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(54) AUTOMATIC WEIGHING METHOD OF LAUNDRY IN WASHING MACHINE

Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine

Procédé de pesage automatique de linge dans un lave-linge

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Description

Background of the Invention

[0001] The invention concerns the automatic weighing method of laundry in a washing machine.

State of the Art

[0002] During washing process a washing machine consumes specific quantity of water, washing detergent and electric energy. In present time, consumption of those items in a washing machine without a weighing system depends on a maximal charge of the washing machine. So, if the washing machine is only one quarter charged of its maximum, a consumption of water, electric energy and detergent is same as for a fully charged washing machine. For the reason of optimal reduction of consumed water and energy the washing machine needs to have an information about amount of laundry inserted into the drum of the washing machine for the specific washing process. There are many ways to detect weight of laundry inside the drum of the washing machine.

[0003] In US 2010/0320007 a method for weighing of washed laundry inside a drum of a washing machine is presented, consisting of following steps:

- laundry distribution in the drum of the washing machine by rotation of mentioned drum by first angular speed,
- rotation of mentioned drum of the washing machine by second angular speed, where the second angular speed is higher than first angular speed, by that the laundry is stable spread on the inner surface of the drum of the washing machine, by that way inertial movement of the laundry with constant moment of inertia is effected,
- measuring of energy absorbed by engine to drive the drum of the washing machine during third angular speed and fourth angular speed, where third angular speed and fourth angular speed is between the first angular speed and the second angular speed.

[0004] In EP 2 264 239 A1 a laundry weighing method for a washing machine is presented, consisting of following steps:

- optimization of laundry distribution in the drum of the washing machine,
- limitation of inertia of the laundry with constant moment of inertia,
- measuring of energy absorbed by engine to drive the drum of the washing machine during predetermined positive and negative angular acceleration of the charged drum.

[0005] In EP 2 009 169 A2 a washing machine consisting of a sensor intended for measuring of rotation of a drum, and control unit intended for calculation amount of laundry based on determined first acceleration of the drum of the washing machine and on determined second acceleration of the drum of the washing machine is presented. However, measuring of weight of laundry based only on knowledge of acceleration and rotation of the drum of the washing machine is insufficient and inaccurate.

[0006] In WO 2004/081276 A1 a system intended for detection of amount of laundry in a drum in an automatic laundry machine is presented, consisting of:

- a voltage sensor intended for detection of voltage on incoming contacts of an engine,
- a rotation sensor intended to detect rotation of the electrical engine,
- a control unit interconnected with a timer, with the voltage sensor and with the rotation sensor, intended to count inertia of charge in the drum of the washing machine by acceleration working time and breaking working time. A signal represents amount, respectively weight, of the laundry in the drum of the washing machine is created by subtraction of the inertia of the drum from inertia of the charge in the drum.

[0007] Disadvantage of all those above mentioned systems is, that there is not any calculation with any correction factors, based on temperature of the engine and on the value of inertia of laundry in the drum of the washing machine. In case of industrial washing machines, which are doing more washing cycles one after another, the difference of the temperature of components of the washing machine between those cycles is substantive. Bearings are heated and its resistance is declined. It causes declination of electrical resistance of the engine and reduction of energy required for acceleration of the washing drum. Declination of energy can influence measured weight of laundry by few kilograms. The same is valid also for unbalance possibly generated by laundry. High unbalance means high energy consumption during acceleration of the drum.

[0008] The aim of the present invention is to disclose an automatic weighing method for a washing machine, which eliminates above mentioned disadvantages of known systems and enables accurate weighing of laundry without sub-

stantial increase of price of the system.

Feature of the Invention

[0009] Above mentioned disadvantages are considerably eliminated by use of the automatic weighing method for a washing machine comprising a drum and an engine for rotating said drum wherein the determination of the temperature of the engine is processed by a frequency modulator based on a value of calculated resistance of a winding of the engine of the washing machine, where for the calculation of the resistance of the winding a value of current is measured on the winding of the engine during its inaction, afterwards the angular speed of the drum of the washing machine is increased up to a distribution angular speed (ω_0), which is intended to distribute laundry in the drum of the washing machine, afterwards the angular speed of the drum of the washing machine is increased up to a medium angular speed (ω_1), which is intended to spread the laundry on the inner surface of the drum of the washing machine, afterwards the angular speed of the drum of the washing machine is decreased to a measuring angular speed (ω_2), and during maintenance of the angular speed at the measuring angular speed (ω_2) a value of unbalance of the drum of the washing machine is determined, afterwards the angular speed of the drum of the washing machine is increased up to a maximal angular speed (ω_3), during which the current consumed for the acceleration of the drum of the washing machine is measured, afterwards the weight of the laundry in the drum of the washing machine is calculated using the determined temperature of the engine, the value of the unbalance of the laundry in the drum of the washing machine, and the sum of current consumed during the acceleration of the drum of the washing machine from the measuring angular speed (ω_2) up to the maximal angular speed (ω_3). consumed during the acceleration of the drum of the washing machine from the measuring angular speed (ω_2) up to the maximal angular speed (ω_3).

[0010] In advantageous embodiment the angular speed is increased up to the distribution angular speed (ω_0) by steps.

[0011] In another advantageous embodiment the distribution angular speed (ω_0) is from 90 to 150 rpm.

[0012] In another advantageous embodiment the medium angular speed (ω_1) is from 300 to 500 rpm.

[0013] In another advantageous embodiment the maximal angular speed (ω_3) is from 450 to 550 rpm, while the maximal angular speed (ω_3) is higher than the medium angular speed (ω_1).

[0014] In another advantageous embodiment determination of the value of unbalance depends on a rage of a value of current amplitude of the engine and on an average value of current of the engine during maintenance of the angular speed at the measuring angular speed (ω_2).

Description of the Drawing

[0015] The invention will be further explained by use of Fig. 1, which presents a graph of continuance of angular speed of a drum of a washing machine.

Preferred Embodiment of the Invention

[0016] An automatic weighing method of laundry in a washing machine according to the invention is based on principle of energy conservation, i.e. energy generated by engine intended to start spinning of the drum of the washing machine charged by laundry is directly proportional to weight of the laundry placed in the drum of the washing machine. So, high weight of the laundry means high effected work. Because the value of effected work is not influenced only by weight of laundry inserted into the drum of the washing machine, this method is not possible to use without calculation of correction factors.

[0017] First of those correction factors is unbalance of laundry in the drum. High unbalance of the laundry means that high work have to be effected for beginning of rotation of the drum of the washing machine up to predetermined angular speed for the same weight of the laundry. This relation is possible to determine by measuring and subsequently setting the correction factor. According to that, measuring of unbalance of laundry in the drum of the washing machine is needed to be inserted into the measuring sequence.

[0018] Another correction factor is temperature of an engine and of whole mechanical system of the washing machine. High temperature means lower effected work for acceleration of rotation of the drum of the washing machine for the same weight of laundry. This relation is possible to determine by measuring and subsequently setting the correction parameters. Temperature of the system is specified by temperature of the engine, which is determined without any additional sensors by frequency modulator.

[0019] Continuance of an automatic weighing method of laundry in the washing machine according to the invention comprises following steps illustrated on Fig. 1, which presents the graph of continuance of angular speed of the drum of the washing machine during weighing of laundry:

- determination of temperature of the engine by frequency modulator, i.e. measuring of current passing through the

winding of the engine of the washing machine during inaction, and calculation of resistance of the winding of the engine of the washing machine based on amount of measured current,

- distribution of the laundry in the inner space of the drum of the washing machine by acceleration of the drum up to the distribution angular speed $\underline{\omega}_0$, which can be from 90 to 150 rpm, based on size of the washing machine, whereas the acceleration of angular speed can be by steps.
- spreading of the laundry on the inner wall of the drum of the washing machine by its acceleration up to the medium angular speed $\underline{\omega}_1$, which can be from 300 to 500 rpm, based on a type of the washing machine.
- reduction of angular speed of the washing machine up to the measuring angular speed $\underline{\omega}_2$. During that value of unbalance generated by laundry in the washing machine is determined. The value of unbalance is determined from ratio between value of amplitude of current of the engine and middle value of current of the engine during the stable measuring angular speed $\underline{\omega}_2$. The measuring angular speed $\underline{\omega}_2$ can be same as the distribution angular speed $\underline{\omega}_0$
- increase of angular speed of the drum of the washing machine up to maximal angular speed $\underline{\omega}_3$, which can be from 450 to 550 rpm, based on a type of the washing machine. During that acceleration energy consumed by engine for this acceleration is measured. The maximal angular speed ω_3 is high than the medium angular speed $\underline{\omega}_1$,
- calculation of weight of the laundry in the drum of the washing machine by the measured parameters, i.e. the temperature of the engine, amount of unbalance of the laundry in the drum of the washing machine, sum of current consumed during acceleration of the drum of the washing machine to the maximal angular speed $\underline{\omega}_3$, calculated by a following formula (1):

$$m = \frac{I + a \cdot T + b \cdot U_n^2 + c \cdot U_n - K}{d} \qquad (1)$$

Where:

I is sum of current during acceleration,
T is temperature of the engine,
U_n is value of unbalance,
K is a calibration constant for the washing machine without loading,
a, b, c, d are experimentally defined constants.

[0020] Calculation of weight of laundry in the drum of the washing machine is based on principle of direct proportion between energy consumed during acceleration of the drum, and weight of laundry in the drum of the washing machine, and further it is based on previously set dependencies on temperature of engine and on a value of unbalance of the laundry in the drum of the washing machine.

[0021] An advantage of the presented technical solution in comparison to prior of the art is determination of weight of laundry without use of any additional sensors arranged in a construction of the washing machine, so production cost of the washing machine is not increased.

[0022] As mentioned before, knowledge of weight of laundry in the drum of the washing machine is important for an economically working process of the washing machine. Thanks to this knowledge effective dosing of water into the washing machine is possible, because water level in the drum depends on weight of laundry. Thanks to that, during whole cycles the washing machine can safe more than 50 % of value of normally consumed water. Another point of economy is value of electrical energy consumed for water heating. In case that the drum comprises less water, heating time is shorter and thanks to that the consumed electrical energy for the whole washing cycle is also less. Knowledge of weight of laundry in the drum of the washing machine also influences consumption of the detergent in direct proportion.

Claims

1. Automatic weighing method for a washing machine comprising a drum and an engine for rotating said drum **wherein**

- the determination of the temperature of the engine is processed by a frequency modulator based on a value of calculated resistance of a winding of the engine of the washing machine, where for the calculation of the resistance of the winding a value of current is measured on the winding of the engine during its inaction,
- afterwards the angular speed of the drum of the washing machine is increased up to a distribution angular speed (ω_0), which is intended to distribute laundry in the drum of the washing machine,
- afterwards the angular speed of the drum of the washing machine is increased up to a medium angular speed (ω_1), which is intended to spread the laundry on the inner surface of the drum of the washing machine,

- afterwards the angular speed of the drum of the washing machine is decreased to a measuring angular speed (ω_2), and during maintenance of the angular speed at the measuring angular speed (ω_2) a value of unbalance of the drum of the washing machine is determined,
- afterwards the angular speed of the drum of the washing machine is increased up to a maximal angular speed (ω_3), during which the current consumed for the acceleration of the drum of the washing machine is measured,
- afterwards the weight of the laundry in the drum of the washing machine is calculated using the determined temperature of the engine, the value of the unbalance of the laundry in the drum of the washing machine, and the sum of current consumed during the acceleration of the drum of the washing machine from the measuring angular speed (ω_2) up to the maximal angular speed (ω_3).

2. Automatic weighing method for a washing machine according to the claim 1 **characterized in, that** the angular speed is increased up to the distribution angular speed (ω_0) by steps.

3. Automatic weighing method for a washing machine according to the claim 1 **characterized in, that** the distribution angular speed (ω_0) is from 90 to 150 rpm.

4. Automatic weighing method for a washing machine according to the claim 1 **characterized in, that** the medium angular speed (ω_1) is from 300 to 500 rpm.

5. Automatic weighing method for a washing machine according to the claim 1 **characterized in, that** the maximal angular speed (ω_3) is from 450 to 550 rpm, while the maximal angular speed (ω_3) is higher than the medium angular speed (ω_1).

6. Automatic weighing method for a washing machine according to the claim 1 **characterized in, that** determination of the value of unbalance depends on a range of a value of current amplitude of the engine and on an average value of current of the engine during maintenance of the angular speed at the measuring angular speed (ω_2).

Patentansprüche

1. Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine, die mit einer Trommel und einem Motor versehen ist, **dadurch gekennzeichnet, dass**

- Wird die Motortemperatur mit Hilfe des Frequenzumformers, mit Hilfe des Wertes von dem ausgerechneten Widerstand der Motorwindung der Waschmaschine festgestellt, wobei für die Berechnung des Widerstandes der Motorwindung der Waschmaschine der Wert des auf der Motorwindung der Waschmaschine gemessenen Storms im Moment verwendet wird, in dem der Motor nicht läuft,
- folglich wird die Drehzahl der Trommel der Waschmaschine auf die Distributionsdrehzahl (ω0) erhöht, die für die Verteilung der Wäsche in der Trommel der Waschmaschine vorgegeben ist,
- folglich wird die Drehzahl der Trommel der Waschmaschine auf die Mitteldrehzahl (ω1) erhöht, die für die Verteilung der Wäsche in der inneren Fläche der Trommel der Waschmaschine vorgegeben ist,
- folglich wird die Drehzahl der Trommel der Waschmaschine auf die messbaren Drehzahl (ω2) gesenkt, wobei während Verbleiben der Drehzahlgeschwindigkeit auf dem Wert der messbaren Drehzahl (ω2) der Wert der Unwucht der Trommel der Waschmaschine festgestellt wird,
- folglich wird die Drehzahl der Trommel der Waschmaschine auf die höchste Drehzahl (ω3) erhöht, wobei während Beschleunigung der Wert der für diese Beschleunigung durch den Motor verbrauchten Energie,
- folglich wird aufgrund der festgestellten Motortemperatur , der Größe der Unwucht der Wäsche in der Trommel der Waschmaschine und der Summe des während der Beschleunigung der Trommel der Waschmaschine von der messbaren Drehzahl (ω2) auf die höchste Drehzahl (ω3) verbrauchten Stroms das Gewicht der Wäsche in der Trommel der Waschmaschine berechnet

2. Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine nach Anspruch 1 **dadurch gekennzeichnet, dass** die Drehzahl der Trommel der Waschmaschine werden auf die Distributionsdrehzahl (ω0) stufenweise erhöht.

3. Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine nach Anspruch 1 **dadurch gekennzeichnet, dass** die Distributionsdrehzahl (ω0) sich im Bereich von 90 bis 150 RpM bewegt.

4. Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine nach Anspruch 1 **dadurch gekennzeichnet, dass** die Mitteldrehzahl (ω1) sich im Bereich von 300 bis 500 RpM bewegt.

5. Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine nach Anspruch 1 **dadurch gekennzeichnet, dass** die höchste Drehzahl (ω3) sich im Bereich von 450 bis 550 RpM bewegt, wobei die höchste Drehzahl (ω3) höher als die Mitteldrehzahl (ω1) ist.

6. Verfahren zum automatischen Wiegen von Wäsche in einer Waschmaschine nach Anspruch 1 **dadurch gekennzeichnet, dass** der Wert der Unwucht aufgrund des Verhältnisses der Amplitudengröße des Motorstroms zu dem bei der konstanten messbaren Drehzahl (ω2) gemessenen Mittelwertes des Motorstroms festgestellt wird.

Revendications

1. Le procédé de pesage automatique de linge dans un lave-linge contenant le moteur pour tourner le tambour **caractérisé en ce que**

   - La température du moteur est déterminée au moyen du changeur rotateur, à l'aide d'une valeur de la résistance du bobinage du moteur calculée pour un lave-linge, où pour le calcul de la résistance du bobinage du moteur du lave-linge la valeur du courant utilisée est mesurée pour le bobinage du moteur du lave-linge dans le moment où le moteur ne marche pas,
   - ensuite les tours du tambour du lave-linge sont augmentés jusqu'aux tours de distribution (ω_0) désignés pour la distribution de linge dans le tambour du lave-linge,
   - ensuite les tours du tambour du lave-linge sont diminués jusqu'aux tours moyens (ω_1) désignées pour la distribution de linge dans toute la longueur de la surface interne du tambour du lave-linge,
   - ensuite les tours du tambour du lave-linge sont diminués jusqu'aux tours de mesure (ω_2), où pendant le moment de persévérance dans la vitesse des tours sur la valeur des tours de mesure (ω_2) la valeur du balourd du tambour du lave-linge est mesurée,
   - ensuite les tours du tambour du lave-linge sont augmentés jusqu'aux tours maximaux (ω_3), où dans le cours de l'accélération l'énergie utilisée par le moteur pour cette accélération est mesurée,
   - ensuite le poids de linge dans le tambour de lave-linge est mesuré sur la base de la température du moteur déterminée et la grandeur du balourd de linge dans le tambour de lave-linge et le total du courant utilisé pendant l'accélération du tambour de lave-linge des tours de mesure (ω_2) aux tours maximaux (ω_3).

2. Le procédé de pesage automatique de linge dans un lave-linge selon la revendication 1 **caractérisé en ce que** l'accélération des tours du tambours du lave-linge jusqu'aux tours de distribution (ω_0) sont faits pas à pas.

3. Le procédé de pesage automatique de linge dans un lave-linge selon la revendication 1 **caractérisé en ce que** les tours de distribution (ω_0) sont dans l'intervalle de 90 jusqu'aux 150 tours par minute (tr/min).

4. Le procédé de pesage automatique de linge dans un lave-linge selon la revendication 1 **caractérisé en ce que** les tours moyens (ω_1) sont dans l'intervalle de 300 jusqu'aux 500 tours par minute (tr/min).

5. Le procédé de pesage automatique de linge dans un lave-linge selon la revendication 1 **caractérisé en ce que** les tours maximaux (ω_3) sont dans l'intervalle de 450 jusqu'aux 550 tours par minute (tr/min), en même temps les tours maximaux (ω_3) sont plus grands que les tours moyens (ω_1).

6. Le procédé de pesage automatique de linge dans un lave-linge selon la revendication 1 **caractérisé en ce que** le valeur du balourd est déterminé du rapport de la grandeur de l'amplitude du courant du moteur et la valeur moyenne du courant du moteur mesurée dans le moment des tours de mesure (ω_2) constants.

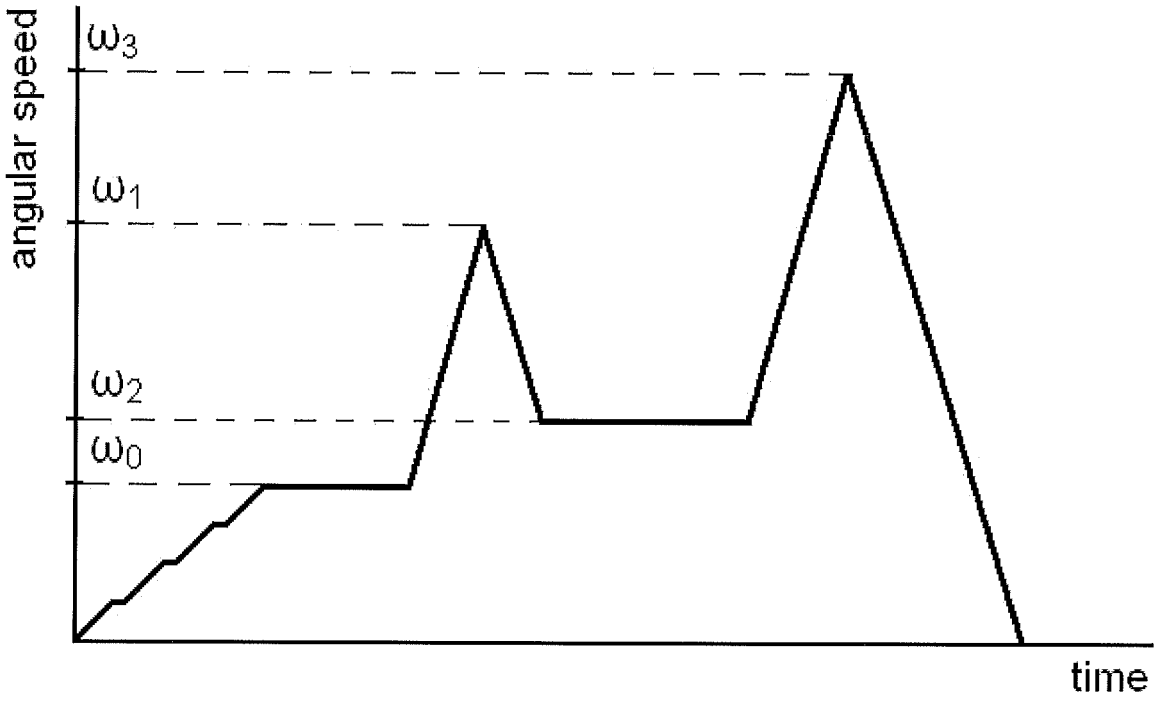

Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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