CLAIMS

[Claim 1]

A method for diagnosing a battery pack having a configuration in which a plurality of cells are connected in series, using a system for obtaining detected data including the current and temperature of the battery pack and the voltage of each cell, the method comprising:

a step of calculating an electric charge capacity and a SOC of each cell, using the current and the temperature, the voltage of each cell, an OCV-SOC function, and a resistance table, and calculating an amount of unbalance, which is an estimated value of the SOC, and a resistance of each cell when the battery pack is fully charged; and

a step of calculating the energy capacity of the battery pack using the electric charge capacity, the amount of unbalance, and the resistance.

[Claim 2]

A method for diagnosing a battery pack having a configuration in which a plurality of cells are connected in series, using a system for obtaining detected data including the current and temperature of the battery pack and the

voltage of each cell, the method comprising:

a step of calculating an electric charge capacity and a SOC of each cell, using the current and the temperature, the voltage of each cell, an OCV-SOC function, and a resistance, and calculating an amount of unbalance, which is an estimated value of the SOC, and a resistance of each cell when the battery pack is fully charged.

~~[Claim 3]~~

~~The diagnosis method according to claim 1, wherein the detected data is acquired at time intervals of less than 5 seconds.~~

~~[Claim 4]~~

~~The diagnosis method according to claim 2, wherein the detected data is acquired at time intervals of less than 5 seconds.~~

~~[Claim 5]~~

~~The diagnosis method according to claim 1, wherein the detected data is acquired at time intervals of 5 seconds or greater.~~

~~[Claim 6]~~

~~The diagnosis method according to claim 2, wherein the detected data is acquired at time intervals of 5 seconds or greater.~~

[Claim ~~7~~3]

The diagnosis method according to claim 1, wherein the energy capacity of the battery pack is calculated by calculating both the current energy capacity and the energy capacity after unbalance is eliminated.

[Claim ~~8~~4]

The diagnosis method according to claim 1, wherein coefficients of the electric charge capacity, an initial value of the SOC, and the resistance of each of the cells that minimize a sum of squares of a difference between an estimated voltage and an actual voltage of each of the cells are obtained.

[Claim ~~9~~5]

The diagnosis method according to claim 1, wherein the SOC of each cell when the battery pack is fully charged is obtained using an initial value of the SOC and the

electric charge capacity of the cell and an electric charge until any of the cells is fully charged.

[Claim ~~10~~6]

The diagnosis method according to claim 1, wherein

using a minimum voltage, a discharging current, an OCV table, and a discharge resistance table with the time when the battery pack is discharged from a full charge and any of the cells reaches the minimum voltage as the time when the discharge of the battery pack is ended, a discharge end SOC of each cell is obtained, an average voltage of each cell from the time of the full charge to the end of the discharge is obtained, and a total sum of the products of the average voltage and the electric charge capacity of each cell is defined as the current energy capacity.

[Claim ~~11~~7]

The diagnosis method according to any one of claims 1 to 6, wherein

a user is notified of a result of determining whether or not a threshold condition for the energy capacity of the battery pack is satisfied.

[Claim ~~12~~8]

The diagnosis method according to claim 1, wherein

a function indicating deterioration of the battery pack is obtained using data on the energy capacity of the battery pack,

a replacement time of the battery pack is predicted from this function, and

a user is notified of the replacement time.

[Claim ~~13~~9]

The diagnosis method according to claim 12, wherein

a time when the speed of progress of the deterioration becomes equal to or greater than a predetermined value is predicted from the function indicating the deterioration, and the user is notified of the time.

[Claim ~~14~~10]

The diagnosis method according to claim 10, wherein

the energy capacity after unbalance is eliminated is obtained by the same calculation as the calculation of the total sum of the products used when calculating the current energy capacity.

[Claim ~~15~~11]

The diagnosis method according to claim 1, further comprising:

a step of obtaining function data of the OCV for each cell; and

a step of creating the resistance table of each cell using the function data and the detected data.

[Claim ~~16~~12]

The diagnosis method according to claim 15, wherein

the function data is obtained by function approximation using the voltage and the SOC of each cell before and after a paused state having no charge nor discharge of the battery pack.

[Claim ~~17~~13]

The diagnosis method according to claim 15, wherein

the detected data includes a representative SOC of the battery pack, and

the representative SOC is used as the SOC.

[Claim ~~18~~14]

The diagnosis method according to claim 15, wherein

in the resistance table of the cell, using past ones of the function data, the representative SOC, and the detected data, data of the resistance during charging of the cell corresponding to each temperature and each SOC is obtained by function approximation as a value obtained by dividing the difference between the OCV and the voltage of the cell by the current of the cell.

[Claim ~~19~~15]

The diagnosis method according to claim 15, wherein

the voltage of each cell is measured by performing a capacity check test of the battery pack, and

the function data of the OCV is obtained using the voltage value.

[Claim ~~20~~16]

The diagnosis method according to claim 15, wherein

when a positive electrode material and a negative electrode material of the cell are known, the function data of the OCV is obtained by function approximation using a potential table of the positive electrode material and the negative electrode material.

[Claim ~~21~~17]

The diagnosis method according to claim 20, wherein

the resistance table is created using the function data of the OCV obtained by the function approximation and a resistance table of the positive electrode material and the negative electrode material.

[Claim ~~22~~18]

The diagnosis method according to claim 1, wherein

the battery pack is built into an electric vehicle,

the detected data is transmitted to a diagnosing device installed inside or outside the electric vehicle, and

the diagnosing device calculates the energy capacity of the battery pack.

[Claim ~~23~~19]

The diagnosis method according to claim 22, wherein

the diagnosing device is installed outside the electric vehicle, receives the detected data of a plurality of the electric vehicles, and calculates the energy capacity of the battery pack of each of the electric vehicles.

[Claim ~~24~~20]

The diagnosis method according to claim 1, wherein

the battery pack is built into an electric vehicle, and

a user is notified of a result of determining whether or not at least one of the mileage of the electric vehicle, the number of rapid charging times of the battery pack, the number of times the temperature of the battery pack exceeds a threshold, an assessed price when the battery pack is used in the electric vehicle, an assessed price when the battery pack is used in a vehicle other than the electric vehicle is satisfied as a threshold condition.

[Claim ~~25~~21]

A device for diagnosing a battery pack, comprising:

a SOC calculation unit;

a battery pack energy capacity calculation unit; and

a storage device having a resistance table, wherein

the SOC calculation unit calculates an electric charge capacity and the SOC of each cell using the current and temperature of the battery pack having a configuration in which a plurality of cells are connected in series, a voltage of each cell, an OCV-SOC function, and the resistance table, and calculates an amount of unbalance, which is an estimated

value of the SOC, and a resistance of each cell when the battery pack is fully charged, and

the battery pack energy capacity calculation unit calculates the energy capacity of the battery pack using the electric charge capacity, the amount of unbalance, and the resistance.

[Claim ~~26~~22]

A device for diagnosing a cell, comprising:

a SOC calculation unit; and

a storage device having a resistance table, wherein

the SOC calculation unit calculates an electric charge capacity and the SOC of each cell using the current and temperature of a battery pack having a configuration in which a plurality of cells are connected in series, a voltage of each cell, an OCV-SOC function, and the resistance table, and calculates an amount of unbalance, which is an estimated value of the SOC, and a resistance of each cell when the battery pack is fully charged.