LAUNDRY TREATMENT APPARATUS AND CONTROL METHOD THEREOF

The present invention relates to a laundry treatment apparatus 1, including: a storage chamber 3, used for storing laundry; an air circulation channel 20, connected to the storage chamber 3 both at a first end and a second end; a blower 4, used for blowing air to pass through the air circulation channel 20 and the storage chamber 3; and a heat pump system 10, having a compressor 12, a primary evaporator 14 disposed within the air circulation channel 20, and a condenser 18 disposed within the air circulation channel 20 and located below the primary evaporator 14, where the primary evaporator 14 is used for absorbing heat of flowing air in the air circulation channel 20, characterized in that the laundry treatment apparatus further includes a water storage chamber 5, used for storing waste hot water that is discharged by the laundry treatment apparatus 1 after a predetermined laundry treatment procedure is finished; and the heat pump system further has a secondary evaporator 16, for absorbing heat of the waste hot water in the water storage chamber 5. In this way, the waste hot water may be stored in the water storage chamber 5, and is used as a source of heat to provide heat for the secondary evaporator 14 in an initial stage in which the heat pump system 10 starts, recycled air in the air circulation channel 20 is heated directly, and temperature of the recycled air is increased rapidly, so that the heat pump system 10 enters a stable running stage rapidly. The present invention further relates to a control method for the laundry treatment apparatus 1.
The present invention relates to a laundry treatment apparatus and a control method thereof.

An existing laundry treatment apparatus, for example, a washing/drying machine, often performs heat treatment on washing water during a washing procedure after the water is inlet for the first washing, to achieve certain washing cleanliness. Before rinse is performed subsequently, this part of heated washing water is discharged, which causes that heat of the heated washing water is wasted. This is contradictory to today's requirement for more energy saving and environmental protection.

An objective of the present invention is to provide a laundry treatment apparatus that not only is energy saving and environmental protection, but also can improve system efficiency in treating laundry.

For the above objective, the technical solutions used in the present invention are:

A laundry treatment apparatus that includes: a storage chamber, used for storing laundry; an air circulation channel, connected to the storage chamber both at a first end and a second end; a blower, used for blowing air to pass through the air circulation channel and the storage chamber; and a heat pump system, having a compressor, a primary evaporator disposed within the air circulation channel, and a condenser disposed within the air circulation channel and located below the primary evaporator, where the primary evaporator is used for absorbing heat of flowing air in the air circulation channel, characterized in that the laundry treatment apparatus further includes a water storage chamber, used for storing waste hot water that is discharged by the laundry treatment apparatus after a predetermined laundry treatment procedure is finished; and the heat pump system further has a secondary evaporator, for absorbing heat of the waste hot water in the water storage chamber.
Disposed in such a manner, after the laundry treatment apparatus completes a predetermined laundry treatment procedure, for example, after a washing procedure is finished, the waste hot water of the laundry treatment apparatus may be stored in the water storage chamber, and is used as a source of heat to provide heat for the secondary evaporator in an initial stage in which the heat pump system starts, recycled air in the air circulation channel is heated directly, and temperature of the recycled air is increased rapidly, so that the heat pump system enters a stable running stage rapidly.

As a further improvement of the present invention, the primary evaporator and the secondary evaporator are disposed in parallel, and are both in communication connection with the compressor.

The term "being disposed in parallel" refers to that in the heat pump system, the primary evaporator and the secondary evaporator may bear an evaporator function of the entire heat pump system separately and independently.

As a further improvement of the present invention, the secondary evaporator is disposed within the water storage chamber. This helps the secondary evaporator absorb heat of the water storage chamber better and faster.

As a further improvement of the present invention, the primary evaporator is an air cooling evaporator, and the secondary evaporator is a liquid cooling evaporator.

As a further improvement of the present invention, the heat pump system has a reversal valve for switching refrigerant in the heat pump system to flow to the primary evaporator or flow to the secondary evaporator. The reversal valve is controlled, so that to select the primary evaporator to work or to select the secondary evaporator to work is achieved.

As a further improvement of the present invention, the water storage chamber is made from a thermal insulation material. In this way, the heat of the waste hot water in the water storage chamber may be kept better.
In addition, the present invention proposes a control method for a laundry treatment apparatus, where the laundry treatment apparatus includes: a storage chamber, used for storing laundry; an air circulation channel, connected to the storage chamber both at a first end and a second end; a blower, used for blowing air to pass through the air circulation channel and the storage chamber;

a water storage chamber, used for storing waste hot water that is discharged by the laundry treatment apparatus after a predetermined laundry treatment procedure is finished; and

a heat pump system, having a compressor, a primary evaporator disposed within the air circulation channel, and a condenser disposed within the air circulation channel and located below the primary evaporator, where the primary evaporator is used for absorbing heat of flowing air in the air circulation channel; and the heat pump system further has a secondary evaporator, for absorbing heat of the waste hot water in the water storage chamber. The control method includes the following steps:

in an initial stage in which the laundry treatment apparatus starts the heat pump system to work, the secondary evaporator in the heat pump system works while the primary evaporator does not work, and the secondary evaporator absorbs the heat of the waste hot water in the water storage chamber as a source of heat of the heat pump system to heat recycled air of the air circulation channel.

As a further improvement of the present invention, when a temperature of the waste hot water that is discharged by the laundry treatment apparatus after the predetermined laundry treatment procedure is finished exceeds a preset temperature, the waste hot water is stored in the water storage chamber.

As a further improvement of the present invention, when a working procedure selected by a user includes a drying procedure or when the laundry treatment apparatus determines, according to a usage habit of the user, when the user selects a predetermined working procedure, that the user performs a drying operation after the predetermined working procedure is finished, the laundry treatment apparatus temporarily stores the waste hot water in the water storage chamber after the working procedure selected by the user is finished.
As a further improvement of the present invention, when a temperature of the waste hot water in the water storage chamber drops below a predetermined temperature, or when a temperature of the recycled air in the air circulation channel rises to a predetermined temperature, the waste hot water is discharged from the water storage chamber, and the secondary evaporator stops working while the primary evaporator starts to work.

The present invention is applicable to various suitable laundry treatment apparatuses, and the following describes specific implementation manners of the present invention by using a washing machine having a drying function as an example. Therein reference is made to the Figures of the accompanying drawing. In the drawing:

FIG. 1 is a brief schematic diagram of a washing machine.

FIG. 1 is a brief schematic diagram of a washing machine 1, and shows some parts related to a heat pump system 10 for a drying period.

As shown in FIG. 1, the heat pump system 10 of the washing machine 1 has a compressor 12, a primary evaporator 14, a secondary evaporator 16, and a condenser 18. The compressor 12, the primary evaporator 14, the secondary evaporator 16, and the condenser 18 are connected by a refrigerant guiding pipe that is exemplarily shown by a corresponding line. The primary evaporator 14 and the secondary evaporator 16 are disposed in parallel, and are both in communication connection with the compressor 12. The primary evaporator 14, the compressor 12, and the condenser 18 are connected in series between each other by using the refrigerant guiding pipe to constitute a refrigerant primary circulation channel 11 together. The secondary evaporator 14, the compressor 12, and the condenser 18 are connected in series between each other by using the refrigerant guiding pipe to constitute a refrigerant secondary circulation channel 13 together. The foregoing refrigerant circulation channel is further provided with a throttling device 15 and a reversal valve 17. By controlling the reversal valve 17, the washing machine 1 changes a direction in which circulated refrigerant flows in the refrigerant circulation channel, that is, the refrigerant is controlled to flow to the primary evaporator 14 or the secondary evaporator 16, thereby implementing that the refrigerant circularly works separately and independently on the refrigerant primary circulation channel 11 or on the refrigerant secondary circulation channel 13. Preferably, the primary evaporator 14 is an air cooling evaporator.
for absorbing heat in air, and the secondary evaporator 16 is a liquid cooling evaporator for absorbing heat in hot water. Here, the terms "evaporator" and "condenser" are used in combination with the enclosed heat pump system 10 and the treatment on the refrigerant. The heat pump system 10, a pipe and electrical cabling thereof, a tub or storage chamber 3 surrounding a rotatable drum (not shown in the figure), a water storage chamber 5, and an air circulation channel 20 are all disposed within a housing or body 2 of the washing machine 1.

At least parts of the primary evaporator 14 and the condenser 18 are disposed within the air circulation channel 20, and the air circulation channel 20 has a first end connected to an inlet 22 of the tub 3, and a second end connected to an outlet 24 of the tub 3. The air circulation channel 20 and the tub 3 form, for example, a closed channel system that is used for circulation of air in a laundry vapor treatment period or a drying period of the washing machine. At least one fan of a blower 4 is arranged within the air circulation channel 20, so that air is forced to circulate in the channel system, that is, the air is blown from the air circulation channel 20 to pass through the inlet 22, the tub 3, and the outlet 24, so as to get out from the tub 3 and go back into the air circulation channel 20 at the second end of the air circulation channel 20.

When the heat pump system 10 achieves the whole working efficiency or almost the whole working efficiency after a starting stage, the normal running of the drying period is implemented, where the blower 4 makes the air circulated with the drum (not shown in the figure) through the air circulation channel 20 and the tub 3. The circulated air is cooled in the primary evaporator 14, so that the air full of moisture is condensed into water on a surface of the primary evaporator 14. The condensed water is collected and guided to a water tank (not shown in the figure), and may be removed there by a user from time to time. Below the primary evaporator 14, the circulated air passes through a surface of the condenser 18, and is heated there by using heat of the condenser 18. The heated air whose humidity is reduced is blown into the tub 3 and the drum (not shown in the figure) through the inlet 22, and passes through laundry in the drum here. The drum rotates, so that the laundry in the drying period is stirred in a roll mode. The heated air takes moisture away from the laundry, brings the moisture out of the drum and the tub through the outlet 24, and brings the moisture to the primary evaporator 14 arranged with the air circulation channel 20.
The water storage chamber 5 is used for storing waste hot water that is discharged by
the washing machine after a predetermined washing procedure, so that the heat pump
system 20 recycles heat in the waste hot water, thereby avoiding a waste of energy. The
water storage chamber 5 is made from a thermal insulation material, and in this way, the
heat of the waste hot water in the water storage chamber 5 can be kept better. The water
storage chamber 5 is connected to the tub 3 through a water inlet channel 51, and the
waste hot water after the washing in the tub 3 is temporarily stored in the water storage
chamber 5 through the water inlet channel 51. The secondary evaporator 16 is disposed
within the water storage chamber 5, for absorbing and making use of the heat in the waste
hot water. When the heat of the waste hot water is recycled, the water storage chamber 5
discharges the water through a drainage channel 52 that is in communication connection
with the water storage chamber 5. As in the prior art, when the heat pump system starts
under the control of a control unit of the washing machine 1, and when the primary evap-
orator 14 and the compressor 12 have temperatures that are almost the same after the
heat pump system has already been not operated for a long time, the heat pump system
10 has a long initial stage having low operation efficiency. The low efficiency is mainly
because there is no or only a small amount of refrigerant vapor in the primary evaporator
14 that is at a low starting temperature. To speed up the starting or the initial stage of the
pump system 10, that is, to shorten a time for achieving the complete running or efficient
running of the heat pump system 10, within at least a time period of the initial stage of the
heat pump system 10, and when the waste hot water is stored in the water storage cham-
ber 5 of the heat pump system 10, the control unit of the washing machine 1 controls the
reversal valve 17 to switch a flowing direction of the refrigerant, so that the refrigerant
temporarily flows to the secondary evaporator 16 and absorbs the heat of the waste hot
water in the water storage chamber 5 rapidly, thereby speeding up a pressure increase of
refrigerant vapor in the secondary evaporator 16. The refrigerant vapor that absorbs the
heat in the waste hot water is circulated to the condenser 18 under the action of the com-
pressor, and heats recycled air flowing in the air circulation channel, thereby speeding up
a temperature increase of the recycled air. In this way, the secondary evaporator 16 and
the water storage chamber 5 are disposed, so that on the one hand, heat of waste hot
water is recycled, thereby achieving an effect of saving energy and reducing consumption;
on the other hand, a time for an initial stage in which the heat pump system 10 is operated
at low power is shortened, so that the heat pump system 10 enters a stable and efficient
running stage rapidly.
A control method for the washing machine having the heat pump system is described next. When a washing working procedure selected by a user includes a drying procedure or when the washing machine determines, according to a usage habit of the user, when the user selects a predetermined working procedure, that the user performs a drying operation after the predetermined working procedure is finished, the washing working 1 temporarily stores waste hot water in a water storage chamber 5 after the washing working procedure selected by the user is finished. Preferably, when it is detected and determined that the waste hot water after the washing reaches a predetermined temperature, the washing machine 1 controls to temporarily store the waste hot water in the water storage chamber. When the washing machine starts a heat pump system 10 to perform a drying operation, within a time period of an initial stage in which the heat pump system 10 starts, a control unit of the washing machine 1 controls a reversal valve 17 to switch a flowing direction of a refrigerant, so that the refrigerant temporarily flows to a secondary evaporator 16 and absorbs heat of the waste hot water in the water storage chamber 5 rapidly. At this time, the secondary evaporator 16 works while the primary evaporator 14 does not work. However, when the washing machine 1 detects that a temperature of the waste hot water in the water storage chamber 5 drops below the predetermined temperature, or when a temperature of recycled air in the air circulation channel 20 rises to the predetermined temperature, the control unit of the washing machine 1 controls to discharge the water hot water from the water storage chamber 5, and at the same time, the control unit of the washing machine 1 controls the reversal valve 17 to switch the flowing direction of the refrigerant to flowing to the primary evaporator 14 from flowing to the secondary evaporator 16, so that the secondary evaporator 16 stops working while the primary evaporator 14 starts to work. At this time, the heat pump system 10 enters a stable and efficient running stage, and the washing machine 1 enters a normal drying operation stage.

Various specific implementation manners described in the foregoing and shown in accompanying drawings are only used for illustrating the present invention, and are not considered as the entirety of the present invention. Within the scope of the basic technical thought of the present invention, any type of modifications for the present invention made by persons of ordinarily skills in the related technical field shall fall within the protection scope of the present invention.
LIST OF REFERENCE NUMERALS

5  1 washing machine
   2 housing
   3 storage chamber, tub
   4 blower
   5 water storage chamber

10  10 heat pump system
    11 refrigerant primary circulation channel
    12 compressor
    13 refrigerant secondary circulation channel
    14 primary evaporator

15  15 throttling device
    16 secondary evaporator
    17 reversal valve
    18 condenser
    20 air circulation channel

20  22 inlet
    24 outlet
    51 water inlet channel
    52 water outlet channel

25
CLAIMS

1. A laundry treatment apparatus (1), comprising:
   a storage chamber (3), used for storing laundry;
   an air circulation channel (20), connected to the storage chamber (3) both at a first
   end and a second end;
   a blower (4), used for blowing air to pass through the air circulation channel (20) and
   the storage chamber (3); and
   a heat pump system (10), having a compressor (12), a primary evaporator (14) disposed
   within the air circulation channel (20), and a condenser (18) disposed within the air
   circulation channel (20) and located below the primary evaporator (14), wherein the
   primary evaporator (14) is used for absorbing heat of flowing air in the air circulation channel
   (20),

   characterized in that the laundry treatment apparatus (1) further comprises a water
   storage chamber (5), used for storing waste hot water that is discharged by the laundry
   treatment apparatus (1) after a predetermined laundry treatment procedure is finished;
   and the heat pump system (10) further has a secondary evaporator (16), for absorbing
   heat of the waste hot water in the water storage chamber (5).

2. The laundry treatment apparatus (1) according to claim 1, characterized in that the
   primary evaporator (14) and the secondary evaporator (16) are disposed in parallel, and
   are both in communication connection with the compressor (12).

3. The laundry treatment apparatus (1) according to one of claims 1 and 2, characterized in that
   the secondary evaporator (16) is disposed within the water storage chamber (5).

4. The laundry treatment apparatus (1) according to one of claims 1 and 2, characterized in that
   the primary evaporator (14) is an air cooling evaporator, and the secondary
   evaporator (16) is a liquid cooling evaporator.
5. The laundry treatment apparatus (1) according to one of claims 1 and 2, characterized in that the heat pump system (20) has a reversal valve (17) for switching refrigerant in the heat pump system (20) to flow to the primary evaporator (14) or flow to the secondary evaporator (16).

6. The laundry treatment apparatus (1) according to one of claims 1 and 2, characterized in that the water storage chamber (5) is made from a thermal insulation material.

7. A control method for a laundry treatment apparatus (1), wherein the laundry treatment apparatus (1) comprises:

   a storage chamber (3), used for storing laundry;
   an air circulation channel (20), connected to the storage chamber (3) both at a first end and a second end;
   a blower (4), used for blowing air to pass through the air circulation channel (20) and the storage chamber (3);
   a water storage chamber (5), used for storing waste hot water that is discharged by the laundry treatment apparatus (1) after a predetermined laundry treatment procedure is finished; and
   a heat pump system (10), having a compressor (12), a primary evaporator (14) disposed within the air circulation channel (20), and a condenser (18) disposed within the air circulation channel (20) and located below the primary evaporator (14), wherein the primary evaporator (14) is used for absorbing heat of flowing air in the air circulation channel (20); and the heat pump system (10) further has a secondary evaporator (16), for absorbing heat of the waste hot water in the water storage chamber (5); and

   the control method comprises the following steps:

   in an initial stage in which the laundry treatment apparatus (1) starts the heat pump system to work, the secondary evaporator (16) in the heat pump system (10) works while the primary evaporator (14) does not work, and the secondary evaporator (16) absorbs the heat of the waste hot water in the water storage chamber (5) as a source of heat of the heat pump system (10) to heat recycled air of the air circulation channel (20).
8. The control method according to claim 7, characterized in that when a temperature of the waste hot water that is discharged by the laundry treatment apparatus (1) after the predetermined laundry treatment procedure is finished exceeds a preset temperature, the waste hot water is stored in the water storage chamber (5).

9. The control method according to one of claims 7 and 8, characterized in that when a working procedure selected by a user comprises a drying procedure or when the laundry treatment apparatus (1) determines, according to a usage habit of the user, when the user selects a predetermined working procedure, that the user performs a drying operation after the predetermined working procedure is finished, the laundry treatment apparatus (1) temporarily stores the waste hot water in the water storage chamber (5) after the working procedure selected by the user is finished.

10. The control method according to one of claims 7 to 9, characterized in that when a temperature of the waste hot water in the water storage chamber (5) drops below a predetermined temperature, or when a temperature of the recycled air in the air circulation channel (20) rises to a predetermined temperature, the waste hot water is discharged from the water storage chamber (5), and the secondary evaporator (16) stops working while the primary evaporator (14) starts to work.
**INTERNATIONAL SEARCH REPORT**

**International application No**

PCT/IB2015/055939

---

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. D06F58/20 D06F39/00 D06F25/00 D06F33/02

---

**ADD.**

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

---

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

D06F

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

---

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

EPO-Internal , WPI Data

---

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, P</td>
<td>page 1, line 1 - line 9</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>page 5, line 17 - line 29</td>
<td>5,9</td>
</tr>
<tr>
<td></td>
<td>page 7, line 32 - page 11, line 7; figures 1, 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>paragraph [0002] - paragraph [0004]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>paragraph [0054] - paragraph [0079]; figures 1-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>paragraph [0296] - paragraph [0312]; figure 28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-----</td>
<td></td>
</tr>
</tbody>
</table>

---

[X] Further documents are listed in the continuation of Box C.  
[ ] See patent family annex.

---

* Special categories of cited documents :

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

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

**L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

---

Further document(s) of the same family

---

Date of the actual completion of the international search

22 October 2015

Date of mailing of the international search report

30/10/2015

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Sabatucci, Ari anna

---

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>EP 2 189 568 Al (ELECTROLUX HOME PROD CORP [BE]) 26 May 2010 (2010-05-26) paragraph [0014] - paragraph [0028]; figures 1-3</td>
<td>1-10</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2015091671 AI</td>
</tr>
<tr>
<td>US 2005066538 AI</td>
<td>31-03-2005</td>
<td>AU 2004277943 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR PI0414841 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2540368 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1667566 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2007531552 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20060083424 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2005066538 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2006179676 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2005032322 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2003103087 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20030028656 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2003056393 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 102272373 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2189568 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2012272689 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2010057547 AI</td>
</tr>
</tbody>
</table>