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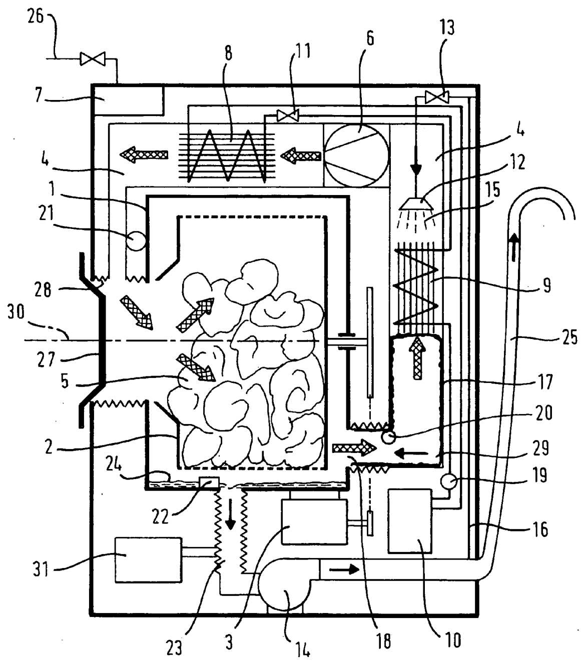
(54) **Process for operating a washer dryer with a heat pump, and a suitable washer dryer**

(57) The invention relates to a process for operating a washer dryer comprising a tub 1, a drum 2 mounted in the tub 1 to be rotatable around an essentially horizontal axis 30 for receiving laundry items 5, a control unit 16, a process air circuit 4 comprising a liquefier 8 of a heat pump circuit 8,9,10,11 and a blower 6 to heat and circulate the heated air through the drum 2, an evaporator 9 to condense moisture from the process air coming out of the drum 2, a temperature sensor 19, 20, 21, and a rinsing device 12, wherein:
(a) the temperature sensor 19, 20, 21 measures a temperature value T_{app} in the process air circuit 4 or the heat pump circuit 8,9,10,11 which are indicative of a temperature of the refrigerant in the heat pump circuit 8,9,10,11; and
(b) the rinsing device 12 flushes the evaporator 9 with an aqueous liquid 15 when the temperature T_{app} reaches or exceeds an upper temperature limit T_{max}^{set}.

Fig.



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Description

[0001] The present invention relates to a process for operating a washer dryer with a heat pump circuit and a washer dryer that is suitable for conducting this process. The invention relates in particular to a process for operating a washer dryer comprising a tub, a drum mounted in the tub to be rotatable around an essentially horizontal axis for receiving laundry items, a control unit, a process air circuit comprising a liquefier of a heat pump circuit and a blower to heat and circulate the heated air through the drum, an evaporator to condense moisture from the process air coming out of the drum, a sensor, and a rinsing device, as well as a washer dryer suitable for carrying out this process.

[0002] Drum washing machines are popular due to their water saving feature and avoidance of damage to the laundry. In recent years, washer dryers, i.e. drum washing machines with a drying function, have become popular among consumers because they combine in a compact manner the functions of a washing machine and a dryer. Moreover, a washer dryer is already provided with a water supply access, such that water is available not only for the washing of laundry, but also for further treatment steps. When drying, such a drum washer dryer takes in air through a fan set on an outside of a tub containing the drum, and heats the air with an air heater, for example an electric heater or the evaporator of a heat pump. The heated air enters the tub and the inside of the drum where it takes up moisture contained in the laundry. The moisture is carried away, condensed in a condensing unit mounted on an outer side of the tub and drained out of the washing machine.

[0003] In general, washer dryers dry the laundry at a substantially constant temperature and in a preset period of time.

[0004] When the washer dryer comprises a heat pump it is important to assure that the temperature of the refrigerant and/or the pressure within the heat pump circuit do not exceed certain values.

[0005] When a heat pump is used in a washer dryer, the cooling of the warm humid process air is effected essentially in a first heat exchanger of the heat pump, in particular an evaporator, where the heat transferred is used for evaporating the refrigerant used in the heat pump. The evaporated refrigerant is then led via a compressor to a second heat exchanger (to be referred to herein also as "liquefier") of the heat pump where heat is set free on account of the condensation of the gaseous refrigerant. This heat can be used for heating the process air before it enters the drum. The liquefied refrigerant is conducted through an expansion valve which reduces its pressure back to the evaporator in order to be there evaporated again by taking up heat from the process air.

[0006] A heat pump thus takes in heat from the hot and humid process air in the condenser, pumps this heat to the air heater in the process air circuit and discharges it there back to the process air. Such a heat pump can be embodied as a compressor heat pump, in which a cooling agent circulates which is cyclically evaporated in the condenser as it absorbs heat from the air flow and condensed in the condenser as it emits heat to the air flow.

[0007] The operation of the heat pump, in particular of the compressor, is optimum in a specific temperature range. Upon applying such a compressor heat pump in a dryer relatively high temperatures can take place in the liquefier, which might lead to a forced shutting off of the compressor. Or the efficiency of the heat pump worsens. This is even more pronounced in cases where an additional heater is used to support the compressor in the air circuit in order to obtain a faster or stronger heating of the process air and a shorter drying process.

[0008] A general problem of heat pump drying systems is the continuous temperature increase in the process. The maximum temperature of the heat pump circuit is limited by the evaporation temperature of the refrigerant and the maximum pressure in the heat pump system. Different measures are known to limit the maximum temperature of the refrigerant. An additional heat exchanger might be used that is cooled by an additional motor fan by the ambient air of the dryer. Another possibility disclosed in prior art document CN 200610153406 A is to partly switch the dryer from a closed loop condenser to an open loop vented dryer. On the other hand, document CN 200710005537 A discloses to cool the compressor of a heat pump unit directly by a motor fan with ambient air. Document CN 200710003005 A discloses as a special solution for washer dryers that an additional water cooled heat exchanger can be arranged in the process air circuit that is cooled by tap water.

[0009] On the other hand it is known to clean heat exchangers in dryers from accumulated fluff by washing it. For example, washer dryers are known where the fluff filtering takes place in the condenser unit with a frequent cleaning at the end of each drying cycle with a small amount of tap water in a flushing process. The accumulated fluff is washed away from the condenser unit, flushed to the tub and pumped out to the water sewage system.

[0010] Document EP 2 037 035 A1 discloses a laundry treatment device having a drying program, comprising a water tub, a rotatable drum disposed within the water tub, a heating assembly for heating air into dry hot air, a condensing assembly for condensing moisture contained in relatively humid hot air, and a blowing device for driving an air circulation, wherein an air circulating loop is formed among said heating assembly and blowing device. A spraying device for flushing fluff accumulated on the condensing assembly is disposed between the condensing assembly and the blowing device.

[0011] In view of this situation, an object underlying the present invention is the provision of a process for the operation of a washer dryer with a heat pump that allows in a convenient way to avoid an overheating of a refrigerant used in the heat pump, as well as a washer dryer that is suitable for conducting this process.

[0012] In accordance with the present invention, this object is achieved by a process for operating a washer dryer and a washer dryer with the features of the respective independent claim. Preferred embodiments of the invention are detailed in respective dependent claims. Preferred embodiments of the washer dryer correspond to preferred embodiments of the process, even if not referred to herein in detail.

[0013] The invention thus relates to a process for operating a washer dryer comprising a tub, a drum mounted in the tub to be rotatable around an essentially horizontal axis for receiving laundry items, a control unit, a process air circuit comprising a liquefier of a heat pump circuit and a blower to heat and circulate the heated air through the drum, an evaporator to condense moisture from the process air coming out of the drum, a temperature sensor, and a rinsing device, wherein

(a) the temperature sensor measures a temperature value T_{app} in the process air circuit or the heat pump circuit which are indicative of a temperature of the refrigerant in the heat pump circuit; and
(b) the rinsing device flushes the evaporator with an aqueous liquid when the temperature T_{app} reaches or exceeds an upper temperature limit T_{max}^{set}.

[0014] The value of T_{max}^{set} will depend on the nature and in particular on the location of the temperature sensor. For example T_{max}^{set} might be very close to a maximum temperature prescribed by manufacturers of the refrigerant for an efficient and safe use of the refrigerant. Another factor might be the maximum admissible coil temperature of the drive motor of the compressor. This is influenced by the isolation used and might be for example 115°C. A further limiting factor which has an influence on T_{max}^{set} is the lubricant used in the compressor. Too high temperatures might lead to carbonization and thus to a failure of the lubricant and finally to a failure of the compressor. An important factor is also the pressure of the gaseous refrigerant behind the compressor which has to be compared with the rigidity of the used tubes.

[0015] Typical limiting temperatures T_{max}^{set} and usual compressors in household washer dryers are for example for the use of R134a as refrigerant a refrigerant temperature of 100°C at the exit of the compressor or a condensate temperature of 75°C at the exit of the liquefier. Or in embodiments, T_{max}^{set} might be set to 65°C for the process air temperature at the exit of the liquefier.

[0016] In a preferred embodiment of the present invention, an air temperature sensor (herein also referred to as "first temperature sensor") is placed in the process air circuit between the tub and the evaporator.

[0017] It is moreover preferred that a refrigerant temperature sensor is placed in the heat pump circuit and the rinsing device flushes the evaporator when the temperature T_{hp} measured by the refrigerant temperature sensor reaches or exceeds a predetermined value T_{hp}^{max}. Thus T_{max}^{set} is here T_{hp}^{max} and T_{app} corresponds to T_{hp}.

[0018] During a drying process the process air flows in general in a direction that is opposite to the direction of the aqueous liquid from the rinsing device. This might result in water to be splashed towards the blower and the liquefier. Thus, the blower is preferably shut off during step (b).

[0019] The blower is preferably situated between the evaporator and the liquefier.

[0020] On the other hand it has been found that an air flow in the same direction as the direction of the aqueous liquid from the rinsing device can assist in the cooling to be achieved in step (b) and even more in the cleaning of the evaporator.

[0021] Therefore, in a preferred embodiment of the present invention, during step (b) an air flow is created in the process air circuit in the direction of the flow of the aqueous liquid. This can be achieved in different ways. For example, the blower might be such so as to allow an operation in both directions. Then a reversal of the rotation direction used in a drying process will create a more or less strong air flow in the direction of the flow of the aqueous liquid.

[0022] In a further preferred embodiment, the aqueous liquid is provided in step (b) in at least two portions. In this case it is especially advantageous when the rinsing device flushes the evaporator with a first set amount of the aqueous liquid, then the aqueous liquid is allowed for a preset time interval Δt_1 to collect in the tub, the pump is then run for a preset time interval Δt_2 to pump off the aqueous liquid collected in the tub, before the rinsing device flushes the evaporator again with a second amount of aqueous liquid.

[0023] In a preferred embodiment, where the flushing phase consists of at least two flushing steps it is possible to carry out a first flushing step with half of the intended amount of aqueous liquid intended for the flushing phase (b). It may then be examined, for example by observing the temperature T_{app}, whether the cooling of the evaporator was sufficient. Accordingly, a second or subsequent flushing steps can be adapted with regard to the amount of aqueous liquid etc.

[0024] The amount of aqueous liquid to be used in step (b) is advantageously determined based on a relationship stored in the control unit between T_{app} and the temperature T_{aq} of the aqueous liquid provided for the rinsing device. This relationship will take into account the location of the temperature sensor. The temperature T_{aq} can be taken to be the temperature of tap water if tap water is used as the aqueous liquid. It is however possible to provide a further temperature sensor in proximity to the rinsing device to measure T_{aq}.

[0025] As an aqueous liquid, water may be used. In that case it might be useful to use water from a public water supply. To this water, ingredients may be supplied that improve the cooling and or cleaning effect. In a preferred process according to the present invention, the aqueous liquid not only functions as a cooling liquid but serves also as an aqueous cleaning liquid and contains ingredients that allow dissolving inorganic deposits on the sensor. A useful ingredient may be an acid that assists in dissolving calcium carbonate. To this end, such ingredients might be provided within the washer dryer and combined in a suitable manner with the aqueous liquid before it is used in the rinsing device. If the aqueous liquid contains ingredients that assist in the cooling and/or cleaning it may be advantageous to carry out a second flushing step with pure water.

[0026] The aqueous liquid is preferably tap water from a water supply system. However, condensate might be added. Since, an efficient cooling can be carried out in step (b) when the temperature of the aqueous liquid is low, the used amount of relatively warm condensate will be usually small. Moreover, it is preferably, also with regard to a cleaning effect of step (b) to use an aqueous liquid that is comparatively clean. In order to determine the degree of cleanliness, a suitable sensor might be used, for example a turbidity sensor. The placement of this sensor depends on the washer dryer and in particular the place where the condensate might be stored.

[0027] If condensate is to be used it is usually necessary to provide a condensate container, since in a usual washer dryer the condensate is usually led to the tub from where it is pumped off to an outside sewage system.

[0028] In order to save even more water it is even more advantageous to provide a suitable storage container in the washer dryer in which the aqueous liquid used in step (b) as well as condensate or comparatively clean water from the washing process can be stored. As the latter, the comparatively clean water from a last rinsing step performed with the laundry items can be used. Thus, in the process of the present invention, the aqueous liquid is preferably transported for a subsequent use in the washer dryer to a storage container provided therein.

[0029] The stored aqueous liquid can be used in a washing process or as aqueous liquid in step (b) of the process of the present invention.

[0030] In a preferred embodiment of the process, the flushing in step (b) is conducted until T_{app} reaches or falls below a lower temperature limit $T_{min}^{set} < T_{max}^{set}$.

[0031] In a preferred process of the present invention, the drum is rotated during the flushing phase (b) to cause the evaporator to vibrate to assist in a heat transfer between the refrigerant and the aqueous liquid in step (b). Moreover, the moving oscillation system vibrations from the rotating drum provide forces which hinder any adhesion at a sensor surface and can assist the removal of fluff and inorganic deposits.

[0032] After a flushing step, a drying process performed in the washer dryer is usually continued until the laundry items have been dried. Accordingly, it is preferable that following step (b) the drying process is continued in a step (c) until a preset time has expired or until a present dryness of the laundry items has been achieved. For example, the drying phase is terminated by shutting off the heat pump and the blower when a set maximum drying temperature T_{max}^{dry} and/or a set lower humidity level H_{min}^{dry} is reached. To this end a humidity sensor may be also provided in the washer dryer, preferably at the exit of the drum, i.e. if present, close to the first temperature sensor.

[0033] Very often a cleaning step is performed after a drying process has been completed in the washer dryer in order to remove any fluff that was deposited during the process on the evaporator and neighboring ducts. In this regard the invention allows modifying a final cleaning step such that less water must be used. In some cases it might be even possible to omit a final cleaning step.

[0034] Accordingly, in a preferred embodiment of the present invention, the evaporator is flushed in a step (d) after step (c) with an amount of aqueous liquid that corresponds to the difference between a preset amount Q_{fin} for a final flushing step in the washer dryer and the amount of aqueous liquid Q_b used in step (b). "Final flushing step" is a flushing step after a drying process has been terminated. Thus if the amount of aqueous liquid Q_b used in step (b) is even larger than Q_{fin} the difference is negative and a last cleaning step might be even avoided.

[0035] In a preferred embodiment of the process, the aqueous liquid is transported for a subsequent use in the washer dryer to a storage container provided therein. More preferably, the aqueous liquid is only transported to the storage container if a given upper limit for the concentration of impurities is not exceeded.

[0036] The invention is moreover directed to a washer dryer comprising a tub, a drum mounted in the tub to be rotatable around an essentially horizontal axis for receiving laundry items, a control unit, a process air circuit comprising a liquefier of a heat pump circuit and a blower to heat and circulate the heated air through the drum, an evaporator to condense moisture from the process air coming out of the drum, a temperature sensor, and a rinsing device, wherein the control unit is adapted to carry out a process wherein

(a) the temperature sensor measures a temperature value T_{app} in the process air circuit or the heat pump circuit which are indicative of a temperature of the refrigerant in the heat pump circuit; and

(b) the rinsing device flushes the evaporator with an aqueous liquid when the temperature T_{app} reaches or exceeds an upper temperature limit T_{max}^{set}.

[0037] A temperature sensor might be placed in the process air circuit between the tub and the evaporator. However, the use of a temperature sensor between the tub and the evaporator might pose the problem that an agglomeration of fluff and inorganic deposits on the sensor can occur easily. Namely, the flushing water contains carbonates whose solubility decreases when the temperature is increased. Higher temperatures thus cause a shift of the equilibrium to calcium carbonate that can be deposited. The deposits might even result in the formation of limestone on the sensor which might hamper the proper functioning of the temperature sensor and thus of the washer dryer. The accumulation of fluff and of inorganic deposits is especially significant in washer dryers with an evaporator of a heat pump, since much fluff usually accumulates on the evaporator. This fluff will disturb for example a correct measurement of the temperature of the process air and might prevent an accurate functioning of the washer dryer.

[0038] In a preferred embodiment, the washer dryer thus comprises a first temperature sensor and a second temperature sensor to allow a better determination of the temperature in the process air circuit as an indication for a temperature of the refrigerant in the heat pump circuit. A measured temperature difference between the two sensors might be used to determine and exclude any effects of fluff or other deposits on temperature measurements. This can be achieved by verifying that a temperature difference ΔT at the first temperature sensor and the second temperature sensor of process air driven through the process air circuit by means of the blower is within a set range ΔT_{adm}. Namely, if both temperature sensors function properly indicating that the first temperature sensor is sufficiently clean, a measured temperature difference between the first and the second temperature sensor should be small. The second temperature sensor is advantageously placed between the liquefier and the tub, for example at the exit of the liquefier or close to the entry of the tub. It is to be noted however that in principle the first temperature sensor can be used as only temperature sensor and be placed between the liquefier and the tub. Thus, the temperature of a refrigerant in a heat pump circuit can be even better controlled.

[0039] The first and/or second temperature sensor has preferably an elongate body with a temperature sensitive tip. The first and/or second temperature sensor is most preferably an NTC temperature sensor. Advantageously, the temperature sensor is inclined in the direction of the evaporator.

[0040] The rinsing device of the washer dryer as used in the process of the present invention is in general also used for cleaning the evaporator and neighboring components. Accordingly, the rinsing device is in general provided above the evaporator of the washer dryer.

[0041] In general, a washer dryer is connected to a water supply system which allows guiding water through a detergent rinsing device such that portions of detergent or auxiliaries can be flushed into the tub. Such a water supply system might comprise a bifurcation to the heat exchanger such that water from the water supply system might be used for the rinsing device as cooling liquid in the heat exchanger.

[0042] A washer dryer comprises in general at its base a suds discharge system including a drain valve and a suds pump and any necessary pipes. Furthermore, a washer dryer in general contains laundry agitators and/or scooping devices. A plurality of such laundry agitators and/or scooping devices, in particular a number of three or four, is preferred. The laundry agitator may be cast into the drum as an integral component or inserted into the drum as an additional component.

[0043] A washer dryer generally has switching means for rotating and stopping the drum. Moreover, a washer dryer according to the present invention preferably comprises a sensor for determining a quantity of liquid disposed in the suds container. The sensor is usually placed in a lower part of the tub. A conventional sensor for determining the water level can be used as a sensor for determining the quantity of liquid disposed in the tub, i.e. the suds container, the sensor signal of which is tracked during the process. Such a sensor generally measures a hydrostatic pressure p and/or a temporal gradient $(\Delta p/\Delta t)_1$ of the hydrostatic pressure p.

[0044] In addition, a washer dryer in general contains a heater for the direct heating of an aqueous liquid, for example suds. This heater, termed herein "water heating", is in general disposed in the tub below the drum.

[0045] The invention has numerous advantages. The operation of the washer dryer can be controlled precisely such that the risk of an overheating of the refrigerant of the heat pump can be avoided, even without using another heat exchanger. Moreover, in specific embodiments the invention does not only allow to assure an efficient and safe operation of the heat pump, but allows to protect sensitive laundry items such as wool, silk or lace during a drying phase by selecting proper upper temperature limits for the refrigerant temperature. These advantages can be achieved in embodiments without additional water consumption since the water might be reused or a final cleaning step after a drying process has been completed might be conducted with less water or might be even omitted. The washer dryer can thus be operated safely without using large amounts of water.

[0046] A preferred embodiment of the invention will be described below by referring to the single Figure of the attached drawing.

[0047] The Fig. shows a washer dryer according to one embodiment of the present invention in which the process of the present invention can be implemented. Other embodiments are conceivable.

[0048] The washer dryer of this embodiment comprises a tub 1 (also to be referred to as "suds container") and a drum 2 which is mounted in the tub 1 such that it can be rotated around an essentially horizontal rotational axis 30 for receiving laundry items 5. In the drum 2, laundry items 5 to be treated are placed.

[0049] The washer dryer comprises moreover a control unit 7, a process air circuit 4 comprising a liquefier 8, an evaporator 9, a compressor 10 and an expansion valve 11 of a heat pump and a blower 6 to heat and circulate the heated air through the drum 2, and to condense moisture from the process air coming out of the drum 2, three temperature sensors 19, 20, 21 and a rinsing device 12. The tub 1 is connected by means of a flexible hose 29 as connecting part to the evaporator 9 of the heat pump as heat exchanger to heat the process air.

[0050] The tub is connected via a suds draining duct 23 to a pump 14 which allows to discharge an aqueous tub liquid 24, for example suds, out of the tub 1 and via a waste water conduit 25 out of the washer dryer. The drum 2 is driven by means of a drive motor 3.

[0051] The drum 2 is filled through a door 27 that allows the access to the interior of the drum with laundry items 5 to be treated. In order to wash laundry in the washer dryer, the washer dryer is connected to a water feed line 26. The water feed line 26 is connected to a detergent rinsing shell (not shown here) from which detergent and auxiliary agents can be flushed with the aid of water from the water feed line 26 into the tub 1 to allow a washing process in the washer dryer. This is achieved in this embodiment through a part of the process air circuit 4 and a sleeve 28.

[0052] For drying wet laundry items in the drum 2 of the washer dryer of the Fig. which operates according to the principle of circulating air, the air heated by means of the liquefier 8 ("process air") is driven through the process air circuit 4 with the aid of the blower 6. Thus, heated process air enters the tub 1 and the drum 2, respectively, through the sleeve 28. The humid and warm process air which results after the passage of the process air through the drum 2, where it has taken up moisture from the wet laundry items 5, arrives at a rear exit 18 of the tub 1 and thereafter at the evaporator 9. There, the process air is cooled with the refrigerant, for example R134a, and the moisture contained in the process air condenses as a result of the cooling in the evaporator 8.

[0053] During the drying phase fluff 17 is accumulated at the wet surfaces in the air ducts between tub 1 and the evaporator 9 and at the fins especially at the inlet of the evaporator 9. The water to wet the surfaces is condensed water from the condensation of humidity in the evaporator 9. The condensate may be collected in a condensate container (not shown here) or may flow back to the tub 1 and finally to the suds draining duct 23 whereby it can be disposed through the waste water conduit 25. Usually however, the condensate is guided to the tub 1 and pumped by the pump 14 to the outside of the washer dryer, usually a sewage water system.

[0054] The dried air flows inside the process air circuit 4, is heated again by the liquefier 8 of the heat pump circuit and then introduced again via the sleeve 28 into the drum 2. The big unfilled arrows indicate the flow direction of the warm air. Short filled arrows indicate the flow direction of an aqueous liquid, for example (tap) water or suds.

[0055] The washer dryer shown in the Fig. allows carrying out a supervision of the refrigerant temperature and a cooling flush phase in accordance with the process of the present invention. To this end, the washer dryer of the Fig. has three temperature sensors 19, 20, 21 and a rinsing device 12 which is placed here above the evaporator 9.

[0056] Between the tub 1 and the evaporator 9, possibly in the flexible hose 29, a sensor 20 is placed which is used to control a drying phase in the washer dryer and in particular the process of the present invention. The sensor 20 is here a first temperature sensor 20 and more particularly an NTC sensor.

[0057] The washer dryer of the Fig. thus allows performing the process of the invention. In a process of the present invention for operating a washer dryer the first temperature sensor 20 measures a temperature value T_{app} which is indicative of a temperature of the refrigerant in the heat pump circuit 8, 9, 10, 11. The rinsing device 12 flushes the evaporator 9 with an aqueous liquid 15, in particular tap water, when the temperature T_{app} reaches or exceeds an upper temperature limit T_{max}^{set}.

[0058] The temperature in the process is increasing towards the end of the drying process. In order to observe and detect temperature changes, two temperature sensors are placed in this embodiment in the process air circuit, namely the first temperature sensor 20 placed at the tub outlet and a second temperature sensor 21 which is placed in this embodiment at the tub inlet. Their temperature signals are provided to the control unit 16 which can initiate the cooling and flushing cycle when the temperature condition of the present invention is fulfilled. In order to allow a more precise control of the refrigerant, also a refrigerant temperature sensor 19 is placed in between the evaporator 9 and the compressor 10.

[0059] The rinsing device 12 allows flushing the evaporator 9 and also the first temperature sensor 20 with an aqueous liquid 15, for example by spraying. The rinsing device 12 is in this embodiment connected by means of a water valve 13 to a water supply system, for example the water feed line 26. Thus, as aqueous liquid 15, comparatively cold water from a water supply system (tap water) can be used. If it is intended that the aqueous liquid shows a significant cleaning effect when it flushes the evaporator 9, it might be possible to use as aqueous liquid an aqueous cleaning liquid that contains ingredients that assist in the cleaning process. For example, the aqueous liquid 30 may contain ingredients that assist in the removal of inorganic deposits like limestone from the sensor 20. As an example, an acid might be employed. It is also possible to use in addition condensate to flush the condenser in order to save water. However, the condensate is usually relatively warm and will thus be used only in a minor amount. In order to allow the use of condensate, the washer dryer of the Fig. allows that the pump 14 pumps condensate via a condensate supplying duct 16 and the valve 13 to the rinsing device 12.

[0060] The Fig. shows also a control unit 7 which controls the operation of the washer dryer based inter alia on the signals received from the first and second temperature sensors 20 and 21 and/or the refrigerant temperature sensor 19 and allows in particular the control of the process of the present invention. The water valve 13 and also the blower 6 and a water heater 22 are controlled by the control unit 7 as a function of a program workflow, which is associated with a time program and/or with the achievement of certain measured values of parameters such as the level of an aqueous liquid, for example the suds level, suds temperature and the speed of the drum 2.

[0061] A drying phase is usually carried out by circulating process air repeatedly through the process air circuit 4 until a desired degree of dryness in the laundry items 5 is obtained. The washer dryer of the Fig. allows a precise control of the refrigerant temperature in that not only the refrigerant temperature can be detected precisely, but also an efficient cooling of the evaporator, i.e. of the refrigerant, by flushing with cold tap water can be performed. Moreover, a drying phase can be efficiently controlled in that the drying phase is conducted by controlling the blower 7 and the evaporator 9 such that a set maximum temperature T_{max} for the temperature of the process air is not exceeded.

[0062] For the cooling/flushing cycle a water valve 13 that is connected to the water supply system 26 will be opened as controlled by the control unit 7 and water as an aqueous liquid is sprayed by the flushing unit 12 to the evaporator 9 cleaning the surfaces and especially the area at the process air inlet of evaporator 9.

[0063] In the process to be performed the blower 6 is advantageously shut off during the cooling/flushing steps. The shutting off of the blower 6 may avoid that water is splashed to the blower 6 and the liquefier 8.

[0064] In addition to this cooling effect, accumulated fluff in the evaporator 9 and in the flexible hose (connecting part) 29 between tub 1 and evaporator 9 is washed also away. The flushing water with the fluff 17 is guided to the tub 1 and can be pumped in this embodiment by the pump 14 to the outside of the washer dryer instead of being used again. During the flushing with cold tap water, the evaporator 9, the air duct 29 between tub 1 and evaporator 9 and the bottom area of the tub are cooled down and heating energy is removed from the process. As a result, the system temperature is reduced and the temperature level is kept below a certain value to avoid an overheating and a too high pressure in the heat pump system.

[0065] In the embodiment of the Fig., a storage container 31 for an aqueous liquid is provided. In the storage container 31, an aqueous liquid from the tub 1 can be stored. The aqueous liquid can be condensate, comparatively clean water from a washing or rinsing process conducted with the laundry item 5 or the aqueous liquid used in step (b) of the process of the present invention. The stored aqueous liquid can be used for different processes in the washer dryer including a repeated use as aqueous liquid in step (b) of the present process.

Reference Numerals

[0066]

1	tub; suds Container
2	drum
3	drive Motor
4	process air circuit
5	laundry items
6	blower
7	control unit
8	liquefier (of heat pump system);
9	evaporator
10	compressor
11	expansion valve
12	rinsing device
13	water valve
14	pump; waste water pump
15	aqueous liquid used for flushing the evaporator
16	condensate supply duct
17	fluff
18	rear exit of the tub
19	refrigerant temperature sensor in heat pump circuit
20	first temperature sensor between tub and evaporator
21	second temperature sensor at tub entrance
22	water heater
23	suds draining duct
24	aqueous tube liquid
25	waste water conduit; (flexible) hose;
26	water feed line
27	door (for accessing the interior of the drum)
28	sleeve
29	connecting part between the tub and the heat exchanger; (flexible) hose
30	rotational axis of drum
31	storage container

Claims

1. Process for operating a washer dryer comprising a tub (1), a drum (2) mounted in the tub (1) to be rotatable around an essentially horizontal axis (30) for receiving laundry items (5), a control unit (16), a process air circuit (4) comprising a liquefier (8) of a heat pump circuit (8,9,10,11) and a blower (6) to heat and circulate the heated air through the drum (2), an evaporator (9) to condense moisture from the process air coming out of the drum (2), a temperature sensor (19,20,21), and a rinsing device (12),
characterized in that

(a) the temperature sensor (19,20,21) measures a temperature value T_{app} in the process air circuit (4) or the heat pump circuit (8,9,10,11) which are indicative of a temperature of the refrigerant in the heat pump circuit (8,9,10,11); and
(b) the rinsing device (12) flushes the evaporator (9) with an aqueous liquid (15) when the temperature T_{app} reaches or exceeds an upper temperature limit T_{max}^{set}.

2. Process according to claim 1, wherein an air temperature sensor (20) is placed in the process air circuit (4) between the tub (1) and the evaporator (9).

3. Process according to claim 1 or 2, wherein a refrigerant temperature sensor (19) placed in the heat pump circuit (8,9,10,11) and the rinsing device (12) flushes the evaporator (9) when the temperature T_{hp} measured by the refrigerant temperature sensor reaches or exceeds a predetermined value T_{hp}^{max}.

4. Process according to any of claims 1 to 3, wherein the blower (6) is shut off during step (b).

5. Process according to any of claims 1 to 3, wherein during step (b) an air flow is created in the process air circuit (4) in the direction of the flow of the aqueous liquid.

6. Process according to any of claims 1 to 5, wherein in step (b) the aqueous liquid (15) is provided in at least two portions.

7. Process according to claim 6, wherein the rinsing device (12) flushes the evaporator (9) with a first set amount of the aqueous liquid (15), then the aqueous liquid is allowed for a preset time interval Δt_1 to collect in the tub (1), the pump is then run for a preset time interval Δt_2 to pump off the aqueous liquid (24) collected in the tub (1), before the rinsing device (13) flushes the evaporator (9) again with a second amount of aqueous liquid (15).

8. Process according to any of claims 1 to 7, wherein the amount of aqueous liquid (15) to be used in step (b) is determined based on a relationship stored in the control unit (16) between T_{app} and the temperature T_{aq} of the aqueous liquid (15) provided for the rinsing device (12).

9. Process according to any of claims 1 to 8, wherein the aqueous liquid (15) is tap water from a water supply system (26).

10. Process according to any of claims 1 to 9, wherein the flushing in step (b) is conducted until the temperature T_{app} reaches or falls below a lower temperature limit $T_{min}^{set} < T_{max}^{set}$.

11. Process according to any of claims 1 to 10, wherein following step (b) the drying process is continued in a step (c) until a preset time has expired or until a present dryness of the laundry items has been achieved.

12. Process according to claim 11, wherein the evaporator (9) is flushed in a step (d) after step (c) with an amount of aqueous liquid (15) that corresponds to the difference between a preset amount Q_{fin} for a final flushing step in the washer dryer and the amount of aqueous liquid Q_b used in step (b).

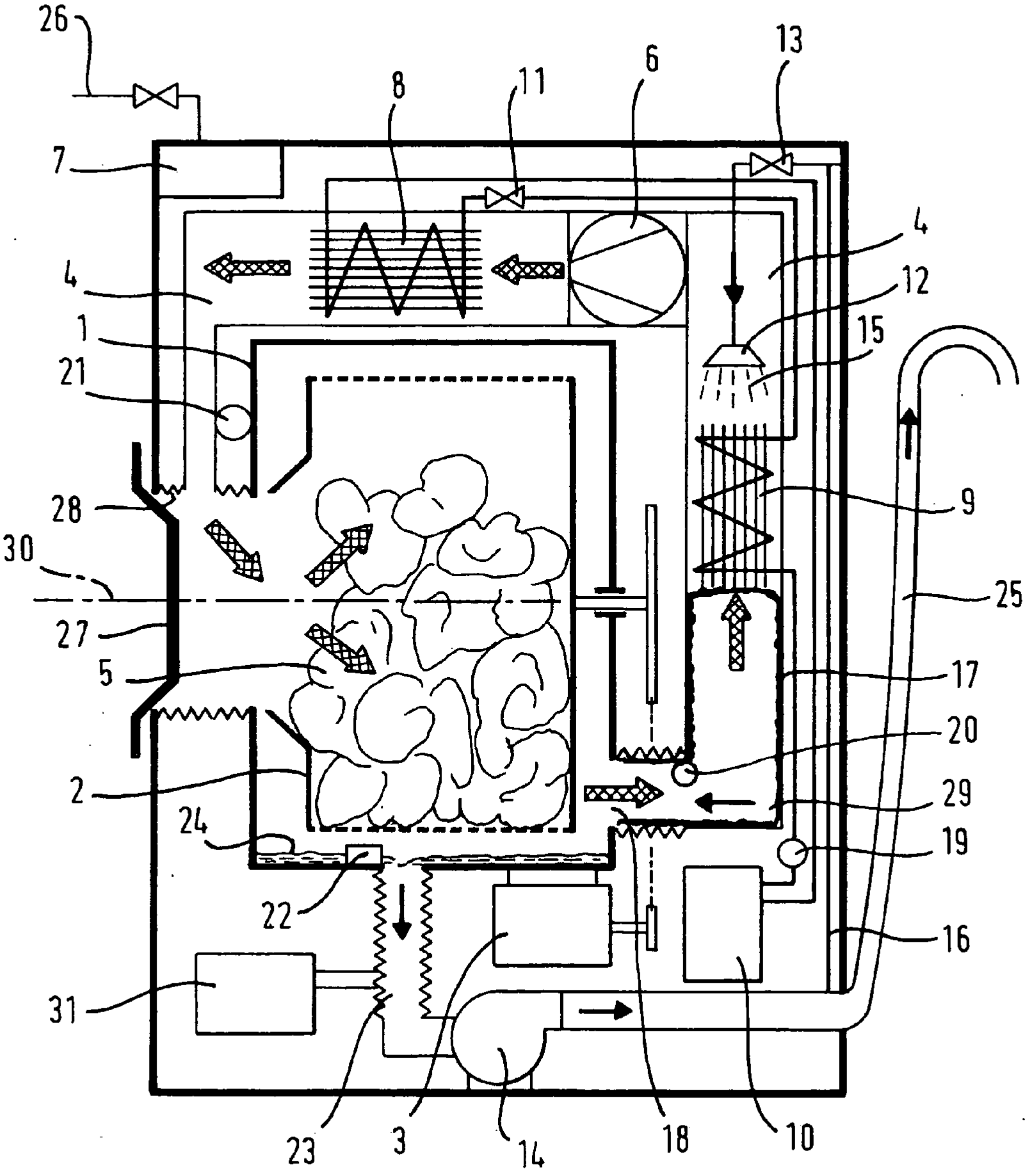
13. Process according to any of claims 1 to 12, wherein the aqueous liquid (15) is transported for a subsequent use in the washer dryer to a storage container (31) provided therein.

14. Process according to claim 13, wherein the aqueous liquid is only transported to the storage container (31) if a given upper limit for the concentration of impurities is not exceeded.

15. Washer dryer comprising a tub (1), a drum (2) mounted in the tub (1) to be rotatable around an essentially horizontal axis (30) for receiving laundry items (5), a control unit (16), a process air circuit (4) comprising a liquefier (8) of a heat pump circuit (8,9,10,11) and a blower (6) to heat and circulate the heated air through the drum (2), an evaporator (9) to condense moisture from the process air coming out of the drum (2), a temperature sensor (19,20,21), and a rinsing device (12), **characterized in that** the control unit (16) is adapted to carry out a process wherein

(a) the temperature sensor (19,20,21) measures a temperature value T_{app} in the process air circuit (4) or the heat pump circuit (8,9,10,11) which are indicative of a temperature of the refrigerant in the heat pump circuit (8,9,10,11); and
(b) the rinsing device (12) flushes the evaporator (9) with an aqueous liquid (15) when the temperature T_{app} reaches or exceeds an upper temperature limit T_{max}^{set}.

Fig.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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 8525

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS

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