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Battery pack having cooling unit provided outside case

Abstract

The present invention relates to a battery pack having a cooling unit provided outside a pack case, and more particularly a battery pack including a battery module (100) including one or more unit cells; a case (200) having a receiving portion configured to receive the battery module (100); a cooling unit (300) located at an outer bottom surface of the case (200); and a reinforcement member (400) configured to protect the cooling unit (300).

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) The present application is a national phase entry under 35 U.S.C. § 371 of International Application No. PCT/KR2021/005214 filed on Apr. 26, 2021, which claims the benefit of priority to Korean Patent Application No. 10-2020-0060598 filed on May 20, 2020, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

(2) The present invention relates to a battery pack having a cooling unit provided outside a pack case, and more particularly to a battery pack having a cooling unit provided outside a case configured such that a cooling unit configured to dissipate heat generated in a battery module is provided outside a case and such that a reinforcement case configured to protect the cooling unit is further provided, whereby it is possible to fundamentally prevent occurrence of an event due to outflow of a refrigerant.

BACKGROUND ART

(3) With recent development of alternative energies due to air pollution and energy depletion caused as the result of use of fossil fuels, demand for secondary batteries capable of storing electrical energy that is produced has increased. The secondary batteries, which are being capable of being charged and discharged, are intimately used in daily life. For example, the secondary batteries are used in mobile devices, electric vehicles, and hybrid electric vehicles.

(4) Required capacities of secondary batteries used as energy sources of various kinds of electronic devices inevitably used in modern society have been increased due to an increase in usage of mobile devices, increasing complexity of the mobile devices, and development of electric vehicles. In order to satisfy demand of users, a plurality of battery cells is disposed in a small-sized device, whereas a battery module including a plurality of battery cells electrically connected to each other or a battery pack including a plurality of battery modules is used in a vehicle.

(5) In the battery module or the battery pack, a plurality of battery cells is connected to each other in series or in parallel in order to increase capacity and output of the battery module or the battery pack. In the case in which a plurality of battery cells is used in a state of being connected to each other, a problem, such as overload, may occur. In particular, for the battery pack, a battery module including a plurality of battery cells is located in a case. As a result, there is a problem in that temperature in the battery pack increases due to overload, whereby abnormality of the battery is amplified. In order to solve this problem, a general battery pack has a cooling unit capable of lowering temperature in the battery, whereby safety of the battery is improved.

(6) FIG. 1 is an exploded perspective view of a conventional battery pack. As shown in FIG. 1, the conventional battery pack includes a battery module **10**, a case **20** having a receiving portion **21** configured to receive the battery module therein, and a cooling unit **30** located between the battery module **10** and the case **20**, i.e. in the receiving portion **21**. The cooling unit **30** includes a heat sink **31** disposed in contact with the battery module **10** so as to lower temperature of the battery module **10** and a refrigerant circulation pipe **32** configured to supply a refrigerant to the heat sink **31**.

(7) In the conventional battery pack, the cooling unit **30** is disposed in the case **20**. When the refrigerant flows out of the heat sink **31** or the refrigerant circulation pipe **32**, therefore, the battery pack is affected, whereby safety of the battery pack is deteriorated. Furthermore, since the heat sink **31** or the refrigerant circulation pipe **32** is located in the case **20**, it is difficult to replace the heat sink or the refrigerant circulation pipe even in the case in which the heat sink or the refrigerant circulation pipe is defective.

(8) In Patent Document 1, a heat sink mounted outside a module case is mentioned. However, this document relates to a battery module and does not mention a heat sink or a refrigerant circulation pipe provided outside a pack case so as to be replaceable.

Prior Art Document

(9) (Patent Document 1) Korean Patent Application Publication No. 2018-0119990 (2018.11.05)
Technical Problem

(10) The present invention has been made in view of the above problems, and it is an object of the present invention to provide a battery pack configured such that outflow of a refrigerant from the battery pack is prevented, whereby performance and safety of the battery are improved.

(11) It is another object of the present invention to provide a battery pack configured such that, when a cooling unit is defective or damaged, part replacement is easily performed, whereby maintenance and repair is easily achieved.

Technical Solution

(12) In order to accomplish the above objects, a battery pack according to the present invention includes a battery module (**100**) including one or more unit cells; a case (**200**) having a receiving portion configured to receive the battery module (**100**); a cooling unit (**300**) located at an outer bottom surface of the case (**200**); and a reinforcement member (**400**) configured to protect the cooling unit (**300**).

(13) The cooling unit (**300**) may include a heat sink (**310**) having a cooling channel (**311**) defined therein and a refrigerant circulation pipe (**320**) having a refrigerant introduction port (**321**) configured to supply a refrigerant to the heat sink (**310**) and a refrigerant discharge port (**322**) configured to collect the refrigerant from the heat sink (**310**).

(14) The cooling unit (**300**) may be fixed to the case (**200**) via an adhesive member (**330**).

(15) The adhesive member (**330**) may be made of a thermally conductive material.

- (16) The refrigerant circulation pipe (320) may further have a fastening portion (312) configured to allow the refrigerant circulation pipe to be coupled to the case (200).
- (17) A heat dissipation plate (210) configured to transfer heat generated from the battery module (100) to the case (200) may be located at the bottom surface of the receiving portion of the case (200).
- (18) The refrigerant circulation pipe (320) may be located outside the reinforcement member (400).
- (19) The reinforcement member (400) may be in tight contact with the outer bottom surface and a pair of opposite side surfaces of the case (200).
- (20) The reinforcement member (400) may be provided with a plurality of openings (410).
- (21) A refrigerant inlet (313) and a refrigerant outlet (314) connected to the refrigerant circulation pipe (320) may be formed at opposite ends of the heat sink (310), and the refrigerant inlet (313) and the refrigerant outlet (314) may be located in a state of protruding outwards through the openings (410).
- (22) A branch pipe (323) may be located between the refrigerant inlet (313) of the heat sink (310) and the refrigerant circulation pipe (320) and between the refrigerant outlet (314) and the refrigerant circulation pipe (320).
- (23) The refrigerant introduction port (321) and the refrigerant discharge port (322) may be directly fixed to the case (200).
- (24) The present invention may provide a device having mounted therein the battery pack having one or more of the constructions that do not conflict with each other mentioned above.
- (25) In the present invention, one or more constructions that do not conflict with each other may be selected and combined from the above among constructions.

Advantageous Effects

- (26) As is apparent from the above description, a battery pack having a cooling unit provided outside a case according to the present invention has an advantage in that the cooling unit is located outside the case, whereby performance of the battery pack is not affected even in the case in which a refrigerant for cooling flows out of the cooling unit, and therefore safety of the battery pack is improved.
- (27) In addition, the battery pack having the cooling unit provided outside the case according to the present invention has a merit in that a reinforcement member configured to cover the cooling unit is further provided, whereby it is possible to safely protect the cooling unit from external impact.
- (28) Furthermore, the battery pack having the cooling unit provided outside the case according to the present invention has an advantage in that the reinforcement member is provided with a plurality of openings configured to allow portions that connect a refrigerant circulation pipe and a refrigerant inlet and outlet of a heat sink to each other to be exposed therethrough, whereby it is possible to easily check leakage of the refrigerant without separation of the entirety of the reinforcement member or to easily replace the heat sink or the refrigerant circulation pipe.

Description

DESCRIPTION OF DRAWINGS

- (1) FIG. 1 is an exploded perspective view of a conventional battery pack.
- (2) FIG. 2 is a perspective view of a battery pack according to a preferred embodiment of the present invention.
- (3) FIG. 3 is a view of the battery pack shown in FIG. 2 when viewed from one side.
- (4) FIG. 4 is a view of the battery pack shown in FIG. 2 when viewed from the front.
- (5) FIG. 5 is a view of the battery pack shown in FIG. 2 when viewed from below.
- (6) FIG. 6 is an exploded view of the upper part of a case in the battery pack shown in FIG. 2.
- (7) FIG. 7 is an exploded view of the lower part of the case in the battery pack shown in FIG. 2.

(8) FIG. 8 is an enlarged sectional view of a heat sink mounted to the battery pack shown in FIG. 2.
DETAILED DESCRIPTION

(9) Now, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings such that the preferred embodiments of the present invention can be easily implemented by a person having ordinary skill in the art to which the present invention pertains. In describing the principle of operation of the preferred embodiments of the present invention in detail, however, a detailed description of known functions and configurations incorporated herein will be omitted when the same may obscure the subject matter of the present invention.

(10) In addition, the same reference numbers will be used throughout the drawings to refer to parts that perform similar functions or operations. In the case in which one part is said to be connected to another part in the entire specification, not only may the one part be directly connected to the other part, but also, the one part may be indirectly connected to the other part via a further part. In addition, that a certain element is included does not mean that other elements are excluded, but means that such elements may be further included unless mentioned otherwise.

(11) FIG. 2 is a perspective view of a battery pack according to a preferred embodiment of the present invention, FIG. 3 is a view of the battery pack shown in FIG. 2 when viewed from one side, FIG. 4 is a view of the battery pack shown in FIG. 2 when viewed from the front, and FIG. 5 is a view of the battery pack shown in FIG. 2 when viewed from below.

(12) The battery pack according to the present invention includes a battery module **100** including one or more unit cells, a case **200** having a receiving portion configured to receive the battery module **100**, a cooling unit **300** located at the outer bottom surface of the case **200**, and a reinforcement member **400** configured to protect the cooling unit **300**.

(13) When describing the case **200** first, the receiving portion, which is formed so as to receive the battery module **100** including the one or more unit cells (not shown), is surrounded by a side wall.

(14) Here, each unit cell may include an electrode assembly and a cell case configured to receive the electrode assembly. The electrode assembly may be a (1) jelly-roll type electrode assembly, which is configured to have a structure in which a long sheet type positive electrode and a long sheet type negative electrode are wound in the state in which a separator is interposed therebetween, (2) a stacked type electrode assembly including unit cells, each of which is configured to have a structure in which a rectangular positive electrode and a rectangular negative electrode are stacked in the state in which a separator is interposed therebetween, (3) a stacked and folded type electrode assembly, which is configured to have a structure in which unit cells are wound using a long separation film, or (4) a laminated and stacked type electrode assembly, which is configured to have a structure in which unit cells are stacked in the state in which a separator is interposed therebetween and are then attached to each other. However, the present invention is not limited thereto. It is preferable for the electrode assembly according to the present invention to be a stacked and folded type electrode assembly or a laminated and stacked type electrode assembly, which has lowest physical stress when a curved module is formed.

(15) The electrode assembly is received in the cell case. The cell case is generally configured to have a laminate sheet structure including an inner layer, a metal layer, and an outer layer. The inner layer is disposed in direct contact with the electrode assembly, and therefore the inner layer must exhibit high insulation properties and high resistance to an electrolytic solution. In addition, the inner layer must exhibit high sealability in order to hermetically seal the cell case from the outside, i.e. a thermally-bonded sealed portion between inner layers must exhibit excellent thermal bonding strength. The inner layer may be made of a material selected from among a polyolefin-based resin, such as polypropylene, polyethylene, polyethylene acrylate, or polybutylene, a polyurethane resin, and a polyimide resin, which exhibit excellent chemical resistance and high sealability. However, the present invention is not limited thereto, and polypropylene, which exhibits excellent mechanical-physical properties, such as tensile strength, rigidity, surface hardness, and resistance to

impact strength, and excellent chemical resistance, is the most preferably used.

(16) The metal layer, which is disposed so as to abut the inner layer, corresponds to a barrier layer configured to prevent moisture or various kinds of gas from permeating into the battery from the outside. An aluminum thin film, which is light and easily shapeable, may be used as a preferred material for the metal layer.

(17) The outer layer is provided on the other surface of the metal layer. The outer layer may be made of a heat-resistant polymer that exhibits excellent tensile strength, resistance to moisture permeation, and resistance to air transmission such that the outer layer exhibits high heat resistance and chemical resistance while protecting the electrode assembly. As an example, the outer layer may be made of nylon or polyethylene terephthalate. However, the present invention is not limited thereto.

(18) Although not shown, a cover may be mounted to the upper part of the case **200**. That is, the cover may be fixed to the case **200** via a well-known coupling means, such as bolting or welding, in the state in which the cover is seated on the upper part of the case. At this time, the surface of the case **200** that comes into contact with the cover may extend for secure coupling or easy mounting to an external device.

(19) Meanwhile, the case **200** may have a partitioned structure in which battery modules **100** remain spaced apart from each other by a predetermined distance or may have a concave-convex structure in which heat dissipation is easily achieved while the strength of the case **200** is improved.

(20) In the battery pack according to the present invention, the cooling unit **300** is located at the outer bottom surface of the case **200**. Specifically, the cooling unit **300** includes a heat sink **310** having a cooling channel defined therein, a refrigerant circulation pipe **320** having a refrigerant introduction port **321** configured to supply a refrigerant to the heat sink **310** and a refrigerant discharge port **322** configured to collect the refrigerant that has been circulated, and an adhesive member **330** configured to fix the refrigerant circulation pipe **320** to the outer bottom surface of the case **200** and to accelerate heat transfer between the case **200** and the heat sink **310**. The cooling unit **300** will be described below in more detail.

(21) Next, the reinforcement member **400**, which protects the cooling unit **300** including the heat sink **310**, will be described.

(22) The shape of the reinforcement member **400** is not particularly restricted as long as it is possible to protect the heat sink **310** of the cooling unit. As an example, the reinforcement member may be configured to wrap the outer bottom surface of the case **200** and a longer one of two pairs of opposite side surfaces of the case. That is, the reinforcement member **400** may be located so as to be brought into tight contact with the outer bottom surface of the case **200** and one pair of opposite side surfaces of the case. At this time, the case **200** and the reinforcement member **400** may be fixed to each other via a well-known fastening means, such as spot welding or screwing.

(23) Meanwhile, it is preferable for a portion of the heat sink **310** and the refrigerant circulation pipe **320** to be exposed outside the reinforcement member **400**, which will be described below.

(24) FIG. **6** is an exploded view of the upper part of the case in the battery pack shown in FIG. **2**. Referring to FIG. **6**, the battery pack according to the present invention is configured such that a heat dissipation plate **210** is located on the bottom surface of the case **200**, which is the receiving portion, i.e. between the battery module **100** and the bottom surface of the case, in order to transfer heat generated from the battery module **100** to the bottom surface of the case **200**. At this time, the heat transferred to the bottom surface of the case **200** may be transferred to the heat sink provided outside the case, whereby it is possible to maintain temperature of the pack at a battery predetermined temperature or lower.

(25) Here, as shown in FIG. **6**, the heat dissipation plate **210** may be configured as a member other than the case **200** and may be located between the battery module **100** and the case **200**, or may be integrally formed with the upper part of the bottom surface of the case **200** or the bottom surface of

the battery module **100**, as needed.

(26) FIG. 7 is an exploded view of the lower part of the case in the battery pack shown in FIG. 2, and FIG. 8 is an enlarged sectional view of the heat sink mounted to the battery pack shown in FIG. 2.

(27) When describing with reference to FIGS. 5, 7, and 8, the cooling unit **300** and the reinforcement member **400** are sequentially located at the lower part of the case **200** of the battery pack according to the present invention.

(28) More specifically, the cooling unit **300** includes at least one heat sink **310** formed so as to have an approximately flat shape, a refrigerant circulation pipe **320**, and an adhesive member **330**. The heat sink **310** includes a cooling channel **311** formed so as to have a zigzag shape such that the refrigerant is circulated as uniformly as possible, a refrigerant inlet **313** configured to receive the refrigerant that flows in the refrigerant circulation pipe **320**, the refrigerant inlet being connected to one side of the cooling channel **311**, and a refrigerant outlet **314** configured to discharge the refrigerant that has been elevated in temperature through heat absorption, the refrigerant outlet **314** being connected to the other side of the cooling channel **311**.

(29) Here, the refrigerant inlet **313** and the refrigerant outlet **314** may be located at opposite ends of the heat sink **310** so as to face each other. As a result, it is possible to reduce the movement distance of the refrigerant that flows into or out of the refrigerant circulation pipe **320** by adjusting the positions of the refrigerant inlet **313** and the refrigerant outlet **314** in the battery pack.

(30) Meanwhile, reference numeral **312** indicates a fastening portion, which provides a space in which a well-known fixing means, such as a bolt and a nut, can be located when the heat sink **310** is fixed to the case **200**. Three heat sinks **310** are shown in the drawings, which, however, is merely an illustration. It is possible to increase or decrease the number of the heat sinks.

(31) The refrigerant circulation pipe **320**, which is configured to supply the refrigerant to the refrigerant inlet **313** of the heat sink **310** and to guide the refrigerant that flows out of the refrigerant outlet **314**, is formed so as to wrap a portion of the contour of the case **200** therealong, and has generally an “L” shape.

(32) The heat sink **310** includes a refrigerant introduction port **321** configured to allow a refrigerant cooled to a predetermined temperature to be supplied therethrough, a refrigerant discharge port **322** configured to allow the refrigerant that has passed through the heat sink **310** to be discharged therethrough, and a branch pipe **323** configured to connect each heat sink **310** and the refrigerant circulation pipe **320** to each other.

(33) Here, it is preferable for the branch pipe **323** to be identical in number to the refrigerant inlet **313** and the refrigerant outlet **314** of the heat sink **310**. As a result, it is possible to selectively replace only the heat sink **310** that is defective, whereby it is possible to reduce maintenance and repair expenses.

(34) Meanwhile, the refrigerant introduction port **321** and the refrigerant discharge port **322** may be fastened to one surface of the case **200**, and the branch pipe **323** of the refrigerant circulation pipe **320** may be connected to the sink heat **310**, whereby the refrigerant circulation pipe **320** may be securely fixed to the case **200**.

(35) It is preferable for each of the heat sink **310** and the refrigerant circulation pipe **320** to be made of a material that is capable of easily transferring heat. As an example, each of the heat sink and the refrigerant circulation pipe may be made of aluminum, which has excellent thermal conductivity.

(36) The adhesive member **330**, which is interposed between the outer bottom surface of the case **200** and the heat sink **310**, prevents separation between the case **200** and the heat sink **310** in order to maximize heat transfer efficiency, in addition to a function of coupling the case and the heat sink to each other.

(37) The material of the adhesive member **330** is not particularly restricted as long as the adhesive member has excellent thermal conductivity and sufficient adhesive force. As an example, the adhesive member may be made of a resin, such as silicone, epoxy, polyurethane, acrylic, a phenol

resin, polyester, or glass frit. As needed, metal particles, such as silver, copper, nickel, silver-lead, or silver-copper, or carbon particles may be additionally included in the above-mentioned resin.

(38) The reinforcement member **400**, which is located under the cooling unit **300** and which is configured to protect the heat sink **310** and the refrigerant circulation pipe **320** from external impact, has generally a “U” shape and extends from the bottom surface of the heat sink **310** to the side surface of the case **200**.

(39) In particular, the reinforcement member **400** is provided in the side surface thereof with one or more openings **410**, specifically openings **410** identical in number to the refrigerant inlet **313** and the refrigerant outlet **314** of the heat sink **310**. As a result, the refrigerant inlet **313** and the refrigerant outlet **314** of the heat sink **310** are connected to the branch pipe **323** in a state of protruding through the openings **410**, and therefore it is possible to observe abnormality without separation of the reinforcement member **400** and furthermore to very easily achieve maintenance and repair.

(40) Meanwhile, the reinforcement member **400** may be configured to have a concave-convex structure made of a metal material that exhibits excellent thermal conductivity, whereby the reinforcement member has high resistance to external impact and natural heat dissipation is easily achieved.

(41) Of course, the reinforcement member **400** may be fixed to the side surface of the case **200** or a flange portion via a well-known fixing means, such as bolting or welding.

(42) Hereinafter, a method of manufacturing the battery pack according to the present invention having the above-described constructions will be briefly described.

(43) The method of manufacturing the battery pack according to the present invention may include S1) a step of receiving a battery module **100** including one or more unit cells in a receiving portion of a case **200**, S2) a step of attaching a cooling unit **300** to the outer bottom surface of the case **200**, and S3) a step of mounting a reinforcement member **400** to the outside of the cooling unit **300**.

(44) Meanwhile, in step S1), a step of disposing a heat dissipation plate **210** between the battery module **100** and the bottom surface of the case **200** may be further performed.

(45) The present invention may provide a device having mounted therein the battery pack having at least one of the characteristics described above. The device may be an electronic device including a large-capacity battery, such as an electric vehicle, a hybrid electric vehicle, or a plug-in hybrid electric vehicle.

(46) Those skilled in the art to which the present invention pertains will appreciate that various applications and modifications are possible within the category of the present invention based on the above description.

DESCRIPTION OF REFERENCE NUMERALS

(47) **10, 100**: Battery modules **20, 200**: Cases **21**: Receiving portion **210**: Heat dissipation plate **30, 300**: Cooling units **31, 310**: Heat sinks **311**: Cooling channel **312**: Fastening portion **313**: Refrigerant inlet **314**: Refrigerant outlet **32, 320**: Refrigerant circulation pipes **321**: Refrigerant introduction port **322**: Refrigerant discharge port **323**: Branch pipe **330**: Adhesive member **400**: Reinforcement member **410**: Opening

Claims

1. A battery pack comprising: a battery module comprising one or more unit cells; a case including a receiving portion configured to receive the battery module; a cooling unit disposed on a first outer surface of the case; and a reinforcement member configured to protect the cooling unit, wherein the cooling unit comprises a refrigerant circulation pipe disposed outside the reinforcement member, the reinforcement member contacting a pair of opposing surfaces of the case and defining an opening in at least one of the pair of opposing surfaces.

2. The battery pack according to claim 1, wherein the cooling unit comprises: a heat sink defining a

cooling channel; and wherein the refrigerant circulation pipe includes a refrigerant introduction port configured to supply a refrigerant to the heat sink and a refrigerant discharge port configured to collect the refrigerant from the heat sink.

3. The battery pack according to claim 2, wherein the cooling unit is coupled to the case via an adhesive member.

4. The battery pack according to claim 3, wherein the adhesive member is formed of a thermally conductive material.

5. The battery pack according to claim 4, wherein the refrigerant circulation pipe includes a fastening portion configured to couple the refrigerant circulation pipe to the case.

6. The battery pack according to claim 1, further comprising a heat dissipation plate disposed between the battery module and the case, the heat dissipation plate configured to transfer heat generated from the battery module to the case.

7. The battery pack according to claim 1, wherein the reinforcement member contacts the first outer surface and the pair of opposing surfaces of the case.

8. The battery pack according to claim 7, wherein the reinforcement member defines a plurality of openings.

9. The battery pack according to claim 8, wherein a refrigerant inlet and a refrigerant outlet coupled to the refrigerant circulation pipe are positioned at opposite ends of the heat sink, and wherein the refrigerant inlet and the refrigerant outlet protrude through the plurality of openings.

10. The battery pack according to claim 9, wherein a branch pipe is disposed between the refrigerant inlet of the heat sink and the refrigerant circulation pipe and between the refrigerant outlet and the refrigerant circulation pipe.

11. The battery pack according to claim 10, wherein the refrigerant introduction port and the refrigerant discharge port are directly fixed to the case.

12. A device having the battery pack according to claim 1 mounted therein.
