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THERMAL MANAGEMENT SYSTEM FOR BATTERY, BATTERY, AND ELECTRIC APPARATUS

Abstract

A thermal management system for battery, a battery, and an electric apparatus are provided, where the thermal management system includes a thermal management system body and a monitoring tube. The thermal management system body includes a medium pipe for circulating a heat exchange medium, where the medium pipe is provided with an inlet end and an outlet end, and the detachable monitoring tube is disposed on at least one of the inlet end and the outlet end.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of International Patent Application No. PCT/CN2023/074297, filed on Feb. 2, 2023, which claims priority to Chinese Patent Application No. 202223253590.8, filed on Dec. 6, 2022. The aforementioned patent applications are incorporated herein by reference in their entirety.

TECHNICAL FIELD
[0002] This application relates to the field of battery technologies, and in particular, to a thermal management system for battery, a battery, and an electric apparatus.
BACKGROUND
[0003] In the related art, a thermal management system is usually provided to adjust temperature of a battery so that the temperature of the battery is not excessively high or low. The thermal management system has pipes for circulating a heat exchange medium. During long-term use, the pipes may be subject to corrosion and leakage due to improper use or other reasons. Therefore, it is necessary to regularly inspect or detect corrosion of the pipes of the thermal management system for the purpose of timely maintenance.
[0004] However, in the related art, pipes of the thermal management system may be damaged during inspection or detection of corrosion of the pipes of the thermal management system, increasing the maintenance cost. How to inspect or detect the corrosion of pipes of the thermal management system with the purpose of facilitating maintenance and reducing maintenance cost is an urgent problem to be solved.
SUMMARY
[0005] Embodiments of this application provide a thermal management system for battery, a battery, and an electric apparatus, so as to inspect or detect corrosion of pipes of the thermal management system without damaging the thermal management system, thereby facilitating maintenance and reducing the maintenance cost.
[0006] According to a first aspect, an embodiment of this application provides a thermal management system for battery, including a thermal management system body, where the thermal management system body includes a medium pipe for circulating a heat exchange medium, and the medium pipe is provided with an inlet end and an outlet end; and a monitoring tube, where the detachable monitoring tube is disposed on at least one of the inlet end and the outlet end.
[0007] In this technical solution, the detachable monitoring tube is disposed on at least one of the inlet end and outlet end of the medium pipe of the thermal management system, so that the heat exchange medium flows through not only the medium pipe but also the monitoring tube during circulation in the thermal management system. The monitoring tube is detachably connected to the inlet end or outlet end of the medium pipe. Therefore, the monitoring tube can be removed from the inlet end or outlet end of the medium pipe when it is necessary to inspect or detect corrosion of the medium pipe of the thermal management system. For example, corrosion in the monitoring tube can be inspected or detected through a nozzle of the monitoring tube, so as to learn about the corrosion situation of pipes of the thermal management system. In this way, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, facilitating maintenance and reducing the maintenance cost.
[0008] In some embodiments, a material of at least part of an inner wall of the monitoring tube is

the same as a material of the medium pipe. In this case, the flowing environment of the heat exchange medium in the monitoring tube is close to or the same as that in the medium pipe, so that corrosion in the monitoring tube can reflect the overall corrosion situation of the pipe of the thermal management system more accurately.

[0009] In some embodiments, the monitoring tube is plug-connected to the medium pipe. With the monitoring tube plug-connected to the medium pipe, the monitoring tube can be mounted and dismounted more conveniently.

[0010] In some embodiments, a first nozzle and a second nozzle are arranged at axial ends of the monitoring tube respectively, and the inlet end or the outlet end is inserted into the monitoring tube through the first nozzle. With the inlet end or outlet end of the medium pipe inserted into the monitoring tube, the monitoring tube can be plug-connected to the medium pipe more conveniently.

[0011] In some embodiments, a first sealing piece is disposed between an inner circumferential wall of the monitoring tube and an outer circumferential wall of the medium pipe, or a first sealing piece is disposed between an outer circumferential wall of the monitoring tube and an inner circumferential wall of the medium pipe. The first sealing piece is disposed between the monitoring tube and the medium pipe to seal the gap therebetween, preventing leakage of the heat exchange medium at the fitting position between the monitoring tube and the medium pipe when the heat exchange medium flows through the monitoring tube.

[0012] In some embodiments, a first nozzle and a second nozzle are arranged at axial ends of the monitoring tube respectively, the inlet end or the outlet end is inserted into the monitoring tube through the first nozzle, and the first sealing piece is attached to the inner circumferential wall of the monitoring tube and wraps up the inlet end or the outlet end. By attaching the first sealing piece to the inner circumferential wall of the monitoring tube, the outer circumferential wall of the medium pipe presses the first sealing piece to deform when the inlet end or outlet end of the medium pipe is inserted into the monitoring tube. In this way, the inlet end or outlet end of the medium pipe can be inserted into the monitoring tube easily, and the medium pipe and the monitoring tube can be sealed.

[0013] In some embodiments, a first accommodating groove is formed on the inner circumferential wall of the monitoring tube, the first accommodating groove is formed into a ring shape extending in a circumferential direction of the monitoring tube, and the first sealing piece is accommodated in the first accommodating groove. The accommodating groove for accommodating the first sealing piece is disposed on the inner circumferential wall of the monitoring tube, which facilitates the disposition and attachment of the first sealing piece and restricts the position of the first sealing piece. This can prevent the first sealing piece from moving due to friction between the medium pipe and the first sealing piece in the process of mounting and dismounting the monitoring tube, so that the first sealing piece can be held in a specified position, guaranteeing the sealing effects of the first sealing piece.

[0014] In some embodiments, the first sealing piece includes a first guiding segment and a first sealing segment arranged in an axial direction of the monitoring tube, where the first guiding segment is located on a side of the first sealing segment adjacent to the first nozzle, a first guiding channel is defined on an inner circumferential side of the first guiding segment, and a cross-sectional area of the first guiding channel gradually decreases in an inserting direction of the inlet end or the outlet end, and the first sealing segment abuts against an outer circumferential wall of the inlet end or the outlet end. The part of the first sealing piece close to the first nozzle is in a flared shape, so that the inlet end or outlet end of the medium pipe can be quickly inserted into the first sealing piece through the first guiding channel, reducing the plug-connection resistance and facilitating the plug-connection between the medium pipe and the monitoring tube. In addition, the sealing effects of the first sealing piece are guaranteed by making the first sealing segment of the first sealing piece abut against the outer circumferential wall of the medium pipe.

[0015] In some embodiments, a first sealing protrusion is formed on an outer circumferential wall of the inlet end or the outlet end, the first sealing protrusion is formed into a ring shape extending in a circumferential direction of the medium pipe, and the first sealing protrusion abuts against the first sealing piece. By disposing the first sealing protrusion on the outer circumferential wall of the inlet end or outlet end of the medium pipe, the first sealing protrusion presses against the first sealing piece located in the monitoring tube when the inlet end or outlet end of the medium pipe is inserted into the monitoring tube. In this way, the outer circumferential wall of the inlet end or outlet end of the medium pipe closely fits the first sealing piece attached to the monitoring tube, further improving the sealing effects.
[0016] In some embodiments, the thermal management system further includes an external pipe, where the monitoring tube is connected between the external pipe and the medium pipe to form a circulating flow channel, and the monitoring tube is detachably connected to the external pipe. The monitoring tube is detachably connected to the external pipe of the thermal management system located outside the battery, allowing the entire monitoring tube to be removed from the thermal management system. This facilitates inspection or detection of corrosion in the monitoring tube.
[0017] In some embodiments, the monitoring tube includes a tube body and a window cover, a monitoring window is formed on an outer circumferential wall of the tube body, the monitoring window runs through an inner circumferential wall of the tube body, the window cover is arranged to cover the monitoring window, and the window cover is detachable and/or the window cover is a transparent part. The monitoring window on the circumferential wall of the monitoring tube provides a new pathway for inspection or detection of the monitoring tube, so that corrosion of the monitoring tube can be inspected or detected in a more convenient, accurate, and comprehensive manner.
[0018] In some embodiments, a material of the tube body is the same as the material of the medium pipe; and/or a material of the window cover is the same as the material of the medium pipe. In this case, the flowing environment of the heat exchange medium in the monitoring tube is close to or the same as that in the medium pipe, so that corrosion in the monitoring tube can reflect the overall corrosion situation of the pipe of the thermal management system more accurately.
[0019] In some embodiments, an inner wall surface of the window cover is flush with an inner wall surface of the tube body. In this case, the flowing environment of the heat exchange medium in the monitoring tube is close to or the same as that in the medium pipe, so that corrosion in the monitoring tube can reflect the overall corrosion situation of the pipe of the thermal management system more accurately.
[0020] In some embodiments, an outer wall surface of the window cover is flush with an outer wall surface of the tube body. This can prevent the window cover from protruding from the tube body to occupy extra space, achieving a compact structure, and can also prevent a larger step from being formed between the window cover and the tube body to protect the operator or other components from scratching.
[0021] In some embodiments, a third sealing piece is disposed between the window cover and the tube body. By disposing the third sealing piece between the window cover and the tube body, the gap between the window cover and the tube body can be sealed, preventing leakage of the heat exchange medium at the fitting position between the window cover and the tube body when the heat exchange medium flows through the monitoring tube.
[0022] In some embodiments, the window cover and the tube body are connected using a fastener. The window cover is mounted and fastened at the monitoring window of the tube body using the fastener, facilitating the mounting and dismounting of the window cover and ensuring the strength of the connection between the window cover and the tube body.
[0023] In some embodiments, the monitoring window is formed into a stepped hole, and an outer circumferential wall of the window cover is formed into a step shape to fit into the stepped hole. By setting the monitoring window to be a stepped hole and setting the outer circumferential wall of the

window cover to be in a step shape fitting into the stepped hole, the fitting area between the window cover and the tube body is increased and the window cover can be mounted and fastened more conveniently.
[0024] In some embodiments, the monitoring window includes a first hole segment and a second hole segment arranged in a wall thickness direction of the tube body, where a cross-sectional area of the first hole segment is larger than a cross-sectional area of the second hole segment and the first hole segment is located outside the second hole segment in a radial direction, and a step surface is formed between the first hole segment and the second hole segment; the window cover includes a cover plate and a boss, where the boss is disposed on an inner side of the cover plate, the cover plate is accommodated in the first hole segment and abuts against the step surface, and the boss is accommodated in the second hole segment. By setting the monitoring window to be stepped holes larger from inside out, corrosion in the tube body can be inspected or detected through the monitoring window conveniently. In addition, the window cover is set to be a structure with the boss, and part of the cover plate located on the outer circumferential side of the boss supports and abuts against the step surface in the monitoring window. This improves the mounting stability of the window cover, and facilitates the mounting and dismounting of the window cover because the step surface can support the cover plate during mounting and dismounting of the window cover.
[0025] In some embodiments, a third sealing piece is disposed between the cover plate and the step surface. By disposing the third sealing piece between the cover plate of the window cover and the step surface of the tube body, the gap between the window cover and the tube body can be sealed, preventing leakage of the heat exchange medium at the fitting position between the window cover and the tube body when the heat exchange medium flows through the monitoring tube. In addition, the third sealing piece is disposed between the cover plate and the step surface, and the step surface can support the third sealing piece, facilitating the mounting and attachment of the third sealing piece.
[0026] In some embodiments, a third accommodating groove is formed on the step surface, the third accommodating groove is formed into a ring shape extending in a circumferential direction of the first hole segment, and the third sealing piece is accommodated in the third accommodating groove. The third accommodating groove for accommodating the third sealing piece is disposed on the step surface, which facilitates the disposition and attachment of the third sealing piece and restricts the position of the third sealing piece. This can prevent the third sealing piece from moving, thereby guaranteeing the sealing effects of the third sealing piece.
[0027] In some embodiments, a first connecting hole is formed on the cover plate, a second connecting hole is formed on the step surface, and a fastener runs through the first connecting hole and the second connecting hole to fasten the window cover to the tube body. The fastener runs through the cover plate, step surface, then into the tube body, so that the cover plate can be reliably mounted at the monitoring window of the tube body. Because the fastener runs into the tube body through the step surface of the tube body, the fastener can be mounted easily.
[0028] In some embodiments, the second connecting hole is a blind hole. The second connecting hole on the step surface of the tube body is set to a blind hole. This can prevent the second connecting hole from penetrating the inner circumferential wall of the tube body to cause the heat exchange medium in the monitoring tube to leak through the fitting position between the second connecting hole and the fastener, thereby strengthening the sealing between the window cover and the tube body.
[0029] According to a second aspect, an embodiment of this application further provides a battery, including at least one battery cell and the foregoing thermal management system, where the thermal management system is configured to adjust temperature of the battery cell. With the thermal management system, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, which facilitates maintenance and reduces the maintenance cost.

[0030] In some embodiments, the battery includes a box, where the battery cell and the thermal management system body are both disposed inside the box, the inlet end and the outlet end are both disposed outside the box, and the monitoring tube is disposed outside the box. With the monitoring tube disposed outside the box for the battery, corrosion can be inspected or detected after removing the monitoring tube from the battery, without a need of dismounting the box for the battery. This facilitates the inspection or detection of pipe corrosion in the thermal management system.
[0031] According to a third aspect, an embodiment of this application further provides an electric apparatus, including the foregoing battery, where the battery is configured to supply electric energy to the electric apparatus. With the thermal management system, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, which facilitates maintenance and reduces the maintenance cost.
[0032] Additional aspects and advantages of this application will be described below in part, and some will be explicit in the following description or may be learned by practicing this application.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0033] The above and/or additional aspects and advantages of this application will become obviously easy to understand from the description of the embodiments with reference to the following drawings.
[0034] FIG. **1** is a schematic diagram of a battery according to some embodiments of this application, where a monitoring tube is removed from an inlet end or an outlet end of a medium pipe;
[0035] FIG. **2** is a schematic diagram of a monitoring tube of a thermal management system according to some embodiments of this application;
[0036] FIG. **3** is a sectional view taken along a line A-A in FIG. **2**;
[0037] FIG. **4** is a diagram of assembly of a monitoring tube and a medium pipe of a thermal management system according to some embodiments of this application;
[0038] FIG. **5** is an enlarged view of position B in FIG. **3**;
[0039] FIG. **6** is an exploded view of a monitoring tube of a thermal management system according to some embodiments of this application;
[0040] FIG. **7** is a top view of a tube body of the monitoring tube in FIG. **6**;
[0041] FIG. **8** is a side view of a window cover of the monitoring tube in FIG. **6**; and
[0042] FIG. **9** is a schematic diagram of an electric apparatus according to some embodiments of this application.
REFERENCE SIGNS
[0043] **1000**: electric apparatus; [0044] **300**: battery; [0045] **301**: box; [0046] **100**: monitoring tube; [0047] **10**: tube body; [0048] **101**: first nozzle; [0049] **102**: second nozzle; [0050] **11**: first accommodating groove; [0051] **12**: monitoring window; [0052] **121**: first hole segment; [0053] **122**: second hole segment; [0054] **13**: step surface; [0055] **14**: second accommodating groove; [0056] **15**: third accommodating groove; [0057] **16**: second connecting hole; [0058] **20**: window cover; [0059] **21**: cover plate; [0060] **211**: first connecting hole; [0061] **22**: boss; [0062] **30**: first sealing piece; [0063] **31**: first guiding segment; [0064] **311**: first guiding channel; [0065] **32**: first sealing segment; [0066] **40**: second sealing piece; [0067] **41**: second guiding segment; [0068] **411**: second guiding channel; [0069] **42**: second sealing segment; [0070] **50**: third sealing piece; [0071] **60**: fastener; [0072] **200**: medium pipe; [0073] **51**: inlet end; [0074] **52**: outlet end; and [0075] **53**: first sealing protrusion.
DETAILED DESCRIPTION
[0076] The embodiments of this application are described in detail below. Examples of the

embodiments are shown in the accompanying drawings, and the same or similar reference signs indicate the same or similar components or components with the same or similar functions. The embodiments described below with reference to the accompanying drawings are illustrative and merely for explaining this application, and cannot be construed as any limitations on this application.

[0077] To make the objectives, technical solutions, and advantages of the embodiments of this application clearer, the following clearly describes the technical solutions in the embodiments of this application with reference to the accompanying drawings in the embodiments of this application. Apparently, the described embodiments are some but not all of the embodiments of this application. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of this application without creative efforts shall fall within the protection scope of this application.

[0078] Unless otherwise defined, all technical and scientific terms used in this application shall have the same meanings as commonly understood by those skilled in the art to which this application belongs. The terms used in the specification of this application are intended to merely describe the specific embodiments rather than to limit this application. The terms “include”, “comprise”, and any variations thereof in the specification and claims of this application as well as the foregoing description of the drawings are intended to cover non-exclusive inclusions. In the specification, claims, or accompanying drawings of this application, the terms “first”, “second”, and the like are intended to distinguish between different objects rather than to describe a particular order or a primary-secondary relationship.

[0079] Reference to “embodiment” in this application means that specific features, structures, or characteristics described with reference to the embodiment may be included in at least one embodiment of this application. The word “embodiment” appearing in various places in the specification does not necessarily refer to the same embodiment, or an independent or alternative embodiment that is exclusive of other embodiments.

[0080] In the description of this application, it should be noted that unless otherwise specified and defined explicitly, the terms “mount”, “connect”, “join”, and “attach” should be understood in their general senses. For example, they may refer to a fixed connection, a detachable connection, or an integral connection; and a direct connection, an indirect connection via an intermediate medium, or an internal communication between two elements. A person of ordinary skills in the art can understand specific meanings of these terms in this application based on specific situations.

[0081] The term “and/or” in this application is only an associative relationship for describing associated objects, indicating that three relationships may be present. For example, A and/or B may indicate three cases: presence of only A; presence of both A and B; and presence of only B. In addition, the character “/” in this application generally indicates an “or” relationship between the contextually associated objects.

[0082] In the embodiments of this application, the same reference signs denote the same components. For brevity, in different embodiments, detailed descriptions of the same components are not repeated. It should be understood that the thickness, length, width and other dimensions of various components in the embodiments of the application shown in the drawings, as well as the overall thickness, length and width of the integrated apparatus, are for illustrative purposes only, and should not constitute any limitation to this application.

[0083] In this application, “a plurality of” means two (inclusive) or more.

[0084] In this application, a battery **300** is a single physical module that includes one or more battery cells for providing a higher voltage and capacity. The plurality of battery cells may be connected in series, parallel, or series-parallel to directly form the battery **300**, and a series-parallel connection means a combination of series and parallel connections among the plurality of battery cells. The plurality of battery cells may be connected in series, parallel, or series-parallel to form battery modules, and then a plurality of battery modules are connected in series, parallel, or series-parallel to form the battery **300**. For example, the battery **300** mentioned in this application may include a battery module, a battery pack, or the like.

[0085] In this application, the battery cell may include a lithium-ion secondary battery, a lithium-ion primary battery, a lithium-sulfur battery, a sodium-lithium-ion battery, a sodium-ion battery, a magnesium-ion battery, or the like, which is not limited in this embodiment of this application. The battery cell may be cylindrical, flat, cuboid, or of other shapes, which is not limited in this embodiment of this application either. The battery cells are typically divided into three types by packaging method: cylindrical battery cell, prismatic battery cell, and pouch battery cell. This is not limited in this embodiment of this application either.

[0086] For example, the battery cell may include a battery housing, an electrode assembly, and an electrolyte, where the battery housing is configured to accommodate the electrode assembly and electrolyte. The electrode assembly includes a positive electrode plate, a negative electrode plate, and a separator. Working of the battery cell mainly relies on migration of metal ions between the positive electrode plate and the negative electrode plate. The positive electrode plate includes a positive electrode current collector and a positive electrode active substance layer. The positive electrode active substance layer is applied on a surface of the positive electrode current collector. A positive electrode current collector uncoated with the positive electrode active substance layer bulges out of a positive electrode current collector coated with the positive electrode active substance layer, and the positive electrode current collector uncoated with the positive electrode active substance layer is used as a positive tab. A lithium-ion battery is used as an example, for which, the positive electrode current collector may be made of aluminum and the positive electrode active substance may be lithium cobaltate, lithium iron phosphate, ternary lithium, lithium manganate, or the like.

[0087] The negative electrode plate includes a negative electrode current collector and a negative electrode active substance layer. The negative electrode active substance layer is applied on a surface of the negative electrode current collector. A negative electrode current collector uncoated with the negative electrode active substance layer bulges out of a negative electrode current collector coated with the negative electrode active substance layer, and the negative electrode current collector uncoated with the negative electrode active substance layer is used as a negative tab. The negative electrode current collector may be made of copper, and the negative electrode active substance may be carbon, silicon, or the like. To allow a large current to pass through without any fusing, a plurality of positive tabs are provided and stacked together, and a plurality of negative tabs are provided and stacked together.

[0088] The separator may be made of PP (polypropylene, polypropylene), PE (polyethylene, polyethylene), or the like. In addition, the electrode assembly may be a wound structure or a laminated structure, but the embodiments of this application are not limited thereto.

[0089] Some batteries **300** may include a box **301** for encapsulating one or more battery cells or a plurality of battery modules, and the box **301** can prevent liquid or other foreign matters from affecting the charging or discharging of the battery cells. Certainly, some batteries **300** may not include the box **301** but are directly disposed in a battery mounting compartment of an electric apparatus **1000**.

[0090] To prevent the temperature of the battery cell from being excessively high or low, a thermal management system is used to adjust the temperature of the battery cell, thereby ensuring the reliable operation and long service life of the entire battery **300**. The thermal management system has pipes for circulating a heat exchange medium. When flowing along the pipes of the thermal management system, the heat exchange medium can dissipate heat generated by the battery cell or heat the battery cell, so as to adjust the temperature of the battery cell.

[0091] During long-term use of the battery **300**, the pipe of the thermal management system may be subject to corrosion and leakage due to improper use or other reasons. Therefore, it is necessary to regularly inspect or detect corrosion of the pipes of the thermal management system for the purpose of timely maintenance.

[0092] In the related art, pipes of the thermal management system may be damaged during inspection or detection of corrosion of the pipes of the thermal management system, and the pipes need to be repaired. This not only hinders inspection or detection of pipe corrosion of the thermal management system, but also increases the maintenance cost.

[0093] In view of this, to facilitate the pipe maintenance of the thermal management system and reduce the maintenance cost, the applicant has proposed, through in-depth research, a thermal management system for the battery **300**. The thermal management system includes a thermal management system body and a monitoring tube **100**. The thermal management system body includes a medium pipe **200** for circulating a heat exchange medium, where the medium pipe **200** is provided with an inlet end **51** and an outlet end **52**, and the detachable monitoring tube **100** is disposed on at least one of the inlet end **51** and the outlet end **52**.

[0094] In the technical solution of this application, the detachable monitoring tube **100** is disposed on at least one of the inlet end **51** and the outlet end **52** of the medium pipe **200** of the thermal management system. During circulation in the thermal management system, the heat exchange medium flows through both the medium pipe **200** and the monitoring tube **100**. The monitoring tube **100** is detachable, so the monitoring tube **100** can be removed when corrosion of the medium pipe **200** of the thermal management system needs to be inspected or detected. Corrosion in the monitoring tube **100** is inspected or detected, so as to learn about the corrosion situation of pipes of the thermal management system. In this way, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, facilitating maintenance and reducing the maintenance cost.

[0095] The battery **300** disclosed in this embodiment of this application may be used without limitation in an electric apparatus **1000** such as a vehicle, a ship, or an aircraft. The electric apparatus **1000** may use a power supply system having the battery **300** disclosed in this application, so that the maintenance difficulty and maintenance cost of the battery **300** of the electric apparatus **1000** can be reduced.

[0096] An embodiment of this application provides an electric apparatus **1000** using the battery **300** as a power source. The electric apparatus **1000** may be, but is not limited to, an electric bicycle, an electric vehicle, a ship, a spacecraft, or the like. The electric vehicle may include a truck, a construction vehicle, a car, and the like, and the spacecraft may include an airplane, a rocket, a space shuttle, a spaceship, and the like.

[0097] The following describes a thermal management system for the battery **300** according to an embodiment of this application with reference to the accompanying drawings.

[0098] As shown in FIG. **1** to FIG. **4**, according to a first aspect, an embodiment of this application provides a thermal management system for the battery **300**, including a thermal management system body and a monitoring tube **100**. The thermal management system body includes a medium pipe **200** for circulating a heat exchange medium, where the medium pipe **200** is provided with an inlet end **51** and an outlet end **52**, and the detachable monitoring tube **100** is disposed on at least one of the inlet end **51** and the outlet end **52**.

[0099] When the heat exchange medium is flowing in the thermal management system, the heat exchange medium can enter the thermal management system body through the inlet end **51** of the medium pipe **200**. When flowing through the thermal management system body, the heat exchange medium can dissipate the heat generated by the battery cell or heat the battery cell, and then flow out of the thermal management system body through the outlet end **52** of the medium pipe **200**.

[0100] Optionally, the heat exchange medium may be water, or the heat exchange medium may be a mixture of water and glycol.

[0101] The detachable monitoring tube **100** is disposed on at least one of the inlet end **51** and the outlet end **52**. For example, the detachable monitoring tube **100** is disposed on the inlet end **51** of the medium pipe **200**, the detachable monitoring tube **100** is disposed on the outlet end **52** of the medium pipe **200**, or the detachable monitoring tube **100** is disposed on both the inlet end **51** and the outlet end **52** of the medium pipe **200**.

[0102] When the detachable monitoring tube **100** is disposed on the inlet end **51** of the medium pipe **200**, the heat exchange medium can flow through the monitoring tube **100** and enter the thermal management system body through the inlet end **51** of the medium pipe **200**. When flowing through the thermal management system body, the heat exchange medium can dissipate the heat generated by the battery cell or heat the battery cell, and then flow out of the thermal management system body through the outlet end **52** of the medium pipe **200**.

[0103] When the detachable monitoring tube **100** is disposed on the outlet end **52** of the medium pipe **200**, the heat exchange medium can enter the thermal management system body through the inlet end **51** of the medium pipe **200**. When flowing through the thermal management system body, the heat exchange medium can dissipate the heat generated by the battery cell or heat the battery cell, and then flow out of the thermal management system body through the outlet end **52** of the medium pipe **200** and flow through the monitoring tube **100**.

[0104] When the detachable monitoring tube **100** is disposed on both the inlet end **51** and the outlet end **52** of the medium pipe **200**, the heat exchange medium can flow through the monitoring tube **100** connected to the inlet end **51** and enter the thermal management system body through the inlet end **51** of the medium pipe **200**. When flowing through the thermal management system body, the heat exchange medium can dissipate the heat generated by the battery cell or heat the battery cell, flow out of the thermal management system body through the outlet end **52** of the medium pipe **200**, and then flow through the monitoring tube **100** connected to the outlet end **52**.

[0105] The detachable monitoring tube **100** means that the monitoring tube **100** can be removed from the inlet end **51** or the outlet end **52** of the medium pipe **200**, without damaging the thermal management system, and the removed monitoring tube **100** can be reassembled to the inlet end **51** or the outlet end **52** of the medium pipe **200**. The detachable connection between the monitoring tube **100** and the inlet end **51** or the outlet end **52** of the medium pipe **200** may include at least one of a plug connection, a clamping connection, and a connection through a fastener **60**.

[0106] In this technical solution, the detachable monitoring tube **100** is disposed on at least one of the inlet end **51** and outlet end **52** of the medium pipe **200** of the thermal management system, so that the heat exchange medium flows through not only the medium pipe **200** but also the monitoring tube **100** during circulation in the thermal management system. The monitoring tube **100** is detachably connected to the inlet end **51** or outlet end **52** of the medium pipe **200**. Therefore, the monitoring tube **100** can be removed from the inlet end **51** or outlet end **52** of the medium pipe **200** when it is necessary to inspect or detect corrosion of the medium pipe **200** of the thermal management system. For example, corrosion in the monitoring tube **100** can be inspected or detected through a nozzle of the monitoring tube **100**, so as to learn about the corrosion situation of pipes of the thermal management system. In this way, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, facilitating maintenance and reducing the maintenance cost.

[0107] In some embodiments, a material of at least part of an inner wall of the monitoring tube **100** is the same as a material of the medium pipe **200**.

[0108] The material of at least part of the inner wall of the monitoring tube **100** is the same as that of the medium pipe **200**, which may include the following cases. For example, the material of part of the inner wall of the monitoring tube **100** is the same as that of the medium pipe **200**. For another example, the material of the entire inner wall of the monitoring tube **100** is the same as that of the medium pipe **200**. For still another example, the material of the entire monitoring tube **100** is the same as that of the medium pipe **200**.

[0109] It can be understood that different materials may have varying anti-corrosion performance for the same heat exchange medium. When the heat exchange medium is flowing through the monitoring tube **100**, the heat exchange medium is in contact with at least part of the inner wall of the monitoring tube **100**. By making the material of at least part of the inner wall of the monitoring tube **100** the same as that of the medium pipe **200**, the flowing environment of the heat exchange medium in the monitoring tube **100** is close to or the same as that in the medium pipe **200**, so that corrosion in the monitoring tube **100** can reflect the overall corrosion situation of the pipe of the thermal management system more accurately.

[0110] In some embodiments, referring to FIG. **3** and FIG. **4**, the monitoring tube **100** is plug-connected to the medium pipe **200**.

[0111] For example, the monitoring tube **100** is inserted into the inlet end **51** or the outlet end **52** of the medium pipe **200**, or the inlet end **51** or the outlet end **52** of the medium pipe **200** is inserted into the monitoring tube **100**.

[0112] Depending on the plug-connection between the monitoring tube **100** and the medium pipe **200**, the monitoring tube **100** can be inserted or removed to conveniently implement the separation and assembly of the monitoring tube **100** and the medium pipe **200**. In this way, the monitoring tube **100** can be mounted and dismounted more conveniently.

[0113] In some embodiments, referring to FIG. **3** and FIG. **4**, a first nozzle **101** and a second nozzle **102** are arranged at axial ends of the monitoring tube **100** respectively, and the inlet end **51** or the outlet end **52** is inserted into the monitoring tube **100** through the first nozzle **101**. With the inlet end **51** or outlet end **52** of the medium pipe **200** inserted into the monitoring tube **100**, the monitoring tube **100** can be plug-connected to the medium pipe **200** more conveniently.

[0114] In some embodiments, referring to FIG. **3** and FIG. **4**, a first sealing piece **30** is disposed between an inner circumferential wall of the monitoring tube **100** and an outer circumferential wall of the medium pipe **200**, or a first sealing piece **30** is disposed between an outer circumferential wall of the monitoring tube **100** and an inner circumferential wall of the medium pipe **200**.

[0115] For example, when the inlet end **51** or the outlet end **52** of the medium pipe **200** is inserted into the monitoring tube **100**, the first sealing piece **30** may be disposed between the inner circumferential wall of the monitoring tube **100** and the outer circumferential wall of the medium pipe **200**. When the monitoring tube **100** is inserted into the inlet end **51** or the outlet end **52** of the medium pipe **200**, the first sealing piece **30** may be disposed between the outer circumferential wall of the monitoring tube and the inner circumferential wall of the medium pipe **200**.

[0116] Optionally, the first sealing piece **30** may be a rubber sealant or a silicone sealant.

[0117] The first sealing piece **30** is disposed between the monitoring tube **100** and the medium pipe **200** to seal the gap therebetween, preventing leakage of the heat exchange medium at the fitting position between the monitoring tube **100** and the medium pipe **200** when the heat exchange medium flows through the monitoring tube **100**.

[0118] In some embodiments, referring to FIG. **3** and FIG. **4**, a first nozzle **101** and a second nozzle **102** are arranged at axial ends of the monitoring tube **100** respectively, and the inlet end **51** or the outlet end **52** is inserted into the monitoring tube **100** through the first nozzle **101**. The first sealing piece **30** is attached to the inner circumferential wall of the monitoring tube **100** and wraps up the inlet end **51** or the outlet end **52**.

[0119] By attaching the first sealing piece **30** to the inner circumferential wall of the monitoring tube **100**, the outer circumferential wall of the medium pipe **200** presses the first sealing piece **30** to deform when the inlet end **51** or outlet end **52** of the medium pipe **200** is inserted into the monitoring tube **100**. In this way, the inlet end **51** or outlet end **52** of the medium pipe **200** can be inserted into the monitoring tube **100** easily, and the medium pipe **200** and the monitoring tube **100** can be sealed.

[0120] In some embodiments, referring to FIG. **3** and FIG. **4**, a first accommodating groove **11** is formed on the inner circumferential wall of the monitoring tube **100**, the first accommodating groove **11** is formed into a ring shape extending in a circumferential direction of the monitoring tube **100**, and the first sealing piece **30** is accommodated in the first accommodating groove **11**.

[0121] The accommodating groove for accommodating the first sealing piece **30** is disposed on the inner circumferential wall of the monitoring tube **100**, which facilitates the disposition and attachment of the first sealing piece **30** and restricts the position of the first sealing piece **30**. This can prevent the first sealing piece **30** from moving due to friction between the medium pipe **200** and the first sealing piece **30** in the process of mounting and dismounting the monitoring tube **100**, so that the first sealing piece **30** can be held in a specified position, guaranteeing the sealing effects of the first sealing piece **30**.

[0122] In some embodiments, referring to FIG. **3** and FIG. **4**, the first sealing piece **30** includes a first guiding segment **31** and a first sealing segment **32** arranged in an axial direction of the monitoring tube **100**, where the first guiding segment **31** is located on a side of the first sealing segment **32** adjacent to the first nozzle **101**, a first guiding channel **311** is defined on an inner circumferential side of the first guiding segment **31**, a cross-sectional area of the first guiding channel **311** gradually decreases in an inserting direction of the inlet end **51** or the outlet end **52**, and the first sealing segment **32** abuts against an outer circumferential wall of the inlet end **51** or the outlet end **52**.

[0123] The part of the first sealing piece **30** close to the first nozzle **101** is in a flared shape, so that the inlet end **51** or outlet end **52** of the medium pipe **200** can be quickly inserted into the first sealing piece **30** through the first guiding channel **311**, reducing the plug-connection resistance and facilitating the plug-connection between the medium pipe **200** and the monitoring tube **100**. In addition, the sealing effects of the first sealing piece **30** are guaranteed by making the first sealing segment **32** of the first sealing piece **30** abut against the outer circumferential wall of the medium pipe **200**.

[0124] In some embodiments, referring to FIG. **4**, a first sealing protrusion **53** is formed on an outer circumferential wall of the inlet end **51** or the outlet end **52**, the first sealing protrusion **53** is formed into a ring shape extending in a circumferential direction of the medium pipe **200**, and the first sealing protrusion **53** abuts against the first sealing piece **30**.

[0125] By disposing the first sealing protrusion **53** on the outer circumferential wall of the inlet end **51** or outlet end **52** of the medium pipe **200**, the first sealing protrusion **53** presses against the first sealing piece **30** located in the monitoring tube **100** when the inlet end **51** or outlet end **52** of the medium pipe is inserted into the monitoring tube **100**. In this way, the outer circumferential wall of the inlet end **51** or outlet end **52** of the medium pipe closely fits the first sealing piece **30** attached to the monitoring tube **100**, further improving the sealing effects.

[0126] In some embodiments, referring to FIG. **3**, the thermal management system further includes an external pipe, where the monitoring tube **100** is connected between the external pipe and the medium pipe **200** to form a circulating flow channel, and the monitoring tube **100** is detachably connected to the external pipe.

[0127] When the detachable monitoring tube **100** is disposed at the inlet end **51** of the medium pipe **200**, one end of the monitoring tube **100** is detachably connected to the inlet end **51** of the medium pipe **200**, the other end of the monitoring tube **100** is detachably connected to one end of the external pipe, and another end of the external pipe is connected to the outlet end **52** of the medium pipe **200**, thereby forming a circulating flow channel for the heat exchange medium.

[0128] When the detachable monitoring tube **100** is disposed at the outlet end **52** of the medium pipe **200**, one end of the monitoring tube **100** is detachably connected to the outlet end **52** of the medium pipe **200**, the other end of the monitoring tube **100** is detachably connected to one end of the external pipe, and another end of the external pipe is connected to the inlet end **51** of the medium pipe **200**, thereby forming a circulating flow channel for the heat exchange medium.

[0129] When the detachable monitoring tube **100** is disposed at both the inlet end **51** and the outlet end **52** of the medium pipe **200**, one end of the monitoring tube **100** connected to the inlet end **51** is detachably connected to the inlet end **51** of the medium pipe **200**, and the other end of the monitoring tube **100** connected to the inlet end **51** is detachably connected to one end of the external pipe. One end of the monitoring tube **100** connected to the outlet end **52** is detachably connected to the outlet end **52** of the medium pipe **200**, and the other end of the monitoring tube **100** connected to the outlet end **52** is detachably connected to another end of the external pipe, thereby forming a circulating flow channel for the heat exchange medium.

[0130] The detachable connection between the monitoring tube **100** and the external pipe may include at least one of a plug connection, a clamping connection, and a connection through a fastener **60**.

[0131] The monitoring tube **100** is detachably connected to the external pipe of the thermal management system located outside the battery **300**, allowing the entire monitoring tube **100** to be removed from the thermal management system. This facilitates inspection or detection of corrosion in the monitoring tube **100**.

[0132] In some embodiments, referring to FIG. **5** to FIG. **8**, the monitoring tube **100** includes a tube body **10** and a window cover **20**, a monitoring window **12** is formed on an outer circumferential wall of the tube body **10**, the monitoring window **12** runs through an inner circumferential wall of the tube body **10**, the window cover **20** is arranged to cover the monitoring window **12**, and the window cover **20** is detachable and/or the window cover **20** is a transparent part.

[0133] That the window cover **20** is detachable and/or the window cover **20** is a transparent part may include the following cases. For example, the window cover **20** is detachable; for another example, the window cover **20** is a transparent part; or for still another example, the window cover **20** is detachable and the window cover **20** is a transparent part.

[0134] Among these cases, when the window cover **20** is detachable and corrosion in the monitoring tube **100** needs to be inspected or detected, the monitoring tube **100** is removed from the inlet end **51** or the outlet end **52** of the medium pipe **200**, or the window cover **20** is removed from the monitoring window **12** of the monitoring tube **100**. In this way, corrosion in the monitoring tube **100** can be inspected or detected through the monitoring window **12** or through the nozzle of the tube body **10**. This increases the pathways for inspecting or detecting corrosion in the monitoring tube **100**, so that corrosion in the monitoring tube **100** can be inspected or detected in a more accurate, comprehensive, convenient, and flexible manner.

[0135] When the window cover **20** is a transparent part and corrosion in the monitoring tube **100** needs to be inspected or detected, the monitoring tube **100** is removed from the inlet end **51** or the outlet end **52** of the medium pipe **200**. In this way, corrosion in the monitoring tube **100** can be inspected or detected through the window cover **20** or through the nozzle of the tube body **10**. This increases the pathways for inspecting or detecting corrosion in the monitoring tube **100**, so that corrosion in the monitoring tube **100** can be inspected or detected in a more accurate, comprehensive, convenient, and flexible manner.

[0136] In a case that the window cover **20** is detachable and the window cover **20** is a transparent part, when it is necessary to inspect or detect corrosion in the monitoring tube **100**, the monitoring tube **100** is removed from the inlet end **51** or the outlet end **52** of the medium pipe **200**. The window cover **20** can be removed or not from the monitoring window **12** of the monitoring tube **100** based on needs. If the window cover **20** is removed from the monitoring window **12** of the monitoring tube **100**, corrosion in the monitoring tube **100** can be inspected or detected through the monitoring window **12**; if the window cover **20** is removed, corrosion in the monitoring tube **100** can be observed through the nozzle of the tube body **10**. This increases the pathways for inspecting or detecting corrosion in the monitoring tube **100**, so that corrosion in the monitoring tube **100** can be inspected or detected in a more accurate, comprehensive, convenient, and flexible manner.

[0137] The monitoring window **12** on the circumferential wall of the monitoring tube **100** provides a new pathway for inspection or detection of the monitoring tube **100**, so that corrosion of the monitoring tube **100** can be inspected or detected in a more convenient, accurate, and comprehensive manner.

[0138] Optionally, one or more monitoring windows **12** may be provided, and each monitoring window **12** is covered by the window cover **20**. When a plurality of monitoring windows **12** are provided, the monitoring windows **12** may be spaced apart along the axial direction and/or circumferential direction of the tube body **10**. When there are a plurality of monitoring windows **12**, more pathways can be provided for inspecting or detecting corrosion in the monitoring tube **100**, so that inspection can be performed in a more accurate, comprehensive, convenient, and flexible manner.

[0139] In some embodiments, the material of the tube body **10** is the same as that of the medium pipe **200**; and/or the material of the window cover **20** is the same as that of the medium pipe **200**.

[0140] For example, the material of the tube body **10** may be the same as that of the medium pipe **200**. In this case, the flowing environment of the heat exchange medium in the monitoring tube **100** is close to or the same as that in the medium pipe **200**, so that corrosion in the monitoring tube can reflect the overall corrosion situation of the monitoring tube **100** of the thermal management system more accurately. When it is necessary to inspect or detect corrosion in the monitoring tube **100**, corrosion in the tube body **10** may be inspected or detected through the monitoring window **12** or the nozzle of the tube body **10**.

[0141] For another example, the material of the window cover **20** may be the same as that of the medium pipe **200**. In this case, the flowing environment of the heat exchange medium in the monitoring tube **100** is close to or the same as that in the medium pipe **200**, so that corrosion in the monitoring tube can reflect the overall corrosion situation of the monitoring tube **100** of the thermal management system more accurately. When it is necessary to inspect or detect corrosion in the monitoring tube **100**, the window cover **20** can be removed from the monitoring window **12**, so as to inspect or detect corrosion on the inner wall of the window cover **20**.

[0142] For another example, the material of the tube body **10** may be the same as that of the medium pipe **200** and the material of the window cover **20** may be the same as that of the medium pipe **200**. In this case, the flowing environment of the heat exchange medium in the monitoring tube **100** is close to or the same as that in the medium pipe **200**, so that corrosion in the monitoring tube can reflect the overall corrosion situation of the monitoring tube **100** of the thermal management system more accurately. When it is necessary to inspect or detect corrosion in the monitoring tube **100**, corrosion in the tube body **10** may be inspected or detected through the monitoring window **12** or the nozzle of the tube body **10**, or corrosion on the inner wall of the window cover **20** may be inspected.

[0143] In this case, the flowing environment of the heat exchange medium in the monitoring tube **100** is close to or the same as that in the medium pipe **200**, so that corrosion in the monitoring tube **100** can reflect the overall corrosion situation of the pipe of the thermal management system more accurately.

[0144] In some embodiments, referring to FIG. **5**, an inner wall surface of the window cover **20** is flush with an inner wall surface of the tube body **10**.

[0145] The inner wall surface of the window cover **20** refers to a wall surface of the window cover **20** facing the flow channel in the monitoring tube **100**, and may be in contact with the heat exchange medium. The inner wall surface of the tube body **10** refers to a wall surface of the tube body **10** facing the flow channel in the monitoring tube **100**, and may be in contact with the heat exchange medium.

[0146] That the inner wall surface of the window cover **20** is flush with the inner wall surface of the tube body **10** may include: the inner wall surface of the window cover **20** is exactly flush with the inner wall surface of the tube body **10**; and the inner wall surface of the window cover **20** is not exactly flush with the inner wall surface of the tube body **10** due to manufacturing or assembly errors.

[0147] In this case, the flowing environment of the heat exchange medium in the monitoring tube **100** is close to or the same as that in the medium pipe **200**, so that corrosion in the monitoring tube **100** can reflect the overall corrosion situation of the pipe of the thermal management system more accurately.

[0148] In some embodiments, referring to FIG. **5**, an outer wall surface of the window cover **20** is flush with an outer wall surface of the tube body **10**.
[0149] The outer wall surface of the window cover **20** refers to a wall surface of the window cover **20** exposed to the outside, and the outer wall surface of the tube body **10** refers to a wall surface of the tube body **10** exposed to the outside.
[0150] That the outer wall surface of the window cover **20** is flush with the outer wall surface of the tube body **10** may include: the outer wall surface of the window cover **20** is exactly flush with the outer wall surface of the tube body **10**; and the outer wall surface of the window cover **20** is not exactly flush with the outer wall surface of the tube body **10** due to manufacturing or assembly errors.
[0151] This can prevent the window cover **20** from protruding from the tube body **10** to occupy extra space, achieving a compact structure, and can also prevent a larger step from being formed between the window cover **20** and the tube body **10** to protect the operator or other components from scratching.
[0152] In some embodiments, referring to FIG. **5**, a third sealing piece **50** is disposed between the window cover **20** and the tube body **10**.
[0153] Optionally, the third sealing piece **50** may be a rubber sealant or a silicone sealant.
[0154] By disposing the third sealing piece **50** between the window cover **20** and the tube body **10**, the gap between the window cover **20** and the tube body **10** can be sealed, preventing leakage of the heat exchange medium at the fitting position between the window cover **20** and the tube body **10** when the heat exchange medium flows through the monitoring tube **100**.
[0155] In some embodiments, referring to FIG. **5** to FIG. **8**, the window cover **20** and the tube body **10** are connected using a fastener **60**.
[0156] Optionally, the fastener **60** may be a threaded fastener **60**. For example, the fastener **60** may be a screw or bolt.
[0157] The window cover **20** is mounted and fastened at the monitoring window **12** of the tube body **10** using the fastener **60**, facilitating the mounting and dismounting of the window cover **20** and ensuring the strength of the connection between the window cover **20** and the tube body **10**.
[0158] In some embodiments, referring to FIG. **5** to FIG. **8**, the monitoring window **12** is formed into a stepped hole, and an outer circumferential wall of the window cover **20** is formed into a step shape to fit into the stepped hole.
[0159] The outer circumferential wall of the window cover **20** refers to a wall of the window cover **20** fitting with the inner circumferential wall of the monitoring window **12**.
[0160] By setting the monitoring window **12** to be a stepped hole and setting the outer circumferential wall of the window cover **20** to be in a step shape fitting into the stepped hole, the fitting area between the window cover **20** and the tube body **10** is increased and the window cover **20** can be mounted and fastened more conveniently.
[0161] In some embodiments, referring to FIG. **5** to FIG. **8**, the monitoring window **12** includes a first hole segment **121** and a second hole segment **122** arranged in a wall thickness direction of the tube body **10**, where a cross-sectional area of the first hole segment **121** is larger than a cross-sectional area of the second hole segment **122** and the first hole segment **121** is located outside the second hole segment **122** in a radial direction, and a step surface **13** is formed between the first hole segment **121** and the second hole segment **122**; the window cover **20** includes a cover plate **21** and a boss **22**, where the boss **22** is disposed on an inner side of the cover plate **21**, the cover plate **21** is accommodated in the first hole segment **121** and abuts against the step surface **13**, and the boss **22** is accommodated in the second hole segment **122**.
[0162] The inner side of the cover plate **21** refers to a side of the cover plate **21** facing the flow channel in the tube body **10**.
[0163] When the window cover **20** includes the cover plate **21** and the boss **22**, the inner wall surface of the window cover **20** refers to a wall surface of the boss **22** facing the flow channel in

the monitoring tube **100**.

[0164] By setting the monitoring window **12** to be stepped holes larger from inside out, corrosion in the tube body **10** can be inspected or detected through the monitoring window **12** conveniently. In addition, the window cover **20** is set to be a structure with the boss **22**, and part of the cover plate **21** located on the outer circumferential side of the boss **22** supports and abuts against the step surface **13** in the monitoring window **12**. This improves the mounting stability of the window cover **20**, and facilitates the mounting and dismounting of the window cover **20** because the step surface **13** can support the cover plate **21** during mounting and dismounting of the window cover **20**.

[0165] In some embodiments, referring to FIG. **5**, a third sealing piece **50** is disposed between the cover plate **21** and the step surface **13**.

[0166] Optionally, the third sealing piece **50** may be attached to the step surface **13**.

[0167] By disposing the third sealing piece **50** between the cover plate **21** of the window cover **20** and the step surface **13** of the tube body **10**, the gap between the window cover **20** and the tube body **10** can be sealed, preventing leakage of the heat exchange medium at the fitting position between the window cover **20** and the tube body **10** when the heat exchange medium flows through the monitoring tube **100**. In addition, the third sealing piece **50** is disposed between the cover plate **21** and the step surface **13**, and the step surface **13** can support the third sealing piece **50**, facilitating the mounting and attachment of the third sealing piece **50**.

[0168] In some embodiments, referring to FIG. **5** to FIG. **7**, a third accommodating groove **15** is formed on the step surface **13**, the third accommodating groove **15** is formed into a ring shape extending in a circumferential direction of the first hole segment **121**, and the third sealing piece **50** is accommodated in the third accommodating groove **15**.

[0169] The third accommodating groove **15** for accommodating the third sealing piece **50** is disposed on the step surface **13**, which facilitates the disposition and attachment of the third sealing piece **50** and restricts the position of the third sealing piece **50**. This can prevent the third sealing piece **50** from moving, thereby guaranteeing the sealing effects of the third sealing piece **50**.

[0170] In some embodiments, referring to FIG. **5** to FIG. **7**, a first connecting hole **211** is formed on the cover plate **21**, a second connecting hole **16** is formed on the step surface **13**, and a fastener **60** runs through the first connecting hole **211** and the second connecting hole **16** to fasten the window cover **20** to the tube body **10**.

[0171] The fastener **60** runs through the cover plate **21**, step surface **13**, then into the tube body **10**, so that the cover plate **21** can be reliably mounted at the monitoring window **12** of the tube body **10**. Because the fastener **60** runs into the tube body **10** through the step surface **13** of the tube body **10**, the fastener **60** can be mounted easily.

[0172] In some embodiments, referring to FIG. **5**, the second connecting hole **16** is a blind hole.

[0173] The second connecting hole **16** is a blind hole, which means that the second connecting hole **16** does not penetrate the inner wall surface of the tube body **10**.

[0174] The second connecting hole **16** on the step surface **13** of the tube body **10** is set to be a blind hole. This can prevent the second connecting hole **16** from penetrating the inner circumferential wall of the tube body **10** to cause the heat exchange medium in the monitoring tube **100** to leak through the fitting position between the second connecting hole **16** and the fastener **60**, thereby strengthening the sealing between the cover plate **21** and the tube body **10**.

[0175] According to a second aspect, referring to FIG. **1**, an embodiment of this application further provides a battery **300**, including at least one battery cell and the foregoing thermal management system, where the thermal management system is configured to adjust temperature of the battery cell.

[0176] With the thermal management system, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, which facilitates maintenance and reduces the maintenance cost.

[0177] In some embodiments, referring to FIG. **1**, the battery **300** includes a box **301**, where the battery cell and the thermal management system body are both disposed inside the box **301**, and an inlet end **51** and an outlet end **52** of a medium pipe **200** are disposed outside the box **301**, and a monitoring tube **100** is disposed outside the box **301**.

[0178] With the monitoring tube **100** disposed outside the box **301** for the battery **300**, corrosion can be inspected or detected after removing the monitoring tube **100** from the battery **300**, without a need of dismounting the box **301** for the battery **300**. This facilitates the inspection or detection of pipe corrosion in the thermal management system.

[0179] According to a third aspect, an embodiment of this application further provides an electric apparatus **1000**, including the battery **300**, where the battery **300** is configured to supply electric energy to the electric apparatus **1000**.

[0180] With the thermal management system, corrosion of pipes of the thermal management system can be inspected or detected without damaging the thermal management system, which facilitates maintenance and reduces the maintenance cost.

[0181] Optionally, as shown in FIG. **9**, when the battery **300** is used in a vehicle, the battery **300** may be disposed at the bottom, front, or rear of the vehicle. The battery **300** may be configured to supply power to the vehicle. For example, the battery **300** may be used as an operational power source for the vehicle. The vehicle may further include a controller and a motor, where the controller is configured to control the battery **300** to supply power to the motor, for example, to satisfy power needs of start, navigation, and driving of the vehicle.

[0182] The following describes a thermal management system and a battery **300** having the same according to some specific embodiments of this application with reference to FIG. **1** to FIG. **8**.

[0183] In this embodiment, the battery **300** includes a box **301**, at least one battery cell, and a thermal management system. The thermal management system includes a thermal management system body, a monitoring tube **100**, and an external pipe. The battery cell and the thermal management system body are both disposed inside the box **301**, an inlet end **51** and an outlet end **52** of a medium pipe **200** are both disposed outside the box **301**, at least one of the inlet end **51** and the outlet end **52** of the medium pipe **200** is provided with the detachable monitoring tube **100**, where the monitoring tube **100** is disposed outside the box **301**, one end of the monitoring tube **100** is plug-connected to the inlet end **51** or the outlet end **52**, and the other end of the monitoring tube **100** is plug-connected to the external pipe.

[0184] The monitoring tube **100** includes a tube body **10**, a window cover **20**, a first sealing piece **30**, a second sealing piece **40**, a third sealing piece **50**, and a fastener **60**, where a monitoring window **12** is formed on an outer circumferential wall of the tube body **10** and runs through an inner circumferential wall of the tube body **10**, and the window cover **20** is detachably disposed to cover the monitoring window **12**. The tube body **10** is a round tube, the window cover **20** extends in an arc shape along the circumferential direction of the tube body **10**, an inner wall surface of the window cover **20** is flush with an inner wall surface of the tube body **10**, and an outer wall surface of the window cover **20** is flush with an outer wall surface of the tube body **10**. Materials of the tube body **10** and the window cover **20** are the same as that of the medium pipe **200**. A cross-sectional area of the flow channel in the tube body **10** is the same as that of the flow channel in the medium pipe **200**.

[0185] The monitoring window **12** is formed into a stepped hole, and an outer circumferential wall of the window cover **20** is formed into a step shape to fit into the stepped hole. The monitoring window **12** includes a first hole segment **121** and a second hole segment **122** arranged in a wall thickness direction of the tube body **10**, where the first hole segment **121** is located outside the second hole segment **122** in a radial direction, and a step surface **13** is formed between the first hole segment **121** and the second hole segment **122**. The window cover **20** includes a cover plate **21** and a boss **22**, where the boss **22** is disposed inside the cover plate **21**, the cover plate **21** is accommodated in the first hole segment **121** and abuts against the step surface **13**, and the boss **22** is accommodated in the second hole segment **122**.

[0186] A third sealing piece **50** is disposed between the cover plate **21** and the step surface **13**, a third accommodating groove **15** is formed on the step surface **13**, and the third sealing piece **50** is accommodated in the third accommodating groove **15**. A first connecting hole **211** is formed on the cover plate **21**, and a second connecting hole **16** is formed on the step surface **13**, where the second connecting hole **16** is a blind hole, and the fastener **60** runs through the first connecting hole **211** and the second connecting hole **16** to fasten the window cover **20** to the tube body **10**.
[0187] The tube body **10** is provided with a first nozzle **101** and a second nozzle **102** arranged opposite each other in an axial direction. The first accommodating groove **11** and a second accommodating groove **14** are formed on the inner circumferential wall of the tube body **10**, where the first accommodating groove **11** is disposed adjacent to the first nozzle **101**, the second accommodating groove **14** is disposed adjacent to the second nozzle **102**, the first sealing piece **30** is accommodated in the first accommodating groove **11**, and the second sealing piece **40** is accommodated in the first accommodating groove **11**. In the axial direction of the tube body **10**, the monitoring window **12** is disposed between the first accommodating groove **11** and the second accommodating groove **14**.
[0188] The first sealing piece **30** includes a first guiding segment **31** and a first sealing segment **32** arranged in the axial direction of the tube body **10**, where the first guiding segment **31** is located on a side of the first sealing segment **32** adjacent to the first nozzle **101**, a first guiding channel **311** is defined on an inner circumferential side of the first guiding segment **31**, and a cross-sectional area of the first guiding channel **311** gradually decreases in an inserting direction of the inlet end **51** or the outlet end **52**. A first sealing protrusion **53** is formed on an outer circumferential wall of the inlet end **51** or the outlet end **52**.
[0189] The second sealing piece **40** includes a second guiding segment **41** and a second sealing segment **42** arranged in the axial direction of the tube body **10**, where the second guiding segment **41** is located on a side of the second sealing segment **42** adjacent to the second nozzle **102**, a second guiding channel **411** is defined on an inner circumferential side of the second guiding segment **41**, and a cross-sectional area of the second guiding channel **411** gradually decreases in an inserting direction of the external pipe. A second sealing protrusion is formed on an outer circumferential wall of the external pipe, and the second sealing protrusion is formed into a ring shape extending in a circumferential direction of the external pipe.
[0190] When the monitoring tube **100** is arranged between the inlet end **51** or the outlet end **52** of the medium pipe **200** and the external pipe, the inlet end **51** or the outlet end **52** of the medium pipe **200** is inserted into the tube body **10** through the first nozzle **101** and quickly reaches the inner circumferential side of the first sealing piece **30** along the first guiding channel **311**. The first sealing protrusion **53** at the inlet end **51** or the outlet end **52** of the medium pipe **200** abuts against the first sealing piece **30** for sealing purposes. One end of the external pipe is inserted into the tube body **10** through the second nozzle **102** and quickly reaches the inner circumferential side of the second sealing piece **40** along the second guiding channel **411**. The second sealing protrusion at one end of the external pipe abuts against the second sealing piece **40** for sealing purposes.
[0191] When it is necessary to inspect or detect corrosion in the monitoring tube **100**, one end of the monitoring tube **100** can be detached from the inlet end **51** or the outlet end **52** of the medium pipe **200**, and the other end of the monitoring tube **100** can be detached from the external pipe. After the monitoring tube **100** is dismounted, the window cover **20** of the monitoring tube **100** may be removed, so that corrosion in the monitoring tube **100** can be detected or inspected through at least one of the monitoring window **12**, the first nozzle **101**, and the second nozzle **102**. In addition, corrosion on the inner wall of the window cover **20** can also be detected or inspected. In this way, corrosion in the monitoring tube **100** can be inspected in multiple paths from different angles.
[0192] In the description of this specification, the description referring to the terms “an embodiment”, “some embodiments”, “exemplary embodiments”, “an example”, “a specific example”, or “some examples” means a specific feature, structure, material or characteristic

described with reference to the embodiment or example is included in at least one embodiment or example of the this application. In this specification, illustrative expressions of these terms do not necessarily refer to the same embodiment or example. Moreover, the specific feature, structure, material, or characteristic described may be combined in any suitable manner in any one or more embodiments or examples.
[0193] Although the embodiments of this application have been shown and described, persons of ordinary skill in the art can understand that various changes, modifications, substitutions, and variants of these embodiments may be made without departing from the principle and essence of this application, and the scope of this application is limited by the claims and its equivalents.

Claims

1. A thermal management system for a battery, comprising: a thermal management system body, wherein the thermal management system body comprises a medium pipe for circulating a heat exchange medium, and the medium pipe is provided with an inlet end and an outlet end; and a monitoring tube, wherein the monitoring tube is disposed on at least one of the inlet end and the outlet end.
2. The thermal management system according to claim 1, wherein a material of at least part of an inner wall of the monitoring tube is the same as a material of the medium pipe.
3. The thermal management system according to claim 1, wherein the monitoring tube is plug-connected to the medium pipe.
4. The thermal management system according to claim 3, wherein a first nozzle and a second nozzle are arranged at axial ends of the monitoring tube respectively, and the inlet end or the outlet end is inserted into the monitoring tube through the first nozzle.
5. The thermal management system according to claim 3, wherein a first sealing piece is disposed between an inner circumferential wall of the monitoring tube and an outer circumferential wall of the medium pipe; or a first sealing piece is disposed between an outer circumferential wall of the monitoring tube and an inner circumferential wall of the medium pipe.
6. The thermal management system according to claim 5, wherein a first nozzle and a second nozzle are arranged at axial ends of the monitoring tube respectively; the inlet end or the outlet end is inserted into the monitoring tube through the first nozzle; and the first sealing piece is attached to the inner circumferential wall of the monitoring tube and wraps up the inlet end or the outlet end.
7. The thermal management system according to claim 6, wherein a first accommodating groove is formed on the inner circumferential wall of the monitoring tube; the first accommodating groove is formed into a ring shape extending in a circumferential direction of the monitoring tube; and the first sealing piece is accommodated in the first accommodating groove.
8. The thermal management system according to claim 6, wherein the first sealing piece comprises a first guiding segment and a first sealing segment arranged in an axial direction of the monitoring tube, wherein the first guiding segment is located on a side of the first sealing segment adjacent to the first nozzle; a first guiding channel is defined on an inner circumferential side of the first guiding segment; a cross-sectional area of the first guiding channel gradually decreases in an inserting direction of the inlet end or the outlet end; and the first sealing segment abuts against an outer circumferential wall of the inlet end or the outlet end.
9. The thermal management system according to claim 6, wherein a first sealing protrusion is formed on an outer circumferential wall of the inlet end or the outlet end; the first sealing protrusion is formed into a ring shape extending in a circumferential direction of the medium pipe; and the first sealing protrusion abuts against the first sealing piece.
10. The thermal management system according to claim 1, further comprising an external pipe, wherein the monitoring tube is connected between the external pipe and the medium pipe to form a circulating flow channel, and the monitoring tube is detachably connected to the external pipe.

11. The thermal management system according to claim 1, wherein the monitoring tube comprises a tube body and a window cover; a monitoring window is formed on an outer circumferential wall of the tube body; the monitoring window runs through an inner circumferential wall of the tube body; the window cover is arranged to cover the monitoring window; and the window cover is detachable and/or the window cover is a transparent part.

12. The thermal management system according to claim 11, wherein a material of the tube body is the same as the material of the medium pipe; and/or a material of the window cover is the same as the material of the medium pipe.

13. The thermal management system according to claim 11, wherein an inner wall surface of the window cover is flush with an inner wall surface of the tube body; and/or an outer wall surface of the window cover is flush with an outer wall surface of the tube body.

14. The thermal management system according to claim 11, wherein a third sealing piece is disposed between the window cover and the tube body; or the window cover and the tube body are connected using a fastener.

15. The thermal management system according to claim 11, wherein the monitoring window is formed into a stepped hole, and an outer circumferential wall of the window cover is formed into a step shape to fit into the stepped hole.

16. The thermal management system according to claim 15, wherein the monitoring window comprises a first hole segment and a second hole segment arranged in a wall thickness direction of the tube body, wherein a cross-sectional area of the first hole segment is larger than a cross-sectional area of the second hole segment; the first hole segment is located outside the second hole segment in a radial direction, and a step surface is formed between the first hole segment and the second hole segment; and the window cover comprises a cover plate and a boss, the boss is disposed on an inner side of the cover plate, the cover plate is accommodated in the first hole segment and abuts against the step surface, and the boss is accommodated in the second hole segment.

17. The thermal management system according to claim 16, wherein a first connecting hole is formed on the cover plate, a second connecting hole is formed on the step surface, and a fastener runs through the first connecting hole and the second connecting hole to fasten the window cover to the tube body.

18. A battery, comprising: at least one battery cell; and the thermal management system according claim 1, wherein the thermal management system is configured to adjust temperature of the battery cell.

19. The battery according to claim 18, further comprising a box, wherein the battery cell and the thermal management system body are both disposed inside the box, the inlet end and the outlet end are both disposed outside the box, and the monitoring tube is disposed outside the box.

20. An electric apparatus, comprising the battery according to claim 18.
