

Method Of Recycling Battery

Technical Field

5 The present application relates to battery recycling technology. In particular, the present application relates to a method of recycling battery.

Background

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

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

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

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Summary

 According to one aspect, the present invention provides a method for recycling a battery. In one embodiment, the method comprises a step of removing an external
30 enclosure of the battery to expose a housing of the battery; a step of removing terminals of the battery; a step of removing a top plate of the battery; a step of extracting a cell of the battery from the housing, and a step of disassembling the cell to obtain electrodes, electrolytes and separators of the battery.

Preferably, the method further comprises, prior to removing the enclosure of the battery, a step of discharging the battery to lower a remaining electrical energy of the battery to a predetermined level. More preferably, the step of discharging the battery comprises soaking the battery in a first solution of 3% to 5% NaH_2PO_4 for 10 hours to 15 hours.

Preferably, the step of removing an external enclosure of the battery comprises moving an ultrasonic blade along a first path and a second path of the enclosure to cut the enclosure into a first part and second part along the respective first path and the second path, and a further step of separating the first part and the second part away from each other to expose the housing and the cover plate.

Preferably, the step of removing the terminals of the battery comprises routing a laser beam surrounding a neck portion of each of the terminals of the battery to separate the terminals from the top plate.

Preferably, the step of extracting a cell of the battery from the housing comprises holding the housing and ejecting the cell out of the housing.

Preferably, the step of disassembling the cell comprise soaking the cell in a second solution to cause detachment of the electrodes, electrolytes and separators from each other.

Preferably, the step of soaking the cell in a second solution further comprises mixing the second solution by an ultrasonic blending.

Preferably, the second solution comprises a 4% to 7% organic acid so as to cause carbonization and complexation reaction with copper ions of the electrodes of the battery.

Preferably, the organic acid comprises at least one of an oxalic acid, a citric acid and a tartaric acid.

Preferably, the method further comprises unwrapping the electrodes and the separators to detach the electrodes and separators from each other.

The present invention is advantages in that the recycled batter components and materials e.g. the electrodes, separators and electrolytes etc can be sorted and collected by individual types for further usage, which helps in achieving higher recycling rate, lower costs and better pollution control.

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 simplified perspective view of a battery which is a subject to which a method of recycling a battery according an embodiment of the present invention may be applied;

Fig. 2 is a partial exploded view of the battery shown in Fig. 1;

Fig. 3 is a flow chart showing a method of recycling a battery according an embodiment of the present invention;

Fig. 4 is a flow chart showing an exemplary detailed step of the method shown in Fig. 3;

Fig. 5 is a flow chart showing an exemplary detailed step of the method shown in Fig. 3;

Fig. 6 is a flow chart showing an exemplary detailed step of the method shown in Fig. 3;

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Detailed Description

Fig. 1 shows a battery 10 which is one example to which a method for recycling a battery may be implemented. Fig. 2 shows the battery 10 of Fig. 1 in a partially disassembled state. Battery 10 includes a housing 20, one or more cells 30 disclosed in the housing 20, a top plate 40 capping the housing 20 and sealing the one or more cells 30 in the housing 40, and battery terminals 42, 44 mounted to the top plate 40. An external enclosure, for example an insulative enclosure 12 wraps around the housing 30, the top plate 40 and the lower portions of the battery terminals 42, 44.

As shown in Figs. 3 and 4, a battery recycling method 100 according to one embodiment of the present invention includes, at step 110, discharging the batteries 10, to reduce the voltage level of the battery 10 below a predetermined level, e.g. a level low enough to avoid a short circuit or any unsafe situation during the subsequent processes. Preferably, as shown in Fig. 4, the discharge step 110 may include a step 112 of soaking the battery 10 in a solution of 3% to 5% NaH_2PO_4 , for 10 hours to 15 hours.

At step 120, as shown in Figs. 3 and with reference to Figs. 1 and 2, the method 100 removes the enclosure 12, to the expose the housing 20 of the battery 10. Preferably, as shown in Fig. 5, the step 120 of removing the enclosure 12 may include a step 122 of moving an ultrasonic blade 82 along a first path 14 and a second path 16 of the enclosure 12 to cut the enclosure 12 into a first part 12a and a second part 12b along the respective first path 14 and the second path 16. At step 124, the method 100 separates the first part 12a and the second part 12b away from each other to expose the housing 20 and the top plate 40.

At step 130, the method 100 removes the terminals 42 of the battery 10. Preferably, as shown in Fig. 6 and with reference to Figs. 1 and 2, the step 130 of removing Preferably, as shown in Fig. 6, the step 130 of removing the terminals 42 may include a step 132 of routing a laser beam 84 surrounding a neck portion 43 of each terminal 42, to cut the terminals 42 from the top plate 40.

At step 140, the method 100 removes the top plate 40 to open the housing 20 and to expose the cell 30. At step 150, the method 100 extracts the cell 30 from the housing 20. Preferably, as shown in Fig. 7 and with reference to Fig. 2, the step 150 of extracting

the cell 30 includes a step 152 of holding the housing 20 and ejecting the cell 30 along a direction 25 out of the housing 20.

At step 160, the method 100 disassembles the cell 30 to obtain electrodes i.e. anode sheets 32, cathode sheets 36, separator sheets 34, electrolyte, and other components from the cell 30. Preferably, as shown in Fig. 8 and with reference to Fig. 2, the step 160 of disassembling the cell 30 includes a step 162 of soaking the cell 30 in a second solution at a temperature of e.g. 25°C to 32°C, to cause detachment of the electrodes, electrolytes and separators from each other. The second solution with the cell soaked therein may be subject to ultrasonic blending at step 164, at an ultrasonic power ranging from e.g. 600w to 800w, to improve the soaking effect. Preferably, the second solution may comprise a 4% to 7% organic acid, so that carbonization and complexation reaction with copper ions of the electrodes take place at step 166. More preferably, the organic acid may include at least one of an oxalic acid, a citric acid and a tartaric acid. After the anode sheets 32, cathode sheets 36, separator sheets 34, electrolyte, etc are separated, the step 160 may further proceed to a step 168 of unwrapping the electrode sheets and separator sheets for further steps of recycling process by, e.g. picking and placing the electrode sheets and separator sheets for sorting, storage and shipment, etc.

This disclosure has been presented for purposes of illustration and description of the embodiments of the present invention, but is not intended to be exhaustive or limiting. For example, while the present invention is presented by making reference to one type of battery as illustrated in the drawings and the description, it should be appreciated that the present invention may be practiced for batteries of various other types, other structures other models and other architectures. Many modifications and variations will be apparent to those of ordinary skilled in the art. 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.

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.

Claims

1. A method for recycling a battery, the method comprising:
removing an external enclosure of the battery to expose a housing of the battery;
5 removing terminals of the battery;
removing a top plate of the battery;
extracting a cell of the battery from the housing;
disassembling the cell to obtain electrodes, electrolytes and separators of the
battery.
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2. The method as recited in claim 1, further comprising, prior to removing the enclosure of the battery, discharging the battery to lower a remaining electrical energy of the battery to a predetermined level.
- 15 3. The method as recited in claim 2, wherein discharging the battery comprises soaking the battery in a first solution of 3% to 5% NaH_2PO_4 for 10 hours to 15 hours.
4. The method as recited in claim 1, wherein removing an external enclosure of the battery comprises moving an ultrasonic blade along a first path and a second path of
20 the enclosure to cut the enclosure into a first part and second part along the respective first path and the second path.
5. The method as recited in claim 4, further comprising separating the first part and the second part away from each other to expose the housing and the cover plate.
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6. The method as recited in claim 5, wherein removing the terminals of the battery comprises routing a laser beam surrounding a neck portion of each of the terminals of the battery to separate the terminals from the top plate.
- 30 7. The method as recited in claim 6, wherein extracting a cell of the battery from the housing comprises holding the housing and ejecting the cell out of the housing.

8. The method as recited in claim 7, wherein disassembling the cell comprise soaking the cell in a second solution to cause detachment of the electrodes, electrolytes and separators from each other.

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9. The method as recited in claim 8, further comprising mixing the second solution by an ultrasonic blending.

10. The method as recited in claim 8, wherein the second solution comprises a 4% to 7% organic acid.

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11. The method as recited in claim 10, wherein the second solution is to cause carbonization and complexation reaction with copper ions of the electrodes.

12. The method as recited in claim 10, wherein the organic acid comprises at least one of an oxalic acid, a citric acid and a tartaric acid.

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13. The method as recited in any one of claims 8 to 12, further comprising unwrapping the electrodes and the separators to detach the electrodes and separators from each other.

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