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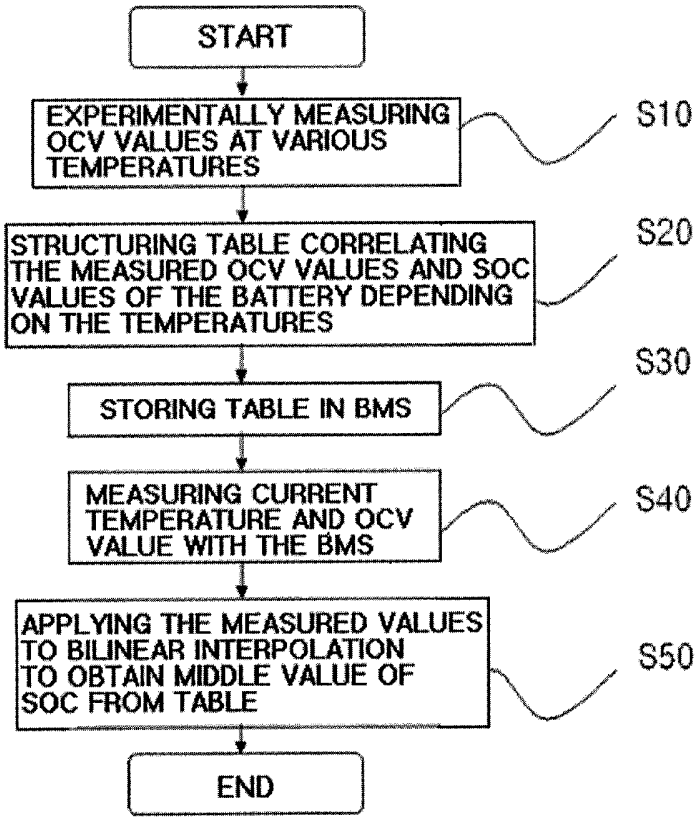
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD OF SETTING INITIAL VALUE OF SOC OF BATTERY USING OCV TEMPERATURE HYSTERESIS



(57) Abstract: Disclosed is a method of setting an initial value of a SOC of a battery more accurately in consideration of an open circuit voltage (OCV) variation depending on temperatures and aging. The method comprises steps of experimentally measuring open circuit voltage (OCV) values under various temperatures; structuring a table correlating the measured OCV values and SOC values of the battery classified by on the temperatures; storing the table in a battery management system (BMS) ; measuring current temperature and OCV value with the BMS; obtaining a SOC value of the battery corresponding to the measured values by referring to the table; and setting the obtained value as an initial SOC value of the battery.

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METHOD OF SETTING INITIAL VALUE OF SOC OF BATTERY USING OCV TEMPERATURE HYSTERESIS

Technical Field

The invention relates to a method of setting an initial value of a residual capacity (SOC; State of Charge) of a battery, and more particularly to a method of setting an initial value of a SOC of a battery more accurately in consideration of an open circuit voltage (OCV) variation depending on temperatures and aging.

Background Art

An electric vehicle uses electric energy stored in a battery as an energy source. A lithium-ion polymer battery is much used as the battery for the electric vehicle, and a research thereof has been also actively carried out.

In the mean time, since a gasoline vehicle drives an engine using the fuel, it is not difficult to measure an amount of the fuel. However, in case of the electric vehicle, it is difficult to measure residual energy accumulated in the battery. In the mean time, it is very important for a driver of the electric vehicle to know the information about how much the energy remains and to what extent the driver can drive.

In other words, since the electric vehicle is driven with the energy stored in the battery, it is very important to perceive the residual capacity of the battery. Accordingly, many technologies have been developed which measure the SOC of the battery during the traveling to notify the operator of the information about the possible distance covered.

In addition, many attempts have been performed which

properly set an initial value of the SOC of the battery before the traveling. At this time, the initial value of the SOC is set with reference to an open circuit voltage (OCV). In this method, the initial value is set on condition that the OCV is not changed depending on the environments and is an absolute reference value of the SOC.

However, according to many tests and theses, the OCV is changed depending on the temperatures and the aging, instead of having a fixed value irrespective of the environments. However, according to the conventional methods of setting an initial value of the SOC of the battery, it is not considered that the OCV is changed depending on the temperatures. Accordingly, the conventional methods cannot accurately estimate the SOC of the battery.

Disclosure of the Invention

Accordingly, the invention has been made to solve the above problems.

An object of the invention is to provide a method of setting an initial value of a SOC of a battery more accurately in consideration of an open circuit voltage (OCV) hysteresis depending on temperatures.

In order to achieve the above object, according to the invention, there is provided a method of setting an initial value of a SOC of a battery comprising steps of: experimentally measuring open circuit voltage (OCV) values under various temperatures; structuring a table correlating the measured OCV values and SOC values of the battery classified by the temperatures; storing the table in a battery management system (BMS); measuring current temperature and OCV value with the BMS; obtaining a SOC value of the battery corresponding to the measured values

by referring to the table; and setting the obtained value as an initial SOC value of the battery.

According to a preferred embodiment of the invention, the method may further comprise a step of re-setting the SOC of the battery using the OCV values depending on the various temperatures.

According to an embodiment of the invention, the table may have a horizontal axis in which the temperatures are divided in a unit of 5℃ between -30℃ and +45℃ and a vertical axis in which the SOC is divided in a unit of 1% between 0 and 100%.

Brief Description of the Drawings

FIG. 1 is a flow chart showing a process of carrying out a method according to an embodiment of the invention.

Mode for Carrying Out the Invention

Hereinafter, a preferred embodiment of the present invention will be described with reference to the accompanying drawings. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

As described above, an open circuit voltage (OCV) which is referred to set an initial value of a SOC of a battery is changed depending on temperatures and aging, instead of having a fixed value irrespective of the environments. Contrary to the prior art of setting the initial value of the SOC on the assumption that the OCV has a fixed value, according to the present invention, an OCV hysteresis, which is changed depending on the temperatures, is considered and used to set the initial

value of the SOC, so that it is possible to reduce a general error of an algorithm for estimating the SOC.

In the followings, it is more specifically described a method according to an embodiment of the invention, with reference to Fig. 1. First, the OCV values are experimentally measured under various temperatures in which the battery is operated (S10), contrary to the prior art.

For example, instead of obtaining only a relationship between the SOC and the OCV which is a reference value of the SOC, the OCV values are experimentally measured in advance under various temperatures in which the battery is actually mounted and operated and then it is structured a table correlating the OCV values and the SOC depending on the temperatures (S20).

According to an embodiment of the invention, the table has a horizontal axis in which the temperatures are divided in a unit of 5℃ between -30℃ and +45℃ in consideration of the actual operating temperatures of the battery and a vertical axis in which the SOC is divided in a unit of 1% between 0 and 100%. An example of the table is shown as follows.

【table 1】 OCV and SOC depending on the temperatures

SOC\temperature (℃	-30	.....	25	30	.....
0.01 (1%)	2.845	.....	2.90	2.95	.....
0.02 (2%)	2.855	.....	2.92	2.96	.....
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

Next, the above table is stored in a battery management system (BMS) (S30) and then current temperature and OCV value are measured in the BMS (S40).

In the mean time, in general, the current temperature and OCV value which are measured at real time in the BMS do not accurately correspond to the temperature and the OCV in the table, but belong to between the values before and after the measured value. Accordingly, in order to find out a SOC value corresponding to the current temperature and OCV measured with reference to the table, the most approximate 2 values are read out from the table and then applied to a bilinear interpolation to approximate a middle value (S50). For example, when the BMS measures the current temperature 27℃ and the OCV 2.93, the corresponding SOC is between 0.01 (1%) and 0.02 (2%) in the table 1. Accordingly, a middle value of the SOC is found out by applying a universal bilinear interpolation and the found SOC value is set as an initial SOC value of the battery (S50).

The initial SOC value estimated and set through the procedures is transmitted to a vehicle control device of the hybrid electric vehicle via the BMS to control the charge/discharge output of the battery.

Like this, according to the invention, contrary to the prior art of setting an initial SOC value with reference to the fixed OCV, it is structured a table in which the OCV values which are changed depending on the temperatures are previously correlated with the SOC values depending on the temperatures. Then, the OCV is measured at a temperature at which it is desired to set the initial SOC value and an approximate SOC value corresponding to the measured OCV is found out from the table and set as the initial value. Accordingly, it is possible to

estimate the initial SOC value depending on the temperatures.

In the mean time, according to a preferred embodiment of the invention, the method may further comprise a step of re-setting the SOC of the battery using the OCV values depending on the various temperatures, so that it is possible to carry out a setting of an initial SOC value at each of the temperatures, as necessary.

Industrial Applicability

As described above, according to the invention, it is set the initial value of the SOC in consideration that the open circuit voltage is changed depending on the temperatures. Accordingly, it is possible to correct the error resulting from no consideration of the OCV change depending on the temperatures, so that the initial value of the SOC can be more accurately set.

While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

Claims

1. A method of setting an initial value of a SOC of a battery comprising steps of:

experimentally measuring open circuit voltage (OCV) values under various temperatures;

structuring a table correlating the measured OCV values and SOC values of the battery classified by the temperatures;

storing the table in a battery management system (BMS);

measuring current temperature and OCV value with the BMS;

obtaining a SOC value of the battery corresponding to the measured values by referring to the table; and

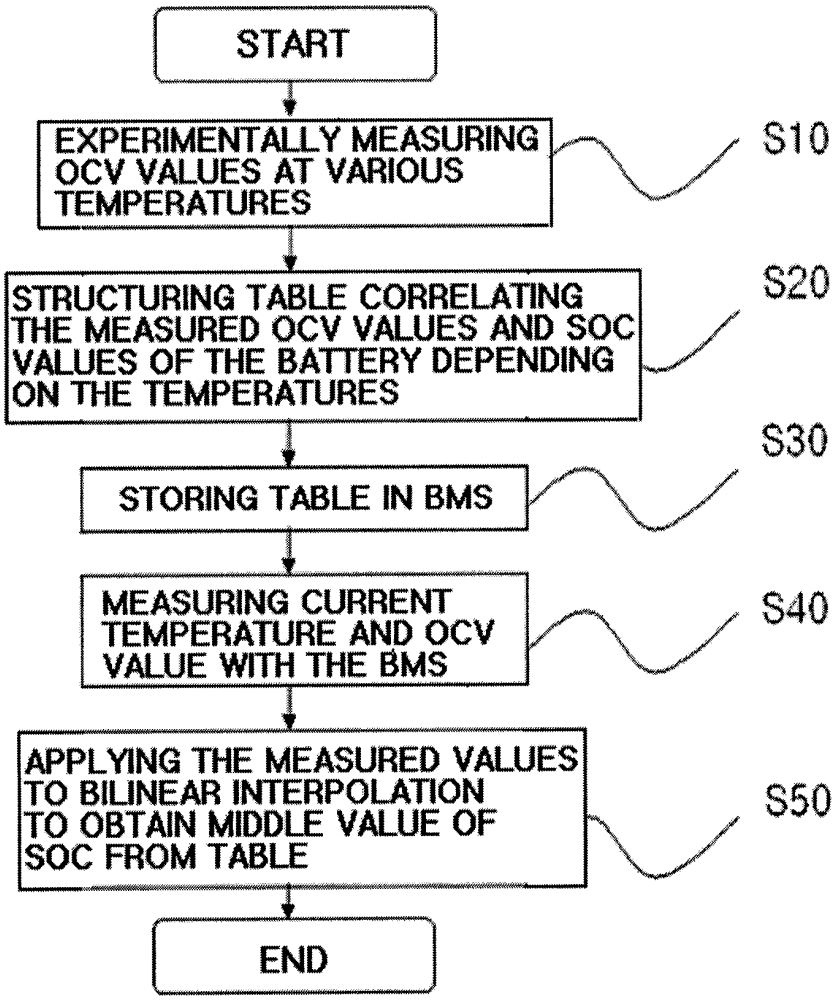
setting the obtained value as an initial SOC value of the battery.

2. The method according to claim 1, further comprising a step of re-setting the SOC of the battery using the OCV values according to the various temperatures.

3. The method according to claim 1 or 2, wherein the table has a horizontal axis in which the temperatures are divided in a unit of 5℃ between -30℃ and +45℃ and a vertical axis in which the SOC is divided in a unit of 1% between 0 and 100%.

4. The method according to claim 1, further comprising a step of re-setting approximating the obtained value by a bilinear interpolation.

FIG 1.


START
EXPERIMENTALLY MEASURING OCV VALUES AT VARIOUS TEMPERATURES
S10
STRUCTURING TABLE CORRELATING THE MEASURED OCV VALUES AND SOC VALUES OF THE BATTERY DEPENDING ON THE TEMPERATURES
S20
STORING TABLE IN BMS
S30
MEASURING CURRENT TEMPERATURE AND OCV VALUE WITH THE BMS
S40
APPLYING THE MEASURED VALUES TO BILINEAR INTERPOLATION TO OBTAIN MIDDLE VALUE OF SOC FROM TABLE
S50
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/000804

A. CLASSIFICATION OF SUBJECT MATTER

H02J 7/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 H02J H01M G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patent and applications for inventions since 1975
Utility models and applications for Utility Model since 1975
Japanese Utility Models and applications for Utility Models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) (((battery)<and>(temperature)) <in> TL)<and>(((voltage)<and>(table)) <in> AB), ((linear interpolation) <in> TL)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-162524A (SANYO ELECTRIC CO LTD) 18 JUNE 1999 See claim 1; paragragh 15 - 20; figure 1.	1 - 4
Y	US 6294894 B1 (Hitachi Maxell, Ltd.) 25 SEPTEMBER See claim 1; the abstract; figures 1, 3.	1 - 3
Y	US 5175701A (Eastman Kodak Company) 29 DECEMBER 1992 See the abstract; figure 1.	4
A	JP 8-43508A (SHINDENGEN ELECTRIC MFG CO LTD) 16 FEBURUARY 1996 See claim 1; figure 2.	1 - 4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 MAY 2006 (25.05.2006)	**26 MAY 2006 (26.05.2006)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP11162524A	18.06.1999	NONE	
US06294894B1	25.09.2001	JP13051030	23.02.2001
		JP13051031	23.02.2001
		JP2001051030A2	23.02.2001
		JP2001051031A2	23.02.2001
		US6294894B1	25.09.2001
		US6294894BA	25.09.2001
US05175701A	29.12.1992	NONE	
JP08043508A	16.02.1996	NONE	