizes of < 5 mm, said fragmentation system comprising an electrical energy store that is discharged by pulses in a reaction vessel onto the fragmentation material in a process liquid, between the ends of two electrodes that are spaced apart to provide a reaction zone, wherein the fragmentation product that is in the process liquid is kept continuously in suspension, thereby forming a suspension with the process liquid; the fragmentation product that is processed from this suspension and which is of the target particle size or below the target particle size is extracted from the reaction vessel; and the fragmentation product that is larger than the target particle size, these being the coarse fractions, are returned to the reaction zone.
2. A method as defined in Claim 1, wherein the fragmentation product that is in the process liquid within the reaction vessel is kept in suspension hydrodynamically.
3. A method as defined in Claim 1, wherein the fragmentation product that is in the process liquid within the reaction vessel is kept in suspension mechanically.
4. A method as defined in Claim 2 or 3, wherein the portion of the processed fragmentation product that has reached the approximate target particle size within the reaction vessel or is smaller than this is removed by reverse-flow classification and then subjected to solid-liquid separation, and the coarse fractions that are greater than the target particle size are returned to the reaction vessel.
5. A method as defined in Claim 2 or 3, wherein the portion of the processed fragmentation product in the reaction vessel that has reached the target particle size or is smaller than this is extracted by hydrocycloning and then subjected to solid-liquid separation, and the coarse fractions that exceed the target particle size are returned to the reaction vessel.

25213-90

6. A method as defined in Claim 2 or 3, wherein the portion of the processed fragmentation product in the reaction vessel that has reached the target particle size or is smaller than this is extracted by a filter that is submerged in the process liquid and the coarse fractions that exceed the target particle size
5 are returned to the reaction zone from the surface of the filter.

7. A fragmentation system for carrying out the method as defined in any one of Claims 1 to 6, comprising:

a chargeable electrical energy store, a pair of electrodes connected thereto, the ends of said electrodes being spaced apart opposite each other in
10 process liquid contained within a reaction vessel, one of the two said electrodes being at reference potential and the other being a high-voltage electrode and acted upon by high voltage pulses from the energy store through an output switch, wherein a device that keeps the fragmentation product that has been introduced into the process liquid in suspension is built onto or into the reaction vessel; a
15 device that removes the fractions of the fragmentation product that are at and smaller than the target particle size from the suspension, routes them to a device for solid-liquid separation, and returns the fragmentation fractions that are larger than the target particle size is built onto or into the reaction vessel; and at least one return line for the process liquid opens out into the reaction vessel.

20 8. A fragmentation system as defined in Claim 7, wherein the device that maintains the suspension of the fragmentation product that is in the process liquid guides the suspension through the suspension zone without the formation of dead zones.

9. A fragmentation system as defined in Claim 8, wherein the device
25 that directs the fragmentation fractions that are at or smaller than the target particle size out of the suspension is the process vessel, which is configured as a reverse-flow classifier.

10. A fragmentation system as defined in Claim 8, wherein the device that directs the fragmentation fractions that are at or smaller than the target

25213-90

particle size out of the suspension is the process vessel, which is configured as a hydrocyclone.

11. A fragmentation system as defined in Claim 8, wherein the device that directs the fragmentation fractions that are at or smaller than the target particle size out of the suspension is at least a filter that takes particle size into account.

12. A fragmentation system as defined in any one of the Claims 9 to 11, wherein the process liquid from the solid-liquid separation is returned to the reaction vessel through one or a plurality of jets in such a way that the process material is kept as completely as possible in suspension within the reaction zone.

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