

Apparatus and Method for Processing Battery Scraps

Technical Field

5 The present application relates to battery recycling technology. In particular, the present application relates to an apparatus and method for recycling battery by processing battery scraps.

Background

10 Batteries such as lithium rechargeable batteries have becoming one of the most widely used mobile energy sources in many industrial and daily life applications. With the usage of rechargeable batteries greatly increasing, aged and discarded batteries have become a major issue of environmental concern and sustainability of social developments.
15 Industrial players have been endeavoured with continuous efforts in developing effective and practical solutions for rechargeable battery recycling for the purposes of possible environmental pollution reduction and the better reuse of the precise metals and other materials from the recycled battery parts.

20 Present battery recycling technologies make use of high temperature treatment and / or complicated chemical processes, which are less efficient due to low recycling rate, high energy consumption and less environmentally friendly and in addition, chemical recycling process itself also raise new environmental pollutions.

25 It is therefore desirable to provide an improved battery recycling solution to solve at least one of the problems identified above.

Summary

30 According to one aspect, the present invention provides an apparatus for processing battery scraps. In one embodiment, the apparatus comprises a housing having a back wall, a front wall and a chamber formed between the back wall and the front wall, a

driving plate movably disposed in the chamber between the back wall and the front wall, and a bearing plate movably disposed in the chamber between the driving plate and the front wall. At an upper portion of the housing there is formed a first port, and at the lower portion there are formed a second and a third port which are arranged adjacent to each other along a longitudinal direction of the housing. The apparatus comprises a filter plate positioned between the chamber and the second port, and a coupling member which is engageable to the driving plate and the bearing plate. The driving plate is movable relative to the housing in the chamber. Displacement of the driving plate towards the front wall causes the coupling member to disengage the bearing plate, and displacement of the driving plate towards the back wall beyond a predetermined distance between the driving plate and the bearing plate causes the coupling member to engage the bearing plate.

Upon the bearing plate being brought into abutment against the front wall, a first displacement of the driving plate towards the bearing plate is to compress battery scraps received in the chamber between the driving plate and the bearing plate, to squeeze liquid contents out of solid contents of the battery scraps whereby the liquid content is collected at the second port. Upon the driving plate being at the predetermined distance spaced apart from the bearing plate, a second displacement of the driving plate towards the back wall causes the coupling member to engage the bearing plate such that further displacement of the driving plate towards the back wall carries the bearing plate to displace towards the back wall to move whereby the solid content is moved to and collected at the third port.

According to another aspect, the present invention provides a method for processing battery scraps. In one embodiment, the method comprises receiving battery scraps through a first port into a chamber of a housing and between a driving plate and a bearing plate, and moving the driving plate towards the bearing plate to squeeze liquid contents of the battery scraps out of solid contents of the battery scraps. The liquid contents are collected at a second port of the chamber while the solid contents are retained in the chamber. The driving plate and the bearing plate are then moved away from the second port to carry the solid contents to a third port of the chamber, and the solid contents are collected at the third port.

The present invention is advantages in that the recycled battery components and materials e.g. the electrodes, separators and electrolytes etc can be sorted and collected by separating the liquid contents from the solid contents of battery scraps, which helps in achieving higher recycling efficiency, lower costs and better environment protection.

Brief Description of Drawings

The technical solutions and corresponding technical features of the embodiments will be more comprehensively understood in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view showing an apparatus for processing battery scraps according to one embodiment of the present invention;

Fig. 2 is a partial exploded view of Fig. 1;

Fig. 3 is an enlarged partial view of portion 3 of Fig. 2;

Fig. 4 is an enlarged partial view of portion 4 of Fig. 3;

Fig. 5 is a side view of Fig. 4;

Fig. 6A to Fig. 6H are partial front views of the apparatus of Fig. 1 showing various positions of the driving plate and the bearing plate;

Fig. 7 is a partial exploded view of the apparatus of Fig. 1 in an actual operation for battery scraps processing showing battery scraps loaded through a first port into the chamber of the apparatus;

Fig. 8 is a partial exploded view of the apparatus of Fig. 1 showing battery scraps compressed the chamber and with liquid contents squeezed from solid contents of the battery scraps and the liquid contents collected and solid contents retained in the housing;

Fig. 9 is a partial exploded view of the apparatus of Fig. 1 showing the driving plate moved away from the bearing plate;

Fig. 10 is a partial exploded view of the apparatus of Fig. 1 showing the bearing plate follows the movement of the driving plate to carry the solid contents over a third port and the solid contents collected at the third port;

Fig. 11 is a partial exploded view of the apparatus of Fig. 1 showing completion of liquid contents and solid contents separation and the driving plate moves toward the front wall to abut against the bearing plate;

Fig. 12 is a partial exploded view of the apparatus of Fig. 1 showing the driving plate carries the bearing plate toward the front wall;

Fig. 13 is a partial exploded view of the apparatus of Fig. 1 showing the driving plate and the bearing plate at standby positions for subsequent round of battery scraps processing.

Fig. 14 is a flowchart illustrating a method for processing battery scraps according one embodiment of the present invention.

Detailed Description

As shown in Figs. 1, 2 and 3, according to one embodiment, an apparatus 100 for processing battery scraps comprises a housing 110 having a back wall 120, a front wall 180 and a chamber 115 formed between the back wall 120 and the front wall 180. A driving plate 130 is movably disposed in the chamber 115 between the back wall 120 and the front wall 180, and a bearing plate 170 is movably disposed in the chamber 115 between the driving plate 130 and the front wall 180. The housing 110 has a first port 112 formed at an upper portion of the chamber 115; a second port 116 and a third port 118 formed at a lower portion of the chamber 115. The second port 116 and the third port 118 are arranged adjacent to each other along a longitudinal direction 102 of the housing 100. The apparatus 100 comprises a filter plate 125 positioned between the chamber 115 and the second port 116, and a coupling member 160 which is engageable to the driving plate 130 and the bearing plate 170. The apparatus 100 may further comprise a plurality of legs, e.g. four legs 119 mounted at the bottom of the housing 110, as shown in Fig. 1 for supporting the apparatus 100 on a ground for operation.

The driving plate 130 is movable in the chamber 115 relative to the housing 110 between the back wall 120 and the front wall 180. The bearing plate 170 is movable in the chamber 115 relative to the housing between the driving plate 130 and the front wall 180. Displacement of the driving plate 130 towards the front wall 180 causes the coupling

member 160 to disengage the bearing plate 170. Displacement of the driving plate 130 towards the back wall 120 and beyond a predetermined distance 145 causes the coupling member 160 to engage the bearing plate 170, such that further movement of the driving plate 130 towards the back wall 120 carries the bearing plate 170 to move together.

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The apparatus 100 further comprises a shaft 150 moveably coupled to the housing 110 and placed to pass through the back wall 120 and the front wall 180 along a longitudinal direction 102. The apparatus 100 may further comprise a driving device 155 coupled to the shaft 150, for driving the shaft 150 to move towards the front wall 180 and the back wall 120. Shown in the figures as a box, the driving device may be one that is capable to provide driving power to move the shaft front and back, by electrical motors, gear boxes, necessary control electronics, or a hydraulic pump, etc. The output power of the driving device 155 is configured to be adequate for driving the shaft 150, driving plate 130 and the bearing plate 170 to compress and squeeze battery scraps to separate liquid contents out of the solid contents of battery scraps, as well as driving the shaft 150, driving plate 130 and the bearing plate 170 for position resetting displacement.

The driving plate 130 is rotatably mounted to and axially fixed to the shaft 150 by, e.g. a pair of flanges 153 fixed to the shaft 150 and with the driving plate 130 positioned between the pair of flanges 153. In this manner, the shaft 150 is rotatable relative to the housing 110 and the driving plate 130, and the pair of flanges 153 restrict axial movement of the driving plate 130 relative to the shaft 150. In other words, the driving plate 130 is rotatably mounted to and axially fixed to the shaft. The bearing plate 170 is rotatably mounted to the shaft 150 and axially movable relative to the shaft 150. The capabilities of the shaft 150 being rotatable relative to the housing 110 is advantageous for removing any battery scraps or residue pieces resting on top of the shaft 150. Any of such battery scraps or pieces may be removed by rotating the shaft 150 relative to the housing 110,

The coupling member 160 is fixed to the shaft 150 at the predetermined distance 145 spaced apart from the driving plate 130, and the bearing plate 170 is positioned between the driving plate 130 and the coupling member 160. Upon the driving plate 130 being positioned at the predetermined distance 145 from the bearing plate 170, the

coupling member 160 abuts against the bearing plate 170, such that displacement of the driving plate 130 toward the back wall 120 carries the bearing plate 170 to displace towards the back wall 120 together with the driving plate 130. Optionally, the apparatus 100 may further comprise a stopper 158 mounted to a front end of the shaft 150, for
5 abutting against the front wall 180 to prevent the front end of the shaft 150 from moving into the chamber 115.

As shown in Figs. 4 and 5, the front wall 180 has an opening 182 formed thereon. The opening 182 is positioned in alignment with the coupling member 160 such that when
10 the coupling member 160 is inside the chamber 115 and when the shaft 150 and the driving plate 130 moves towards the front wall 180 and upon the coupling member 160 reaching the front wall 180, further displacement of the driving plate 130 carries the coupling member 160 to move out of the housing 110 through the opening 182. Likewise,
15 when coupling member 160 is outside the chamber 115 and when the shaft 150 and the driving plate 130 moves towards the back wall 120 and upon the coupling member 160 reaching the front wall 180, further displacement of the driving plate 130 towards the back wall 120 carries the coupling member 160 to move back into the housing 110 through the opening 182.

The apparatus 100 further comprises a pair of rails 113 fixed to the housing 110 in the chamber 115 and arranged parallel to the longitudinal direction 102. The driving plate 130 and the bearing plate 170 each has a pair of notches 133, 173 through which the pair of rails 113 passes. The pair of rails 113 serves to guide the movement of the driving plate 130 and the bearing plate 170 with reliable operability. By the engagement of the pair of
20 rails 113 with the notches 133 and 173, the driving plate 130 and the bearing plate 170 in the chamber 115 are restricted to move parallel to the longitudinal direction 102 in the chamber 115 and with improved structural strength, rigidity and reliability in operation.

As shown in Figs. 4 and 5, the coupling member 160 may comprise a plurality of
30 twigs, e.g. four twigs 162, 164 166 and 168 of the same shape and dimension, and radially extending out of the shaft 150. The opening 182 comprises a plurality of slots shaped and positioned complementary to the plurality of twigs 162, 164 166 and 168.

The opening 182 is positioned at a center of the front wall 180. The opening 182 and has a first perimeter contour 185 complementary to a cross section of the shaft 130 and a second perimeter contour 186 complementary to a cross section of the coupling member 160. The first perimeter contour 185 intersects the second perimeter contour 186 to form four bearing members 187, each being positioned between adjacent two of the four twigs and annularly arranged surrounding the center portion of the opening 182, such that the opening 182 allows the coupling member 160 to pass through, while the bearing members 187 support and retain the shaft 150 to be movably placed to pass through the center portion of the opening 182.

Fig. 6A to Fig. 6H illustrate positions and movements of the driving plate 130 and the bearing plate in the chamber 115, and the movements of the coupling member 160 inside and outside the chamber 115 through the opening 182. As shown in Fig. 6A to Fig. 6H, the driving plate 130 and the bearing 170 may be at any arbitrary position in the chamber 115, e.g. one scenario as shown in Fig. 6A, in which, the driving plate 130 is positioned spaced apart from the bearing plate 170 within the predetermined distance 145.

As shown in Figs. 6A and 6B, the movement of the shaft 150 towards the front wall 180 i.e. along forward direction 151 brings the driving device 155 to move together. A movement of the shaft 150 along the forward direction 151 causes the coupling member 160 to disengage the bearing plate 170, while the bearing member 170 remains stationary relative to the housing 110. Upon the driving plate 130 being brought into abutment against the bearing plate 170, further movement of the shaft 150 and the driving plate 130 along the forward direction 151 moves the coupling member 160 to extend out of the housing 110 through the opening 182 and simultaneously carries the bearing plate 170 to move together towards the front wall 180. Movement of the driving plate 130 reaches a frontend position upon the bearing plate 170 being brought into abutment against the front wall 180, as shown in Fig. 6B.

In a movement in backward direction 159 and upon the driving plate 130 being away from the bearing plate 170 at the predetermined distance 145, as shown in Fig. 6C,

the coupling plate 160 is brought into engagement with the bearing plate 170, and further movement of the shaft 150 and the driving plate 130 in the backward direction 159 carries the bearing plate 170 to move together, by the engagement of the coupling member 160 against the bearing plate 170, as show in Fig. 6D.

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Upon the bearing plate 170 reaching a predetermined backend position i.e. between the second port 116 and the third port 118, as shown in Fig. 6E, the backward movement of the driving plate 130 is completed.

10 As shown in Fig. 6F, movement of the shaft 150 and the driving plate 130 from the backend position towards the front wall 180, i.e. along forward direction 151 again causes the coupling member 160 to disengage the bearing plate 170. Upon the driving plate 130 being brought into abutment against the bearing plate 170, further movement of the driving plate 130 towards the front wall 180 carries the bearing plate 170 to move
15 together.

Further movement of the shaft 150 and the driving plate 130 causes the coupling member 160 to extend out of the housing by passing through the opening 182, and carries the bearing plate 170 to move and pass over the second port 116, as shown in Fig. 6G. At
20 the status shown in Fig. 6G, the distance between the driving plate 130 and the bearing plate 170 is shorter than the predetermined distance 145.

Thereafter, the driving plate 130 moves in the backward direction 159 toward the back wall 120. The bearing plate 170 remains stationary relative to the housing 110 until
25 the driving plate 130 passes over the second port 116, as shown in Fig. 6H.

Figs. 7 to 13 show an exemplary operation of the apparatus 100 in use for battery scraps processing. At the start of an operational process, as shown in Fig. 7, the driving plate 130 and the bearing plate 170 are positioned spaced apart from each other at
30 respective standby positions and with the first port 112 and the second 116 positioned therebetween, to allow battery scraps 50 to be loaded into the chamber 115 through the first port 112. The battery scraps 50 maybe produced by shredding waste and/or discarded

batteries, which contain a mix of liquid contents such as liquid electrolytes and solid contents such as shredded electrodes and other solid parts of batteries.

Once a predetermined volume of the battery scraps 50 is loaded into the chamber 115 between the driving plate 130 and the bearing plate 170, the driving device 155 is activated to move the shaft 150 toward the front wall 180, which in turn causes the driving plate 130 to move along the same direction. The driving plate 130 then presses the battery scraps 50 against the bearing plate 170 and result in the battery scraps to become compressed, as shown in Fig. 8.

Stopped by the front wall 180, the bearing plate 170 is held stationary relative to the housing 110, and the coupling member 160 is disengaged from the bearing plate 170 and moved outside the chamber 115 through the opening 182.

By the effect of the driving plate 130 further moving toward the front wall 180, the battery scraps 50 are squeezed between the driving plate 130 and the bearing plate 170, which results in the liquid contents being pressed out of and separated from the solid contents. The filter plate 125 is constructed with through holes to allow the liquid contents to flow through, and to prevent the solid contents from passing through. The separated liquid contents 52 from the battery scraps 50 flows out of the chamber 115 through the filter plate 125 and maybe collected by a liquid container 42 placed underneath the second port 116. In the meantime, the remaining solid contents 54 are blocked by the filter plate 125 and retained in the chamber 115 between the driving plate 130 and the bearing plate 170. If any battery scraps is kept on the shaft 150, the driving device 155 may rotate the shaft 150 such that the battery scraps remaining on the top side of the shaft 150 may be cleared by being dropped down onto the filter plate 125.

As shown in Fig. 9, upon the pressing step shown in Fig. 8 being completed, the driving device 115 operates to move the shaft 150 and the driving plate 130 in the backward direction 159. Carried by the shaft 150, the coupling member 160 moves towards the bearing plate 170 and upon the driving plate 130 being positioned way from

the bearing plate 170 at the predetermined distance 145, the coupling member 160 is brought into engagement with the bearing plate 170.

Due to the engagement of the coupling member 160 with the bearing plate 170, further movement of the shaft 150 in the backward direction 159 carries the bearing plate 170 to move together in the same direction. Movement of the bearing plate 170 towards the back wall 120 then carries the solid contents 54 away from the second port 116 and towards the third port 118.

With the bearing plate 170 being moved by the shaft 150 to approach the third port 118, the solid contents 54 are carried by the bearing plate 170 to the third port 118, and drop out of the chamber 115 through and collected at the third port 118, by e.g. a solid container 44 placed underneath the third port 118. One round of battery scrap separation and collection is thus processed.

To prepare for a subsequent batch of battery scrapes processing, as shown in Fig. 11, the driving device 155 operates to move the shaft 150 towards the front wall 180, which disengages the coupling member 160 from the bearing plate 170. The bearing plate 170 therefore remains stationary relative to the housing 110 until the driving plate 130 being brought into abutment against the bearing plate 170 by the shaft 150.

Thereafter, as shown in Fig. 12, further movement of the shaft 150 in the forward direction 151 carries the coupling member 160 to extend out of the housing 110 through the opening 182. Simultaneously, the shaft 150 carries the bearing plate 170 to move together in the forward direction 151 until the driving plate 130 being brought to abut the bearing plate 170 against the front wall 180. The bearing plate 170 is now resumed to a standby bearing position.

To bring the driving plate 130 away from the bearing plate 170, the driving device 155 moves the shaft 150 in the backward direction 159, which carries the driving plate 130 to move together towards the back wall 120. The driving plate 130 reaches a standby driving position upon passing over the first port 112 and the second port 116, as shown in

Fig. 13. The apparatus 100 is now ready for a subsequent round of processing, which generally repeats the process as illustrated above, in conjunction with Figs. 7 to 13. Based on the actual volume of battery scraps to be processed, the apparatus 100 is operatable to repeat the processes illustrated above, for multiple batches of battery scraps processing.

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In a method 200 of processing battery scraps, as shown in Fig. 14, at step 210, battery scraps are received into a chamber of a housing between a driving plate and a bearing plate, through a first port of the housing. At step 220, the driving plate is moved towards the bearing plate to squeeze the liquid contents of the battery scraps out of solid contents of the battery scraps. At step 230, the liquid contents are collected at a second port of the chamber, and the solid contents are retained in the chamber.

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At step 240, the bearing plate is moved away from the second port and carries the solid contents to a third port of the chamber.

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At step 250, the solid contents are collected at the third chamber.

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Corresponding the operation of the apparatus as illustrated above, the method may further comprises a step 260 of resuming the driving plate and the bearing plate back to the respective driving standby position and bearing standby position, and repeat the steps 210 through 250 for subsequent batches of battery scraps processing.

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Embodiments of the present invention are presented above for purposes of illustration and description of the technical solutions and relevant technical features therein, but is not intended to be understood to be exhaustive or limiting. Modifications and/or variations will become apparent to those of ordinary skilled in the art to contemplate and implemented based on the inventive concept and technical solutions disclosed herein. The example embodiments are chosen and described to explain principles and practical application of the present invention, and to enable those of ordinary skilled in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular technical solution contemplated and described. Further, while some technical details may be omitted from the description and

drawings, for the purpose of clarity and conciseness, such omissions are not meant to be understood that the omitted features are necessarily absent or missing in the relevant structures, parts, processes and/or steps, as described herein, for understanding and practicing the invention.

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Thus, although illustrative example embodiments have been described herein with reference to the accompanying drawings, it is to be understood that this description is not limiting and that various other changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the disclosure as sets out and defined the claims appended hereto.

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CLAIMS

1. An apparatus for processing battery scraps, the apparatus comprising:

a housing having a back wall, a front wall and a chamber formed between the
5 front wall and the back wall,

a first port formed at an upper portion of the chamber;

a second port and a third port formed at a lower portion of the chamber and
arranged adjacent to each other along a longitudinal direction of the housing;

a filter plate positioned between the chamber and the second port;

10 a driving plate movably disposed in the chamber between the front wall and the
back wall;

a bearing plate movably disposed in the chamber between the front wall and the
driving plate; and

a coupling member engageable to the driving plate and the bearing plate;

15 wherein displacement of the driving plate towards the front wall causes the
coupling member to disengage the bearing plate;

wherein displacement of the driving plate towards the back wall beyond a
predetermined distance between the driving plate and the bearing plate causes
the coupling member to engage the bearing plate.

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2. The apparatus as recited in claim 1,

wherein upon the bearing plate being brought into abutment against the front wall,

a displacement of the driving plate towards the bearing plate is to compress
battery scraps received in the chamber between the driving plate and the

25 bearing plate to squeeze liquid contents out of solid contents of the battery
scraps and collected at the second port while retaining the solid contents in the
chamber, and

wherein upon the driving plate being at the predetermined distance from the

bearing plate, a displacement of the driving plate towards the back wall causes

30 the coupling member to engage the bearing plate such that further displacement
of the driving plate towards the back wall carries the bearing plate to displace
towards the back wall to move the solid content towards the third port.

3. The apparatus as recited in claim 2, further comprising a shaft movably coupled to the housing and passing through the front wall and the back wall, wherein the driving plate is rotatably mounted to and axially fixed to the shaft, the bearing plate is rotatably mounted to the shaft and axially movable relative to the shaft, wherein the coupling member is fixed to the shaft and the bearing plate is positioned between the driving plate and the coupling member, wherein the coupling member abuts against the bearing plate upon the driving plate being positioned at the predetermined distance from the bearing plate such that displacement of the driving plate toward the back wall carries the bearing plate to displace towards the back wall.
4. The apparatus as recited in claim 3, wherein the coupling member is fixed to the shaft at a position spaced apart from the driving plate at the predetermined distance.
5. The apparatus as recited in claim 3, wherein the front wall has an opening formed thereon, the coupling member being positioned in alignment with the opening such that a displacement of the driving plate towards the front wall carries the coupling member to extend out of the housing through the opening.
6. The apparatus as received in claim 5, wherein the opening is positioned at a center of the front wall and has a first perimeter contour complementary to a cross section of the shaft and a second perimeter contour complementary to a cross section of the coupling member, wherein the first perimeter contour intersects the second perimeter contour to form bearing members surrounding the center portion of the opening such that the opening allows the coupling member to pass through while the bearing members support the shaft at the center portion of the opening.
7. The apparatus as recited in claim 6, wherein the coupling member comprises a plurality of twigs radially extending outwardly from the shaft, wherein the opening comprises a plurality of slots shaped and positioned complementary and corresponding to the plurality of twigs.

8. The apparatus as recited in claim 7, wherein the bearing members are each formed between adjacent two of the plurality of slots.

5 9. The apparatus as recited in claim 3, wherein the shaft is rotatable relative to the housing.

10. The apparatus as recited in claim 3, further comprising a pair of rails fixed in the chamber and arranged parallel to the longitudinal direction, wherein the driving plate and the bearing plate each has a pair of notches to engage the pair of rails pass.

10 11. The apparatus as recited in claim 1, further comprising a driving device coupled to the shaft, wherein the driving device is operable to move the shaft towards the front wall and towards the back wall.

15 12. The apparatus as recited in claim 1, further comprising a stopper mounted to a front end of the shaft for abutting against the front wall to prevent the front end of the shaft from moving into the chamber.