METHOD AND APPARATUS FOR TREATING LAUNDRY

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ABSTRACT

A laundry treatment method and apparatus are provided. The laundry treatment method includes (a) choosing one of a first operating course in which a set of operating conditions are determined based on the weight of laundry and a second operating course in which the operating conditions are determined based on a plurality of operating variables; and (b) treating the laundry according to whichever of the first and second operating courses is chosen.
[Fig. 7]

- WEIGHT OF LAUNDRY
- AMOUNT OF DETERGENT REMAINED
- USER MANIPULATION SIGNAL

CONTROL UNIT

160

- NECESSITY OF ADDITIONAL RINSING PROCESS
- WASH WATER LEVEL
- ROTATION SPEED OF DRUM
- DURATION OF SPIN-DRYING PROCESS
Fig. 8)

[Diagram]

1. Process: Measure amount of detergent supplied (S158)
2. Decision: Is supplied detergent amount within predefined range? (S150)
   - Yes: Determine operating conditions for performing washing operation and operating conditions for performing rinsing operation (S151)
   - No: Notify user that drum-type washing machine needs to be switched to first operating course (S210)
3. Receive signal for allowing drum-type washing machine to be switched to first operating course (S220)
4. Decision: Does user allow drum-type washing machine to be switched to first operating course? (S230)
   - Yes: Drive drum-type washing machine according to first operating course (S240)
   - No: Continue with previous operations

End
Fig. 9)

1. **Measure amount of detergent remained** (S158)
2. **Is remained detergent amount within predefined range?**
   - **No:** Notify user that drum-type washing machine needs to be switched to first operating course (S250)
   - **Yes:** Determine whether to perform additional rinsing process (S164)
3. **Receive signal for allowing drum-type washing machine to be switched to first operating course from user** (S260)
4. **Does user allow drum-type washing machine to be switched to first operating course?**
   - **No:** Drive drum-type washing machine according to first operating course so as to perform rinsing operation (S280)
   - **Yes:** Perform spin-drying (S290)

**END**
START

MEASURE WEIGHT OF LAUNDRY

MEASURE WEIGHT OF LAUNDRY > REFERENCE VALUE?

CHOSE FIRST OPERATING COURSE

CHOSE SECOND OPERATING COURSE

END

Fig. 11

STANDARD DETERGENT AMOUNT

TOO LITTLE DETERGENT

TOO MUCH DETERGENT

182

182a

182b

182c
Fig. 12

- TOO LITTLE DETERGENT
- STANDARD DETERGENT AMOUNT
- TOO MUCH DETERGENT

COLOR CHANGES ACCORDING TO AMOUNT OF DETERGENT

Fig. 13

15% COMPLETE
Fig. 14

15% COMPLETE

(a)

MODIFYING OPERATING CONDITIONS

(b)

Fig. 15
METHOD AND APPARATUS FOR TREATING LAUNDRY

TECHNICAL FIELD

[0001] The present invention relates to a laundry treatment method and apparatus, and more particularly, to a method of controlling a laundry treatment apparatus, which can improve user satisfaction regarding washing performance.

BACKGROUND ART

[0002] Conventionally, when laundry is loaded into a drum of a washing machine, a set of operating conditions for the washing machine are automatically set based on the weight of the laundry. The operating conditions generally include the duration of a washing process and the level of wash water. However, since the operating conditions are set only based on the weight of laundry, various problems such as waste of wash water and a prolonged washing operation are highly likely to arise. In addition, there is high possibility of detergent remaining in laundry even after a washing operation is complete, and thus, user dissatisfaction may increase.

DISCLOSURE OF INVENTION

Technical Problem

[0003] The present invention provides a method of controlling a laundry treatment apparatus, which can improve user satisfaction regarding washing performance.

[0004] The present invention also provides a method of controlling a laundry treatment apparatus which can reduce the amount of detergent remained in laundry and can announce information regarding the amount of detergent.

Technical Solution

[0005] According to an aspect of the present invention, there is provided a laundry treatment method including (a) choosing one of a first operating course in which a set of operating conditions are determined based on the weight of laundry and a second operating course in which the operating conditions are determined based on a plurality of operating variables; and (b) treating the laundry according to whichever of the first and second operating courses is chosen.

[0006] According to another aspect of the present invention, there is provided a laundry treatment apparatus including a tub into which wash water for washing laundry is supplied; a control unit which determines a set of operating conditions based on a plurality of operating variables including the hardness of the wash water; and an alarm device which outputs information regarding the operating conditions.

ADVANTAGEOUS EFFECTS

[0007] According to the present invention, it is possible to improve user satisfaction regarding washing quality by choosing one of first and second operating courses in consideration of, for example, the weight of laundry, and performing a washing operation according to whichever of the first and second operating courses is chosen.

[0008] Since, in the second operating course, a set of operating conditions are determined based on a plurality of operating variables, it is possible to properly treat laundry in the second operating course in consideration various operating variables.

[0009] According to the present invention, it is possible to reduce the amount of detergent remained in laundry and thus to reduce the number of times a rinsing process needs to be performed.

[0010] According to the present invention, it is possible for a user to easily determine whether too much detergent has been supplied or how a rinsing operation progresses based on information regarding the amount of detergent.

[0011] According to the present invention, it is possible to provide an electrode sensor, which has a simple structure and is thus easy to assemble.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 illustrates an exploded perspective view of a laundry treatment apparatus according to an exemplary embodiment of the present invention;

[0013] FIG. 2 illustrates a cross-sectional view of the laundry treatment apparatus shown in FIG. 1;

[0014] FIG. 3 illustrates a block diagram of the laundry treatment machine shown in FIG. 1;

[0015] FIG. 4 illustrates a flowchart of a laundry treatment method according to an exemplary embodiment of the present invention;

[0016] FIG. 5 illustrates a block diagram for explaining control logic for performing a washing operation shown in FIG. 4;

[0017] FIG. 6 illustrates a block diagram for explaining control logic for performing a rinsing operation shown in FIG. 4;

[0018] FIG. 7 illustrates a block diagram for explaining control logic for performing an additional rinsing process shown in FIG. 4;

[0019] FIGS. 8 and 9 illustrate partial flowcharts of a laundry treatment method according to another exemplary embodiment of the present invention;

[0020] FIG. 10 illustrates a flowchart of a laundry treatment method according to another exemplary embodiment of the present invention;

[0021] FIG. 11 illustrates a diagram of an example of a display unit shown in FIG. 3;

[0022] FIG. 12 illustrates a diagram of another example of the display unit shown in FIG. 3;

[0023] FIG. 13 illustrates a diagram of another example of the display unit shown in FIG. 3;

[0024] FIG. 14 illustrates a diagram of another example of the display unit shown in FIG. 3;

[0025] FIG. 15 illustrates a cross-sectional view showing how an electrode sensor according to an exemplary embodiment of the present invention is coupled to a tub shown in FIG. 1;

[0026] FIG. 16 illustrates an exploded lateral view of the electrode sensor shown in FIG. 15;

[0027] FIG. 17 illustrates a lateral view of the electrode sensor shown in FIG. 15;

[0028] FIG. 18 illustrates a perspective view of the electrode sensor shown in FIG. 15;

[0029] FIG. 19 illustrates an exploded perspective view of the electrode sensor shown in FIG. 15;

[0030] FIG. 20 illustrates a lateral view of the electrode sensor shown in FIG. 17, as seen from direction A of FIG. 17;

[0031] FIG. 21 illustrates a perspective view of an electrode sensor according to another exemplary embodiment of the present invention;
FIG. 2 illustrates a graph showing the relationship between the concentration of detergent and the voltage of the electrode sensor shown in FIG. 21;

FIG. 23 illustrates a perspective view of an electrode sensor according to another exemplary embodiment of the present invention;

FIG. 24 illustrates a perspective view of an electrode sensor according to another exemplary embodiment of the present invention;

FIG. 25 illustrates an exploded perspective view of the electrode sensor shown in FIG. 24;

FIG. 26 illustrates a perspective view of an electrode sensor according to another exemplary embodiment of the present invention;

FIG. 27 illustrates a perspective view of an electrode sensor according to another exemplary embodiment of the present invention;

FIG. 28 illustrates a plan view of a sensor body shown in FIG. 27, as seen from direction A of FIG. 27;

FIG. 29 illustrates a plan view of a sensor body of an electrode sensor according to another exemplary embodiment of the present invention;

FIG. 30 illustrates a perspective view of a wash water sensing apparatus according to an exemplary embodiment of the present invention;

FIG. 31 illustrates a plan view of the wash water sensing apparatus shown in FIG. 30, as seen from direction A of FIG. 30;

FIG. 32 illustrates a perspective view of a wash water sensing apparatus according to another exemplary embodiment of the present invention;

FIG. 33 illustrates a perspective view of a wash water sensing apparatus according to another exemplary embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention will hereinafter be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown.

The term ‘laundry treatment apparatus’ as used herein, may indicate nearly all types of devices capable of handling laundry such as a washing machine, a dryer and a spin dryer.

A laundry treatment apparatus according to an exemplary embodiment of the present invention will hereinafter be described, taking a drum-type washing machine as an example.

FIG. 4 illustrates an exploded perspective view of a laundry treatment apparatus according to an exemplary embodiment of the present invention, i.e., a drum-type washing machine 100, and FIG. 2 illustrates a cross-sectional view of the drum-type washing machine 100.

Referring to FIGS. 1 and 2, the drum-type washing machine 100 may include a cabinet 110 defining the interior of the drum-type washing machine 100. A laundry inlet/outlet hole 112 may be formed at the front of the cabinet 110, and thus, laundry may be injected into or ejected from a drum 125 through the laundry inlet/outlet hole 112. A door assembly 130 may be disposed at the front of the cabinet 110 so as to be able to open or close the laundry inlet/outlet hole 112.

The drum-type washing machine 100 may also include a tub 120 which is disposed in the cabinet 110 so as to be buffered by a spring and a damper and can be loaded with wash water; the drum 125 which is disposed in the tub 120 so as to be rotatable and can be loaded with laundry; and a driving device 145 which is disposed at the rear of the tub 120 and applies rotation force to the drum 125. A plurality of through holes 127 may be formed on the drum 125 so that wash water can pass through the through holes 127. A lifter 129 may be disposed on an inside surface of the drum 125 and may lift and then drop laundry with the use of gravitational force during the rotation of the drum 125.

FIG. 3 illustrates a block diagram of the drum-type washing machine 100. Referring to FIG. 3, a control unit 160 may also include a control panel 177 which is disposed at an upper part of the cabinet 110, displays various information regarding the operation of the drum-type washing machine 100, and controls a motor 173 which operates the drum-type washing machine 100.
may receive various information from a weight sensing unit 183, the electrode sensor 150 and an input unit 184 and may control the operations of the water supply device 140, the driving device 145, a display unit 182 and an audio output unit 181.

The weight sensing unit 183 may sense the weight of laundry loaded in the drum 125. The input unit 184 may receive a user manipulation signal from a user. The input unit 184 may be included in the control panel 117. Examples of the user manipulation signal include a signal for turning on or off the drum-type washing machine 100, a signal for choosing a washing course, a signal for performing an additional rinsing process, and a signal for performing an additional spin-drying process.

An alarm device 180 may include the audio output unit 181 and the display unit 182. The audio output unit 181 may output audio data regarding the amount of detergent. The display unit 182 may output visual data regarding the amount of detergent.

The drum-type washing machine 100 may also include a memory unit 170 in which various audio data and display information is stored. The control unit 160 may control the alarm device 180 to notify the user of the amount of detergent either auditorily or visually using the information present in the memory unit 170.

The audio output unit 181 may output information regarding the amount of detergent as an audio message. The audio output unit 181 may be implemented as a speaker.

The display unit 182 may output text data or graphic data regarding the amount of detergent. The display unit 182 may account for part of the control panel 117 for setting a washing course. For example, the display unit 182 may be implemented as a liquid crystal display (LCD) or a light-emitting diode (LED) and may be disposed on one side of the control panel 117. The display unit 182 may display not only information regarding the amount of detergent but also various other information indicating how a washing operation progresses such as information indicating the beginning and/or the end of a washing operation.

FIG. 4 illustrates a flowchart of a laundry treatment method according to an exemplary embodiment of the present invention. Referring to FIG. 4, the input unit 184 may receive a signal for choosing an operating course from the user (S110). More specifically, the input unit 184 may include a button for choosing an operating course and may thus allow the user to choose one of first and second operating courses. Alternatively, if the user chooses a set of operating conditions for a whole operation, the input unit 184 may determine that the user has chosen the first operating course. On the other hand, if the user does not choose any operating conditions for the whole operation, the input unit 184 may determine that the user has chosen the second operating course. Still alternatively, if the user chooses an operating condition for only part of the whole operation, the input unit 184 may determine that the user has chosen the first operating course for part of the whole operation corresponding to the chosen operating condition and has chosen the second operating course for the rest of the whole operation.

If the user chooses the first operating course (S115), the weight of laundry may be determined (S120). A set of default operating conditions for the first operating course may be in advance based on the weight of laundry. The default operating conditions for the first operating course may include the duration of a washing process, the temperature of wash water, the duration of a rinsing process, the duration of a rinsing/spin-drying process, the rotation speed of the drum 125, the driving pattern of the drum 125, the level of wash water in the tub 120, a target temperature to which wash water is to be heated, the number of times a rinsing process is to be performed, and the duration of a spin-drying process. The user may change at least some of the default operating conditions for the first operating course by inputting a user manipulation signal to the drum-type washing machine 100 with the use of the input unit 184 (S123). Once a set of operating conditions for the first operating course are finally set, a washing operation, a rinsing operation and a spin-drying operation may be sequentially performed (S125, S127 and S129) according to the operating conditions for the first operating course. Since the treatment of laundry during the first operating course is rather simple, the user may easily estimate the time required for treating laundry.

If the user chooses the second operating course (S115), the weight of laundry may be determined (S130). Thereafter, if a user manipulation signal is detected (S135), a washing operation may be performed. More specifically, wash water is supplied into the tub 120 (S140), the hardness of the wash water may be measured using the electrode sensor 150 (S142), and the temperature of the wash water may be measured using the temperature sensor 186 (S144). The temperature of the wash water may be measured during or after the supply of detergent into the tub 120.

The electrode sensor 150 may measure the conductivity of the wash water and may transmit measurement data regarding the conductivity of the wash water to the control unit 160. The control unit 160 may determine the hardness of the wash water based on the measurement data provided by the electrode sensor 150.

Thereafter, detergent may be supplied into the tub 120 (S146). Thereafter, the amount of the detergent may be measured using the electrode sensor 150. Since the electrode sensor 150 is sensitive to temperature variations, the heater 187 may be turned on during the measurement of the amount of the detergent by the electrode sensor 150.

The control unit 160 may determine the amount of detergent in the wash water in the tub 120 based on the measurement data provided by the electrode sensor 150 and data present in the memory unit 170. More specifically, the control unit 160 may compare the measurement data provided by the electrode sensor 150 with data present in the memory unit 170 and may determine the amount of detergent in the wash water in the tub 120 based on the results of the comparison.

In addition, the control unit 160 may also determine whether too little detergent has been supplied into the tub 120 by comparing the determined detergent amount with a standard detergent amount stored in the memory unit 170.

Thereafter, the control unit 160 may control the audio output unit 181 to output information regarding the amount of detergent supplied into the tub 120 using audio data present in the memory unit 170. For example, the audio output unit 181 may output a voice message, Too much detergent has been input, An appropriate amount of detergent has been input, or Too little detergent has been input. As a result, the user may easily recognize whether too much or too little detergent has been supplied into the tub 120 based on the voice message and may thus be able to supply an appropriate amount of detergent into the tub 120.
The drum-type washing machine 100 may provide the user with video data regarding the amount of detergent supplied into the tub 120. More specifically, the display unit 182 may display a text message, “Too much detergent has been input,” “An appropriate amount of detergent has been input,” or “Too little detergent has been input.”

Alternatively, the display unit 182 may display graphic data such as geometrical figures, images, or colors, instead of a text message, in order to provide information regarding the amount of detergent supplied into the tub 120. The display unit 182 will be described later in further detail with reference to FIGS. 11 and 12.

The control unit 160 may determine whether the amount of detergent supplied into the tub 120 is within a predefined range (S150) in order to determine whether the electrode sensor 150 is malfunctioning. The electrode sensor 150 may determine the amount of detergent based on the conductivity of wash water and may thus react sensitively to the wash water environment in the tub 120. That is, if a measured detergent amount provided by the electrode sensor 150 is outside the predefined range, it may be determined that the electrode sensor 150 is malfunctioning, instead of determining whether the user has input too much or too little detergent. Thus, the user may be notified of the malfunction of the electrode sensor 150 with the use of the display unit 182 or the audio output unit 181 (S152). Thereafter, that the drum-type washing machine 100 may be automatically switched from the second operating course to the first operating course, and the laundry treatment method returns to operation S125.

On the other hand, if the measured detergent amount provided by the electrode sensor 150 is within the predefined range (S150), the control unit 160 may determine a set of operating conditions for performing a washing operation (S151). FIG. 5 illustrates a block diagram of control logic for performing a washing operation. The control unit 160 may use various control logics to determine the operating conditions for performing a washing operation. In the exemplary embodiment of FIG. 4, the control unit 160 may use fuzzy logic. In the fuzzy logic, the weight of laundry, the amount of detergent supplied, the temperature of wash water, the hardness of wash water and a user manipulation signal may be condition variables, and the driving pattern of the drum 125, the target temperature to which wash water is to be heated, the duration of a washing process, and the number of times a rinsing process is to be performed during a washing operation may be conclusion variables. The control unit 160 may determine the conclusion variables using a membership function between the condition variables and the conclusion variables. The fuzzy logic may use various operating variables, other than those set forth herein, as condition variables.

It will hereinafter be described in detail how to determine the operating conditions for performing a washing operation based on the hardness of wash water.

In operation S142, the control unit 160 may determine the hardness of wash water supplied into the tub 120 based on the conductivity of the wash water. The memory unit 170 may store a table showing the correspondence between a plurality of water hardness levels and a plurality of wash durations. According to the table, the higher the hardness of wash water, the longer the washing duration becomes. For example, if the hardness level of wash water supplied into the tub 120 is high, the control unit 160 may increase the duration of a washing process. In this manner, it is possible to improve the performance of the drum-type washing machine 100.

In operation S148, the control unit 160 may change a default wash duration according to the amount of detergent supplied into the tub 120 and may control a washing operation to be performed according to the changed wash duration. In this manner, it is possible to further improve the performance of the drum-type washing machine 100.

The operating conditions for performing a washing operation may be modified based on a plurality of operating variables. That is, the control unit 160 may collect a number of operating variables of the drum-type washing machine 100 during a washing operation, and may modify the operating conditions for performing a washing operation based on the collected operating variables. For example, if the amount of detergent measured by the electrode sensor 150 is within a predefined range, the control unit 160 may modify the driving pattern of the drum 125, the target temperature to which wash water is to be heated, and the duration of a washing process. Therefore, the control unit 160 may control the drum-type washing machine 100 to operate optimally according to such modifications to the operating conditions for performing a washing operation. The control unit 160 may modify the operating conditions for performing a washing operation not only before but also during a washing operation.

The control unit 160 may output information indicating how a washing operation progresses with the use of the display unit 182 and the audio output unit 181, and this will be described later in further detail with reference to FIGS. 13 and 14.

FIG. 6 illustrates a block diagram for explaining control logic for performing a rinsing operation. Referring to FIG. 6, the control unit 160 may use fuzzy logic to determine a set of operating conditions for performing a rinsing operation. In the fuzzy logic, the weight of laundry, the amount of detergent supplied, and a user manipulation signal may be condition variables, and the water level in the tub 120, the rotation speed of the drum 125, which is the measure of a rinsing/spin-drying speed, and the duration of a rinsing/spin-drying operation may be conclusion variables. The control unit 160 may determine the conclusion variables using a membership function between the condition variables and the conclusion variables.

The control unit 160 may modify the operating conditions for performing a rinsing operation before a rinsing operation. That is, when a washing operation is complete, the control unit 160 may collect a plurality of operating variables, and may modify the operating conditions for performing a rinsing operation based on the collected operating variables. That is, when a washing operation is complete, the control unit 160 may control wash water to be supplied into the tub 120 and may measure the amount of detergent in the wash water using the electrode sensor 150. Thereafter, the control unit 160 may control the water in the tub 120, the rotation speed of the drum 125 and the duration of a rinsing/spin-drying operation based on the measured detergent amount.

The control unit 160 may output information indicating how a rinsing operation progresses with the use of the display unit 182 or the audio output unit 181, and this will be described later in further detail with reference to FIGS. 13 and 14.

Once the operating conditions for performing a washing operation such as the driving pattern of the drum 125, the target temperature to which wash water is to be heated, the duration of a washing process and the number of times a washing operation is to be performed are all deter-
mined, a washing operation may be performed according to the determined operating conditions for performing a washing operation (S153). During the washing operation, the laundry loaded in the drum 125 may be washed with wash water while rotating the drum 125. Thereafter, a rinsing/spin-drying operation and a rinsing operation may be performed according to the operating conditions for performing a rinsing operation such as the water level in the tub 120, the rotation speed of the drum 125, and the duration of a rinsing/spin-drying operation (S154 and S156).

In short, if it is determined in operation S166 that an additional rinsing process needs to be performed, the operating conditions for performing an additional rinsing process may be determined (S168). Thereafter, an additional rinsing/spin-drying operation may be performed (S170 and S172). The control unit 160 may provide the user with information regarding an additional rinsing process to be performed in operation S172 with the use of the display unit 182 or the audio output unit 181.

If the measured remaining detergent amount is outside a predefined range (S160), the control unit 160 may determine whether an additional rinsing process need to be performed based on the weight of the laundry loaded in the drum 125 and a user manipulation signal, if any, received from the user (S164). If it is determined that an additional rinsing process needs to be performed (S166), the control unit 160 may operate a set of conditions for performing an additional rinsing process (S168). The operating conditions for performing an additional rinsing process may include the water level in the tub 120, the rotation speed of the drum 125 and the duration of a spin-drying process. The control unit 160 may provide the user with information regarding an additional rinsing process with the use of the display unit 182 or the audio output unit 181.

FIG. 7 illustrates a block diagram for explaining control logic for performing an additional rinsing process. Referring to FIG. 7, the control unit 160 may use fuzzy logic to determine the necessity of an additional rinsing process and the operating conditions for performing an additional rinsing process. In the fuzzy logic, the weight of laundry and a user manipulation signal may be condition variables, and the water level in the tub 120, the rotation speed of the drum 125 and the duration of a spin-drying process may be conclusion variables. The control unit 160 may determine the conclusion variables using a membership function between the condition variables and the conclusion variables. The fuzzy logic may also use various operating variables, other than those set forth herein, as condition variables. However, since the amount of detergent remained in laundry is one of the most important factors for determining whether to perform an additional rinsing process, operating variables associated with the amount of detergent remained in laundry may be used as condition variables. That is, the amount of detergent measured by the electrode sensor 150 and the weight of laundry are important factors for determining the amount of detergent remained in laundry, and a user manipulation signal is also an important factor because it indicates whether to perform an additional rinsing process or whether to terminate a rinsing operation. In short, since only the amount of detergent remained, the weight of laundry and a user manipulation signal are used as condition variables, it is possible to simplify fuzzy control and thus to facilitate the use of a membership function.

As described above, during the second operating course, a washing operation and a rinsing operation may be performed in consideration of a plurality of operating variables of the drum-type washing machine 100. Therefore, it is possible to reduce the amount of detergent remained in laundry and the consumption of wash water and electricity.

FIGS. 8 and 9 illustrate partial flowcharts of a laundry treatment method accordingly to another exemplary embodiment of the present invention. The exemplary embodiment of FIGS. 8 and 9 will hereinafter be described, focusing mainly on differences with the exemplary embodiment of FIG. 4. Referring to FIG. 8, if the amount of detergent supplied into the tub 120 is outside a predefined range (S150), the control unit 160 may notify the user with the use of the display unit 182 or the audio output unit 181 that the drum-type washing machine 100 needs to be switched to the first operating course (S210). Thereafter, if a signal for allowing the drum-type washing machine 100 to be switched to the first operating course is received from the user (S220), the control unit 160 may determine whether the user allows the drum-type washing machine 100 to be switched to the first operating course (S230). Thereafter, the control unit 160 may switch the drum-type washing machine 100 to the first operating course and thus to drive the drum-type washing machine 100 according to the first operating course (S240). On the other hand, if the user does not allow the drum-type washing
machine 100 to be switched to the first operating course, the operation of the drum-type washing machine 100 may be terminated.

[0091] Referring to FIG. 9, the amount of detergent remained in wash water in the tub 120 may be measured by the electrode sensor 150 during a rinsing operation (S158). If the measured amount of detergent is outside a predefined range (S160), the control unit 160 may notify the user with the use of the display unit 182 or the audio output unit 181 that the drum-type washing machine 100 needs to be switched to the first operating course (S250). If the user allows the drum-type washing machine 100 to be switched to the first operating course (S270), the control unit 160 may switch the drum-type washing machine 100 to the first operating course and may control the drum-type washing machine 100 to perform a rinsing operation (S280) and then a spin-drying operation (S290). On the other hand, if the user does not allow the drum-type washing machine 100 to be switched to the first operating course, the operation of the drum-type washing machine 100 may be terminated.

[0092] As described above, in the exemplary embodiment of FIGS. 8 and 9, the drum-type washing machine 100 may be switched from the second operating course to the first operating course with the user’s approval, whereas, in the exemplary embodiment of FIG. 4, the drum-type washing machine 100 is automatically switched from the second operating course to the first operating course. Therefore, it is possible to offer a choice to the user. In addition, it is possible to prevent deterioration of the performance of the drum-type washing machine 100, which may be caused by automatically switching the drum-type washing machine 100 between the first and second operating courses.

[0093] FIG. 10 illustrates a flowchart of a laundry treatment method according to another exemplary embodiment of the present invention. The exemplary embodiment of FIG. 10 will hereinafter be described, focusing mainly on differences with the exemplary embodiment of FIG. 4.

[0094] Referring to FIG. 10, when laundry is loaded into the drum 125, the weight of the laundry may be measured (S310). If the weight of the laundry is greater than a predefined value (S320), the laundry may be handled according to the first operating course (S330). On the other hand, if the weight of the laundry is less than the predefined value (S320), the laundry may be handled according to the second operating course (S340). That is, when only a small amount of laundry is loaded in the drum 125, the laundry may be handled in consideration of not only the weight of the laundry but also various other operating variables. Therefore, it is possible to reduce the consumption of wash water and electricity.

[0095] In short, in the exemplary embodiment of FIG. 10, one of the first and second operating courses may be automatically chosen according to the weight of laundry loaded in the drum 125. Thus, it is possible to improve user convenience.

[0096] FIG. 11 illustrates a schematic diagram of an example of the display unit 182. Referring to FIG. 11, the display unit 182 may include a plurality of first segments 182a which are selectively turned on or off according to the amount of detergent supplied and represent different colors and a second segment 182b whose color changes according to the amount of detergent supplied. More specifically, one of the first segments 182a may be turned on according to the amount of detergent supplied, and the color of the second segment 182b may be determined by the amount of detergent supplied. If the color of the second segment 182b is the same as the color of whichever of the first segments 182a is turned on according to the amount of detergent supplied, the user may be able to easily recognize the amount of detergent supplied.

[0097] The display unit 182 may also include a third segment 182c displaying information regarding the amount of detergent remained. If a reference remaining detergent amount is “100%”, the third segment 182c may display the information regarding the amount of detergent remained as, for example, “0%” or “95%”. If there is no detergent remained, the third segment 182c may display the information regarding the amount of detergent remained as “0%”. Therefore, the user may easily determine how well laundry in the drum 125 has been rinsed out based on the information regarding the amount of detergent remained. Thus, it is possible to improve user satisfaction.

[0098] Alternatively, the information regarding the amount of detergent remained may be displayed using the first segments 182a, instead of using the third segment 182c. That is, the first segment 182a labeled as “Too much detergent” may be turned on at the beginning of a rinsing operation. Therefore, the first segments 182a except the first segment 182a labeled as “Too much detergent” and the second segment 182b labeled as “Too little detergent” may be sequentially turned on in accordance with the amount of detergent remained decreases. If the amount of detergent remaining is less than a predefined level, the first segment 182a labeled as “Too little detergent” may be turned on.

[0099] FIG. 12 illustrates a schematic diagram of another example of the display unit 182, i.e., a display unit 282. Referring to FIG. 12, the display unit 282 may include a plurality of first segments 282a arranged side by side in a horizontal direction. One of the first segments 282a may be turned on according to the amount of detergent.

[0100] FIG. 13 illustrates a schematic diagram of another example of the display unit 182, i.e., a display unit 382. Referring to FIG. 13, the display unit 382 may display the progress of a washing operation or a rinsing operation using a progress bar. The progress bar may be increased or decreased according to the progress of a washing operation or a rinsing operation. However, if a set of operating conditions are modified based on a plurality of operating variables, the size of the filled portion of the progress bar may decrease.

[0101] The display unit 382 may be implemented as an LCD.

[0102] FIG. 14 illustrates a schematic diagram of another example of the display unit 182, i.e., a display unit 482. Referring to FIG. 14(a), the display unit 483 may display a progress bar having a certain shape, other than a bar shape. The progress bar may be increased or decreased according to the progress of a washing operation or a rinsing operation.

[0103] Referring to FIG. 14(b), the display unit 482 may display, for example, a spinning hourglass, in order to indicate that the modification of a set of operating conditions based on a plurality of operating variables is under way.

[0104] The alarm device 180 is illustrated in FIG. 3 as including both the audio output unit 181 and the display unit 182, but the present invention is not restricted to this. That is, the alarm device 180 may include only one of the audio output unit 181 and the display unit 182. Even if the alarm device 180 includes both the audio output unit 181 and the display unit 182, the control unit 160 may control the audio output unit 181 and the display unit 182 not to operate at the same time,
i.e., the control unit 160 may control only one of the audio output unit 181 and the display unit 182 to operate at a time.

[0105] FIG. 15 illustrates a cross-sectional view showing how an electrode sensor 150 according to a first exemplary embodiment of the present invention is coupled to the tub 120 shown in FIG. 1. FIG. 16 illustrates an exploded lateral view of the electrode sensor 150 shown in FIG. 15. FIG. 17 illustrates a lateral view of the electrode sensor 150 shown in FIG. 15. FIG. 18 illustrates a perspective view of the electrode sensor 150 shown in FIG. 15. FIG. 19 illustrates an exploded perspective view of the electrode sensor 150 shown in FIG. 15, and FIG. 20 illustrates a lateral view of the electrode sensor 150, as seen from direction A of FIG. 17.

[0106] Referring to FIGS. 15 through 19, the electrode sensor 150 may include a sealing cover 60 and a sensor body 70. The sealing cover 60 may be coupled to the tub 120 by being inserted into the hole 5a. The sensor body 70 may include a plurality of electrodes 72 and may be coupled to the sealing cover by being inserted into a through hole 61 formed through the sealing cover 60.

[0107] The sealing cover 60 may be coupled to the tub 120 by pressing the sensor body 70 into the tub 120. Thus, the sealing cover 60 may be more elastic than the sensor body 70. The sealing cover 60 may be formed of rubber.

[0108] The sealing cover 60 may include a cover insertion portion 62 which can be inserted into the hole 5a. Referring to FIG. 16, when the cover insertion portion 62 is yet to be inserted into the hole 5a, the cover insertion portion 62 may have an outer diameter d2 which is greater than a diameter d1 of the hole 5a. For example, the outer diameter d2 may be about 5 mm greater than the diameter d1. On the other hand, referring to FIG. 17, when the cover insertion portion 62 is inserted in the hole 5a, the cover insertion portion 62 may be pressed by the inner circumferential surface of the hole 5a, and thus, the outer diameter of the cover insertion portion 62 may be reduced to an outer diameter d1 which is the same diameter as the diameter d1.

[0109] Referring to FIG. 15, the sealing cover 60 may also include first and second ribs 63 and 64. The first and second ribs 63 and 64 may protrude beyond the outer circumferential surface of the cover insertion portion 62. When the sealing cover 60 is coupled to the tub 120, the first and second ribs 63 and 64 may be disposed at the front and rear, respectively, of the hole 5a on a rear surface 5 of the tub 120 and thus firmly fix the sealing cover 60 in the hole 5a. More specifically, the first and second ribs 63 and 64 may protrude radially from the cover insertion portion 62. The first and second ribs 63 and 64 may be a predetermined distance apart from each other. Due to the first and second ribs 63 and 64, the cover insertion portion 62 of the sealing cover 60 may be fit in the hole 5a when the sealing cover 60 is inserted in the hole 5a.

[0110] Referring to FIG. 17, a surface 64a of the second rib 64 may be placed in contact with the rear surface 5 of the tub 120 when the sealing cover 60 is inserted into the hole 5a. The surface 64a of the second rib 64 may be recessed toward the centre of the through hole 61.

[0111] A hem portion 65 of the sealing cover 60 may be tapered so that the sealing cover 60 can be easily inserted into the hole 5a.

[0112] Referring to FIGS. 18 through 20, the sealing cover 60 may also include a cover cylinder portion 66 which extend backwards from the second rib 64 and a number of hook portions 67 which protrude from the cover cylinder portion 66 so as to be able to be coupled to the sensor body 70. At least one hook portion 67 may be formed on the cover cylinder portion 66. Referring to FIGS. 19 and 20, two hook portions 67 may be formed on opposite sides of the cover cylinder portion 66.

[0113] The sensor body 70 may be formed from injection molding, and the electrodes 72 may be inserted into the sensor body 70 during the formation of the sensor body 70. For example, two electrodes 72 may be inserted into the sensor body 70 so that the ends of the two electrodes 72 can be exposed.

[0114] The sensor body 70 may include a body insertion portion 73 which can be inserted into the through hole 61 and a body cylinder portion 74 which extends backwards from the body insertion portion 73.

[0115] Referring to FIG. 16, when the body insertion portion 73 is yet to be inserted into the through hole 61, the body insertion portion 73 may have an outer diameter d4 which is greater than a diameter d3 of the through hole 61. For example, the outer diameter d4 may be about 2 mm greater than the diameter d3. On the other hand, referring to FIG. 17, when the body insertion portion 73 is inserted into the through hole 61, the inner circumferential surface of the through hole 61 may be pressed by the body insertion portion 73, and thus, the diameter of the through hole 61 may be reduced to a diameter d3 which is the same as the outer diameter d4.

[0116] Referring to FIGS. 18 through 20, the sensor body 70 may also include an engaging protrusion 75 which engages with the hook portion 67 when the body insertion portion 73 is inserted into the through hole 61. The engaging protrusion 75 may protrude radially from a portion of the body insertion portion 74 corresponding to the hook portions 67. The body cylinder portion 74 may include a plurality of recessed portions 74a into which the hook portions 67 can be inserted.

[0117] How to assemble the electrode sensor 150 will hereinafter be described in detail.

[0118] The sealing cover 60 may be pressed into the hole 5a of the tub 120. Since the sealing cover 60 is formed of rubber and the outer diameter of the cover insertion portion 61 is greater than the diameter of the insertion hole 5a, when the cover insertion portion 61 is yet to be inserted into the hole 5a, the cover insertion portion 61 may be pressed by and thus firmly attached onto the inner circumferential surface of the hole 5a when the sealing cover 60 is inserted into the hole 5a.

[0119] Therefore, it is possible to easily install the sealing cover 60 simply by inserting the sealing cover 60 into the hole 5a of the tub 120. In addition, since the cover insertion portion 62 is pressed by and thus firmly attached onto the inner circumferential surface of the hole 5a when the sealing cover 60 is inserted into the hole 5a, there is no need to additionally seal the connection between the sealing cover 60 and the hole 5a.

[0120] Once the installation of the sealing cover 60 is complete, the sensor body 70 may be inserted into the through hole 61 of the sealing cover 60. Since the outer diameter of the body insertion portion 73 is greater than the diameter of the through hole 61 when the sensor body 70 is yet to be inserted into the through hole 61, the body insertion portion 73 may be pressed by and thus firmly attached onto the inner circumferential surface of the through hole 61 when the sensor body 70 is inserted into the through hole 61.

[0121] Therefore, it is possible to easily assemble the electrode sensor 150 simply by inserting the sensor body 70 into the through hole 61 of the sealing cover 60. In addition, since the body insertion portion 73 of the sensor body 70 is pressed
by and thus firmly attached onto the inner circumferential surface of the hole 5a when the sensor body 70 is inserted into the through hole 61 of the sealing cover 60; there is no need to additionally seal the connection between the sealing cover 60 and the hole 5a.

[0122] The operation of the electrode sensor 150 will hereinafter be described in detail.

[0123] When laundry is loaded into the drum 125 and wash water is supplied into the tub 120, the electrode sensor 150 measures the conductivity of the wash water in the tub 120.

[0124] More specifically, if a voltage is applied to the electrodes 72 of the electrode sensor 150, the electrodes 72 may be electrically connected, and thus, the electrode sensor 150 may thus be able to measure the conductivity of the wash water in the tub 120.

[0125] FIG. 21 illustrates a perspective view of an electrode sensor 80 according to a second exemplary embodiment of the present invention. Referring to FIG. 21, the electrode sensor 80 may include a sealing cover 84, which is coupled to the tub 120 by being inserted into the hole 5a of the tub 120, and a sensor body 86, which is coupled to the sealing cover 84 by being inserted into a through hole of the sealing cover 84 and includes first through third electrode sensors 81 through 83. The second exemplary embodiment is almost the same as the first exemplary embodiment except that the electrode sensor 80 includes at least three electrodes and that at least one of the three electrodes has a different length from the other electrodes. Thus, the second exemplary embodiment will hereinafter be described, focusing mainly on differences with the first exemplary embodiment.

[0126] The first and second electrodes 81 and 82 may have the same length, and the third electrode 83 may be shorter than the first and second electrodes 81 and 82.

[0127] The operation of the electrode sensor 80 will hereinafter be described in detail.

[0128] FIG. 22 illustrates a graph showing the relationship between the concentration of detergent and the voltage of the electrode sensor 80. Referring to FIG. 22, when a current is applied to the electrode sensor 80, the concentration of detergent may serve as a resistor. That is, the higher the concentration of detergent, the lower the voltage of each of the first through third electrodes 81, 82 and 83 becomes. The more the voltage of an electrode varies according to the concentration of detergent (i.e., the greater the slope of a voltage-detergent concentration curve of an electrode), the better the electrode is able to precisely determine the amount of detergent.

[0129] Any two of the first through third electrodes 81 through 83 producing a greatest voltage variation for a given detergent concentration variation may be selectively used. The amount by which the voltage of each of the first through third electrodes 81 through 83 varies according to the concentration of detergent may differ from a first concentration section S1 to a second concentration section S2.

[0130] The first concentration section S1 may correspond to a period of time during which there is little, if any, detergent detected, i.e., a period of time during which a rinsing operation is performed. The second concentration section S2 may correspond to a period of time during which a wash operation is performed alone or together with a rinsing operation.

[0131] During the first concentration section S1, the first and second electrodes 81 and 82 may produce a greatest voltage variation for any given detergent concentration variation. More specifically, there is little, if any, detergent detected during the first concentration section S1. In addition, since the first and second electrodes 81 and 82 are longer than the third electrode 83, the contact area between each of the first and second electrodes 81 and 82 and wash water is larger than the contact area between the third electrode 83 and the wash water. Thus, during the first concentration section S1, the first and second electrodes 81 and 82 may be selectively used to detect the amount of detergent.

[0132] On the other hand, during the second concentration section S2, the third electrode 83 and one of the first and second electrodes 81 and 82 may produce first a greatest voltage variation for any given detergent concentration variation. More specifically, the amount of detergent is greater during the second concentration section S2 than during the first concentration section S1. Thus, during the second concentration section S1, the third electrode 83 and one of the first and second electrodes 81 and 82 (particularly, the first electrode 81) may be selectively used to detect the amount of detergent.

[0133] Therefore, during the first concentration section S1, a current may be applied to the first and second electrodes 81 and 82, and thus, the amount of detergent may be determined based on voltage measurements obtained from the first and second electrodes 81 and 82. On the other hand, during the second concentration section S2, a current may be applied to the first and third electrodes 81 and 83, and thus, the amount of detergent may be determined based on voltage measurements obtained from the first and third electrodes 81 and 83. In this manner, it is possible to precisely determine the amount of detergent by selectively using the first through third electrodes 81 through 83 according to the concentration of detergent.

[0134] FIG. 23 illustrates a perspective view of an electrode sensor 90 according to another exemplary embodiment of the present invention. The third exemplary embodiment is almost the same as the second exemplary embodiment except that the electrode sensor 90 includes three electrodes having different lengths. Thus, the third exemplary embodiment will hereinafter be described, focusing mainly on differences with the second exemplary embodiment.

[0135] Referring to FIG. 23, the electrode sensor 90 may include fourth through sixth electrodes 91 through 93. The fourth electrode 91 may be shorter than the fifth electrode 92, and the fifth electrode 92 may be shorter than the sixth electrode 93. The fourth through sixth electrodes 91 through 93 may be sequentially arranged in order of length.

[0136] The electrode sensor 90 may be able to precisely measure the amount of detergent by selectively using the fourth through sixth electrodes 91 through 93. In addition, the electrode sensor 90 may be able to prevent foreign materials from being stuck between the fourth through sixth electrodes 91 through 93.

[0137] FIG. 24 illustrates a perspective view of an electrode sensor 1100 according to a fourth exemplary embodiment of the present invention, and FIG. 25 illustrates an exploded perspective view of the electrode sensor 1100. Referring to FIGS. 24 and 25, the electrode sensor 1100 may include a sealing cover 1103 coupled to the tub 120 and a sensor body 1104 coupled to the sealing cover 1103 and including a plurality of electrodes 1102. At least one of the contact surfaces of wash water in the tub 120 and each of the electrodes 1102 may be disposed on a level with a surface of the sensor body 1104.

[0138] More specifically, the electrodes 1102 may be inserted into a body insertion portion 1105 of the sensor body...
Each of the electrodes 1102 may include a first portion 1102a disposed on the body insertion portion 1105, and at least one surface of each of the electrodes 1102 may be exposed on a front surface 1105a of the body insertion portion 1105, facing the tub 120.

The area of the second portions 1102b of the electrodes 1102 may be determined by the thickness of the electrodes 1102. The area of the second portions of the electrodes 1102 may be appropriately adjusted in order to control the performance of the electrode sensor 1100.

The operation of the electrode sensor 1100 will hereinafter be described in detail.

When laundry is loaded into the drum 125 and wash water is supplied into the tub 120, the electrode sensor 1100 measures the conductivity of the wash water in the tub 120.

More specifically, if a voltage is applied to the electrodes 72 of the electrode sensor 150, the voltage of the electrodes 1102 may vary according to the concentration of detergent in the wash water in the tub 120. The electrode sensor 1100 may determine the amount of detergent by measuring the voltage of the electrodes 1102.

Since the electrodes 1102 do not protrude beyond the sensor body 1104, it is possible to prevent foreign materials from being stuck between the electrodes 1102. Therefore, it is possible to prevent deterioration of the performance of the electrode sensor 1100 and thus to increase the lifetime of the electrode sensor 1100.

FIG. 26 illustrates a perspective view of an electrode sensor 1110 according to a fifth exemplary embodiment of the present invention. The fifth exemplary embodiment is almost the same as the fourth exemplary embodiment except that an electrode 1112 is attached onto the surface of a sensor body 1114. Thus, the fifth exemplary embodiment will hereinafter be described, focusing mainly on differences with the fourth exemplary embodiment.

Referring to FIG. 26, the electrode 1112 may be attached onto an outer circumferential surface 1115a of a body insertion portion 1115 of the sensor body 1114. The electrode 1112 may be formed as a plate, but the present invention is not restricted to this. That is, the electrode 1112 may be formed as a stick.

The electrode 1112 may be bonded onto the outer circumferential surface 1115a of the body insertion portion 1115 by an adhesive. A groove (not shown) for accommodating the electrode 1112 may be formed on the outer circumferential surface 1115a.

According to the fifth exemplary embodiment, it is possible to increase the contact area between the electrode 1112 and wash water.

FIG. 27 illustrates a perspective view of an electrode sensor 1120 according to a sixth exemplary embodiment of the present invention, and FIG. 28 illustrates a plan view of a sensor body 1121 of the electrode sensor 1120, as seen from direction A of FIG. 27. The sixth exemplary embodiment is almost the same as the fourth exemplary embodiment except that a body insertion portion 1130 of a sensor body 1121 includes first and second protrusions 1131 and 1132, and that first and second electrodes 1141 and 1142 are disposed on the first and second protrusions 1131 and 1132, respectively.

Thus, the sixth exemplary embodiment will hereinafter be described, focusing mainly on differences with the fourth exemplary embodiment.

Referring to FIGS. 27 and 28, the first and second protrusions 1131 and 1132 may protrude toward the tub 120. The first and second protrusions 1131 and 1132 may face each other.

A surface 1131a of the first protrusion 1131 on which the first electrode 1141 is disposed and a surface 1131b of the second protrusion 1132 on which the second electrode 1142 is disposed may face each other. Thus, the first and second electrodes 1141 and 1142 may face each other. The first and second electrodes 1131 and 1132 may be attached onto or inserted into the first and second protrusions 1131 and 1132, respectively.

The first and second electrodes 1141 and 1142 may be exposed on the surfaces 1131a of the first and second protrusions 1131 and 1132 and on top surfaces 1131b and 1132b of the first and second protrusions 1131 and 1132 and may thus be able to contact wash water.

FIG. 29 illustrates a plan view of a sensor body of an electrode sensor according to a seventh exemplary embodiment of the present invention. The seventh exemplary embodiment is almost the same as the sixth exemplary embodiment except that first and second electrodes 1151 and 1152 are disposed on opposite sides of a sensor body. Thus, the seventh exemplary embodiment will hereinafter be described, focusing mainly on differences with the sixth exemplary embodiment.

More specifically, the first electrode 1151 may be disposed on a surface 1131c of a first protrusion 1131, and the second electrode 1152 may be disposed on a surface 1132c of a second protrusion 1132. The surfaces 1131c and 1132c may be on opposite sides of the sensor body.

FIG. 30 illustrates a perspective view of a wash water sensing apparatus 1200 according to an eighth exemplary embodiment of the present invention, and FIG. 31 illustrates a plan view of the wash water sensing apparatus 1200 as seen from direction A of FIG. 30. Referring to FIGS. 30 and 31, the wash water sensing apparatus 1200 may include a sealing cover 1201 which is coupled to the tub 120 by being inserted into the hole 5a of the tub 120; a sensor body 1202 which is coupled to the sealing cover 1201 by being inserted into a through hole of the sealing cover 1201; an optical sensor 1210 which is disposed on one side of the sensor body 1202 and measures the pollution level of wash water; and an electrode sensor 1220 which is disposed on the other side of the sensor body 1202 and measures the conductivity of wash water.

The sealing cover 1201 may be pressed into the tub 120, and the sensor body 1202 may be pressed into the sealing cover 1201. The sealing cover 1201 may be more elastic than the tub 120 or the sensor body 1202. The sealing cover 1201 may be formed of rubber.

The sensor body 1202 may include a body insertion portion 1203 which is formed as a protrusion and can thus be inserted into the sealing cover 1201 and a body connector portion 1204 which extends backwards from the body insertion portion 1203 and to which wires are connected to optical sensor 1220 and the electrode sensor 1210 are coupled.

The body insertion portion 1203 may be cylindrical. The body insertion portion 1203 may include first and second
protrusions 1205 and 1206 which protrude toward the tub 120. The first and second protrusions 1205 and 1206 may face each other.

[0159] The optical sensor 1210 may include a light emitter 1211 disposed on the first protrusion 1205 and emitting light and a light receptor 1212 disposed on the second protrusion 1206 and receiving the light emitted by the light emitter 1211. A surface of the first protrusion 1205 on which the light emitter 1211 is disposed and a surface of the second protrusion 1206 on which the light receptor 1212 is disposed may face each other.

[0160] The electrode sensor 1220 may include first and second electrodes 1221 and 1222. The first and second electrodes 1221 and 1222 may be disposed between the first and second protrusions 1205 and 1206. The sensor body 1202 may be formed through injection molding, and the first and second electrodes 1221 and 1222 may be inserted into the sensor body 1202 during the formation of the sensor body 1202. The first and second electrodes 1221 and 1222 may be a predetermined distance apart from each other.

[0161] The operation of the wash water sensing apparatus 1200 will hereinafter be described in detail.

[0162] Laundry may be loaded into the drum 125, and wash water mixed with detergent may be supplied into the tub 120. The wash water in the tub 120 may be polluted by dust and dirt from the laundry.

[0163] The wash water sensing apparatus 1200 may measure the quality of the wash water in the tub 120.

[0164] If the light emitter 1211 of the optical sensor 1210 emits light, the light receptor 1212 of the optical sensor 1210 may receive the light through the wash water in the tub 120. The more polluted the wash water is, the less the amount of light received by the light receptor 1212. Therefore, the wash water sensing apparatus 1200 may determine the pollution level of the wash water in the tub 120 based on the amount of light received by the light receptor 1212. Thus, the wash water sensing apparatus 1200 may determine for how long a washing operation is to be performed and how much detergent is to be used in the washing operation based on the pollution level of the wash water in the tub 120.

[0165] If a current is applied to the first and second electrodes 1221 and 1222 of the electrode sensor 1220, the voltage of the first and second electrodes 1221 and 1222 may vary according to the concentration of detergent in the wash water in the tub 120. Thus, the wash water sensing apparatus 1200 may determine the amount of detergent in the wash water in the tub 120 based on the voltage of the first and second electrodes 1221 and 1222.

[0166] Therefore, it is possible to appropriately adjust the duration of a washing process and the temperature of the wash water in the tub based on measurement data provided by the optical sensor 1210 and the electrode sensor 1220.

[0167] That is, if the measurement data provided by the optical sensor 1210 and the electrode sensor 1220 indicates that the pollution level of the wash water in the tub 120 is lower than a reference pollution level, and that the amount of detergent in the wash water in the tub 120 is greater than a reference detergent amount level, the duration of a washing process or the temperature of the wash water in the tub 120 may be reduced. In the latter case, it is possible to reduce the heating energy of a heater and thus to reduce the time and cost required for performing a washing operation.

[0168] On the other hand, if the measurement data provided by the optical sensor 1210 and the electrode sensor 1220 indicates that the pollution level of the wash water in the tub 120 is higher than the reference pollution level, and that the amount of detergent in the wash water in the tub 120 is less than the reference detergent amount level, the duration of a washing process or the temperature of the wash water in the tub 120 may be increased.

[0169] In this manner, it is possible to improve the performance of a washing operation by appropriately adjusting the duration of a washing process and the temperature of wash water based on the pollution level and conductivity of the wash water.

[0170] FIG. 32 illustrates a perspective view of a wash water sensing apparatus 1230 according to a second exemplary embodiment of the present invention. The ninth exemplary embodiment is almost the same as the eighth exemplary embodiment except that first and second electrodes 1231 and 1232 of an electrode sensor 1230 are disposed on a level with a surface 1202a of a sensor body 1202. Thus, the ninth exemplary embodiment will hereinafter be described, focusing mainly on differences with the eighth exemplary embodiment.

[0171] Referring to FIG. 32, the electrode sensor 1230 may include the first and second electrodes 1231 and 1232. The first and second electrodes 1231 and 1232 may be disposed between first and second protrusions 1205 and 1206. The first and second electrodes 1231 and 1232 may be inserted into the sensor body 1202 so that at least one surface of each of the first and second electrodes 1231 and 1232 can be exposed on the surface 1202a of the sensor body 1202. The contact area between wash water and each of the first and second electrodes 1231 and 1232 may be determined by the thickness of the first and second electrodes 1231 and 1232. The thickness of the first and second electrodes 1231 and 1232 may be appropriately adjusted in order to control the performance of the electrode sensor 1230.

[0172] Since the first and second electrodes 1231 and 1232 do not protrude beyond the sensor body 1202, it is possible to prevent foreign materials from being stuck between the electrodes 1231 and 1232. Therefore, it is possible to prevent deterioration in the performance of the electrode sensor 1230 and the performance of an optical sensor 1210.

[0173] FIG. 33 illustrates a perspective view of a wash water sensing apparatus 1240 according to a tenth exemplary embodiment of the present invention. The tenth exemplary embodiment is almost the same as the eighth exemplary embodiment except that first and second electrodes 1241 and 1242 of an electrode sensor 1240 are attached onto a sensor body 1202. Thus, the tenth exemplary embodiment will hereinafter be described, focusing mainly on differences with the eighth exemplary embodiment.

[0174] Referring to FIG. 33, the first and second electrodes 1241 and 1242 may be attached onto the first and second protrusions 1205 and 1206, respectively. More specifically, the first and second electrodes 1241 and 1242 may be disposed on opposite sides of the sensor body 1202. The first and second electrodes 1241 and 1242 may be formed as plates. A pair of grooves for accommodating the first and second electrodes 1241 and 1242 may be respectively formed on the first and second protrusions 1205 and 1206.

[0175] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be
made therein without departing from the spirit and scope of the present invention as defined by the following claims.

1. A laundry treatment method comprising: (a) choosing one of a first operating course in which a set of operating conditions are determined based on the weight of laundry and a second operating course in which the operating conditions are determined based on a plurality of operating variables; and (b) treating the laundry according to whichever of the first and second operating courses is chosen.

2. The laundry treatment method of claim 1, further comprising, if the second operating course is chosen, (c) determining the operating conditions based on the operating variables.

3. The laundry treatment method of claim 2, wherein: (c) comprises determining a set of operating conditions for performing a washing operation; the operating variables include at least one of the amount of detergent supplied, the temperature of wash water, the hardness of wash water and a user manipulation signal; and the operating conditions for performing a washing operation include at least one of the driving pattern of a drum, a target temperature to which wash water is to be heated, the duration of a washing process and the number of times a rinsing process is to be performed during a washing operation.

4. The laundry treatment method of claim 2, wherein: (c) comprises determining a set of operating conditions for performing a rinsing operation; the operating variables include at least one of the amount of detergent remained and a user manipulation signal; and the operating conditions for performing a washing operation include at least one of a wash water level, the rotation speed of a drum, and the duration of a rinsing/spin-drying operation.

5. The laundry treatment method of claim 1, further comprising determining whether the value of at least one of the operating variables is outside a predefined range during the treatment of the laundry.

6. The laundry treatment method of claim 5, further comprising, if the value of at least one of the operating variables is outside the predefined range, automatically switching to the first operating course and treating the laundry according to the first operating course.

7. The laundry treatment method of claim 1, further comprising (d) automatically modifying the operating conditions based on the operating variables during the treatment of the laundry.

8. The laundry treatment method of claim 1, further comprising (e) outputting information regarding the operating conditions during the treatment of the laundry.

9. A laundry treatment apparatus comprising: a tub in which wash water for washing laundry is loaded; a control unit which determines a set of operating conditions based on a plurality of operating variables including the hardness of the wash water; and an alarm device which outputs information regarding the operating conditions.

10. The laundry treatment apparatus of claim 9, wherein: the operating variables further include the weight of laundry; and the laundry treatment apparatus further comprises a weight sensing unit which determines the weight of laundry.

11. The laundry treatment apparatus of claim 9, further comprising a wash water sensing apparatus which measures the conductivity of the wash water and thus determines the hardness of the wash water based on the result of the measurement.

12. The laundry treatment apparatus of claim 11, wherein the wash water sensing apparatus measures the amount of detergent remaining in the wash water.

13. The laundry treatment apparatus of claim 11, wherein the wash water sensing apparatus measures the temperature of the wash water.

14. The laundry treatment apparatus of claim 11, wherein the wash water sensing apparatus measures the turbidity of the wash water.

15. The laundry treatment apparatus of claim 11, wherein the wash water sensing apparatus comprises a sealing cover, which is coupled to a tub by being inserted into a hole of the tub and includes a through hole, and a sensor body, which includes a plurality of electrodes for measuring the conductivity of wash water and is coupled to the sealing cover by being inserted into the through hole.

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