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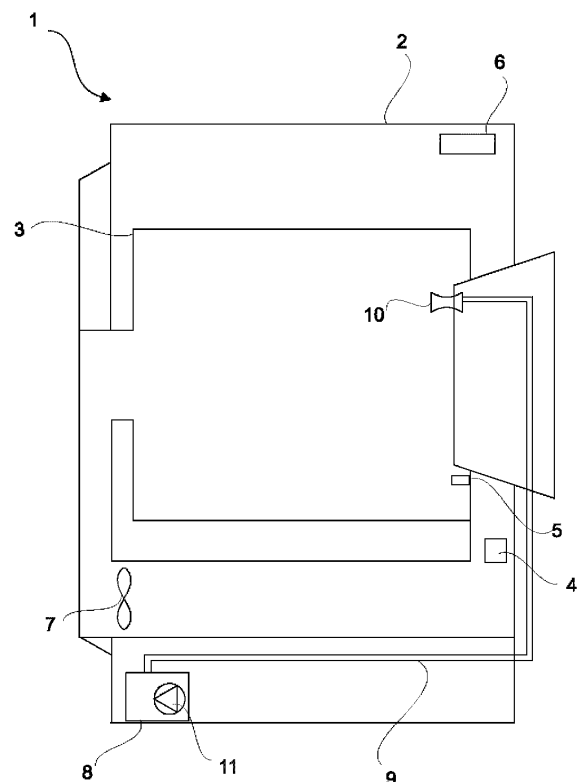
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(54) **A LAUNDRY DRYER WITH IMPROVED WRINKLE REMOVAL PERFORMANCE**

(57) The present invention relates to a laundry dryer (1) comprising a body (2); a drum (3) which is disposed in the body (2) and wherein the laundry is loaded; a temperature sensor (4) which is provided in the body (2) and which measures the temperature of the drying air in the drum (3); a humidity sensor (5) which is provided in the body (2) and which measures the humidity of the laundry; a water delivery system which sprays water into the drum (3); and a control unit (6) which controls the water delivery system, which determines the weight and textile type of the laundry in the drum (3), and which determines the amount of water to be delivered into the drum (3) depending on the weight of the laundry in the drum (3).

Figure 1



Description

[0001] The present invention relates to a laundry dryer with improved wrinkle removal performance.

[0002] The laundry dryers may have wrinkle removal functions as an additional feature. The wrinkle depends on various structural factors which vary according to external factors especially the type of fiber. Many natural or artificial textile fibers are polymers and have different physical and chemical properties due to differences in the chain sequences and molecular structures thereof. The drying programs developed do not provide the same effect on every type of textile due to the different physical and chemical properties of textiles. One of the methods to reduce the wrinkles in the laundry in the drum is to spray water into the drum at certain intervals.

[0003] In the United States Patent Application No. US2010024243, a laundry dryer is disclosed, wherein the wrinkle removal performance is improved. The document discloses that the wrinkle removal performance is improved by delivering water onto the laundry in the drum during the drying process. The document further discloses that the water is delivered into the drum when the humidity rate of the laundry is between 10% to 20%. However, since the wrinkle removal dynamics (yarn mobility) differ depending on the temperature and humidity value according to the yarn type of the laundry, this method cannot provide an efficient wrinkle removal performance for every laundry.

[0004] In the European Patent No. EP2333147, it is disclosed that the humidity content of the textile in production varies according to the type of the textile, and in a laundry dryer having a water spraying system, the drying process is performed by delivering water twice as much as the commercial humidity contained in these textiles, thus improving wrinkle removal.

[0005] The aim of the present invention is the realization of a laundry dryer wherein the wrinkle removal performance is improved by applying a drying process which changes depending on the fiber type and weight of the laundry.

[0006] The laundry dryer of the present invention comprises a body; a drum which is disposed in the body and wherein the laundry is loaded; a temperature sensor which is provided in the body and which measures the temperature of the drying air in the drum; a humidity sensor which is provided in the body and which measures the humidity of the laundry; a water delivery system which sprays water into the drum; and a control unit which controls the water delivery system, which determines the weight and textile type of the laundry in the drum, and which determines the amount of water to be delivered into the drum depending on the weight of the laundry in the drum. In the preferred version of the present invention, the control unit operates the water delivery stem so as to deliver approximately 40 ml of water for each piece of laundry into the drum.

[0007] The laundry dryer of the present invention fur-

ther comprises the control unit which, when the data received from the temperature sensor is between 35°C and 45°C, operates the water delivery system so as to deliver the amount of water determined according to the weight of the laundry in the drum into the drum when it is determined that cotton laundry is loaded into the drum, when the data received from the humidity sensor is between 12% and 16% or when it is determined that viscose laundry is loaded into the drum, when the data received from the humidity sensor is between 30% and 35% or when it is determined that polyester laundry is loaded into the drum, and when the data received from the humidity sensor is between 4% and 8%. The glass transition temperature is the temperature where the fibers on the laundry start to actively move. Since the molecular structures of each polymer differ from each other, the humidity-dependent glass transition temperature curves of textiles with different polymer structures are different from each other. When a temperature above the glass transition temperature is applied to the laundry, the fibers on the laundry fabric can actively move. Figure 2 shows the humidity-dependent glass transition temperature curve for a piece of 100% cotton laundry. According to this curve, when there is 30% humidity on a piece of 100% cotton laundry, the fibers on the laundry fabric tend to move at each temperature above 0°C. As the humidity on the laundry increases, the glass transition temperature decreases. Therefore, the humid laundry loaded into the drum to be dried is treated at a temperature above the glass transition temperature at the beginning of the drying process. As the humidity on the laundry decreases, the glass transition temperature increases. It is not possible to move the fibers on the laundry fiber at a temperature below the glass transition temperature. For example, when a wrinkled piece of laundry is treated at a temperature below the glass transition temperature, the amount of wrinkles thereon does not change. According to the graphic in Figure 2, the glass transition temperature is approximately 45°C when there is 12% humidity on a piece of 100% cotton laundry, and the glass transition temperature is approximately 35°C when the humidity rate is 16%. Figure 3 shows the humidity-dependent glass transition temperature for a 100% viscose fabric. According to the graphic in Figure 3, the glass transition temperature is approximately 45°C when there is 30% humidity on a piece of 100% viscose laundry, and the glass transition temperature is approximately 35°C when the humidity rate is 35%. Figure 4 shows the humidity-dependent glass transition temperature for a 100% polyester fabric. According to the graphic in Figure 4, the glass transition temperature is approximately 45°C when there is 4% humidity on a piece of 100% polyester laundry, and the glass transition temperature is approximately 36°C when the humidity rate is 8%. After the type of laundry loaded into the drum is determined by the control unit, a drying air at a temperature between 35°C and 45°C is sent into the drum. The humidity sensor periodically measures the humidity rate of the laundry. Upon

determining that the laundry loaded into the drum is cotton, the control unit, if the data received from the humidity sensor is between 12% and 16%, delivers a predetermined amount of water into the drum by means of the water delivery system. Since the humidity rate of the laundry increases after the water is delivered into the drum, the glass transition temperature decreases. Thus, the laundry is enabled to be treated at a temperature above the glass transition temperature. Thus, the wrinkles on the laundry are reduced. Upon determining that the type of laundry loaded into the drum is viscose while the data received from the humidity sensor is between 30% and 35%, and that the type of laundry loaded into the drum is polyester while the data received from the humidity sensor is between 4% and 8%, the control unit operates the water delivery system to deliver a predetermined amount of water into the drum. Thus, by spraying water into the drum at humidity ranges determined for the humidity-dependent glass transition temperature for each type of fabric, the laundry is enabled to be treated at a temperature above the glass transition temperature for a longer period of time.

[0008] In another embodiment of the present invention, the laundry dryer comprises an air distribution system which sends air into the drum at a first air flow rate or at a second air flow rate lower than the first air flow rate. The drying air is delivered into the drum at different air flow rates at different times depending on the type of laundry.

[0009] In an embodiment of the present invention, the control unit controls the air distribution system so as to send air into the drum at the second air flow rate after the water is delivered into the drum. After the laundry is loaded into the drum, the laundry is dried by being exposed to the air at the first air flow rate until the humidity rates predetermined for the types of fabric. At this step which is the drying step, the laundry is quickly dehumidified by sending the air thereon at the first air flow rate. At the point where the temperature and humidity values intersect on the glass transition graphic, the water is delivered into the drum and the laundry is moistened for a certain amount so as to decrease the glass transition temperature. Since the temperature of the drying air delivered into the drum is not changed, the laundry is treated with the drying air having a temperature above the glass transition temperature. By delivering the air at the second air flow rate onto the laundry after the water is delivered into the drum, the laundry is enabled to be delicately dried and the fibers on the fabric surface are easily flattened by means of the low air flow rate. Thus, the wrinkles in the laundry are removed without damaging the laundry.

[0010] In an embodiment of the present invention, the air distribution system comprises a fan which delivers air at the first air flow rate while rotating in one direction and which delivers air at the second air flow rate while rotating in the other direction.

[0011] In an embodiment of the present invention, the laundry dryer comprises the water delivery system hav-

ing a water reservoir which is disposed in the body, a spraying line which extends between the water reservoir and the drum, a nozzle which is provided at the end of the spraying line and which sprays water into the drum, and a pump which provides the delivery of the water from the water reservoir to the nozzle. The water reservoir can be a reservoir which can be detached from the body and filled. The pump is positioned in the water reservoir. The pump is controlled by the control unit. When it is desired to deliver water into the drum, the control unit operates the pump so as to deliver water to the nozzle. The water reaching the nozzle is sprayed into the drum.

[0012] In an embodiment of the present invention, the laundry dryer comprises a flowmeter which is provided in the spraying line.

[0013] By means of the present invention, a laundry dryer is realized, wherein the wrinkle removal performance is improved by applying different drying processes depending on the type of the laundry loaded into the drum.

[0014] The advantages of the laundry dryer of the present invention will be disclosed with the detailed description of the embodiments with reference to the accompanying figure, where:

Figure 1 - is the schematic view of the laundry dryer in an embodiment of the present invention.

Figure 2 - is the curve of the glass transition temperature for a 100% cotton fabric dependent on the percentage of humidity thereon.

Figure 3 - is the curve of the glass transition temperature for a 100% viscose fabric dependent on the percentage of humidity thereon.

Figure 4 - is the curve of the glass transition temperature for a 100% polyester fabric dependent on the percentage of humidity thereon.

[0015] The following numerals are referred to in the description of the present invention:

1. Laundry dryer
2. Body
3. Drum
4. Temperature sensor
5. Humidity sensor
6. Control unit
7. Fan
8. Water reservoir
9. Spraying line
10. Nozzle
11. Pump

[0016] The laundry dryer (1) comprises a body (2); a drum (3) which is disposed in the body (2) and wherein the laundry is loaded; a temperature sensor (4) which is provided in the body (2) and which measures the temperature of the drying air in the drum (3); a humidity sensor (5) which is provided in the body (2) and which measures the humidity of the laundry; a water delivery system

which sprays water into the drum (3); and a control unit (6) which controls the water delivery system, which determines the weight and textile type of the laundry in the drum (3), and which determines the amount of water to be delivered into the drum (3) depending on the weight of the laundry in the drum (3). The temperature sensor (4) which measures the temperature of the drying air in the drum (3) is positioned in the vicinity of the air outlet through which the drying air leaves the drum (3) after being delivered onto the laundry. The humidity sensor (5) is positioned so as to face the inner volume of the drum (3). The humidity sensor (5) directly contacts the laundry so as to detect the humidity of the laundry. The control unit (6) determines the weight and fabric type of the laundry in the drum (3). In a version of the present invention, the user selects the fabric type of the laundry loaded into the drum (3), and can send the information on the fabric type of the laundry to be dried to the control unit (6). In another version of the present invention, the control unit (6) can determine the fabric type of the laundry loaded into the drum (3) by means of an optical sensor or other sensors to be provided in the body (2). In a version of the present invention, the user selects the weight of the laundry loaded into the drum (3) via the control panel such that the control unit (6) determines the weight. The user can transmit the information on the weight of the laundry loaded into the drum (3) to the control unit (6) by means of buttons for full load, half load, quarter load or buttons for selecting the number of pieces of laundry provided on the control panel. In another version of the present invention, the control unit (6) can determine the weight of the laundry in the drum (3) by means of the sensors which are provided in the body (2) and which are suitable for measuring the weight of the drum (3). The water delivery system which provides the spraying of water into the drum (3) is disposed in the body (2). By controlling the water delivery system, the control unit (6) ensures that the water is delivered into the drum (3) at certain intervals. Thus, the movement of the fibers on the fabrics of the laundry is facilitated. The control unit (6) determines the amount of water to be delivered into the drum (3) according to the weight of the laundry in the drum (3). As the weight of the laundry in the drum (3) increases, the amount of water to be delivered into the drum (3) during the drying process also increases.

[0017] The laundry dryer (1) of the present invention further comprises the control unit (6) which, when the data received from the temperature sensor (4) is between 35°C and 45°C, operates the water delivery system so as to deliver the amount of water determined according to the weight of the laundry in the drum (3) into the drum (3) when it is determined that cotton laundry is loaded into the drum (3) and when the data received from the humidity sensor (5) is between 12% and 16% or when it is determined that viscose laundry is loaded into the drum (3) and when the data received from the humidity sensor (5) is between 30% and 35% or when it is determined that polyester laundry is loaded into the drum (3)

and when the data received from the humidity sensor (5) is between 4% and 8%. The temperature where the fibers on the fabrics of the laundry start to actively move is the glass transition temperature. The fibers on the fabric can actively move at temperatures above the glass transition temperature. The glass transition temperature is dependent on the humidity and has a different temperature/humidity curve for each type of fabric. As the humidity on the laundry increases, the glass transition temperature decreases. Figure 2 shows the humidity-dependent glass transition temperature for a 100% cotton fabric. Figure 2 shows that when there is 12% humidity on a piece of 100% cotton laundry, the fibers on the laundry can easily move at each temperature above 45°C. Moreover, Figure 2 shows that when there is 16% humidity on a piece of 100% cotton laundry, the fibers on the laundry can easily move at each temperature above 35°C. Upon determining that the fabric type of the laundry in the drum (3) is cotton, when the temperature of the drying air during the drying process is between 35°C and 45°C and the humidity ratio on the laundry is between 12% and 16%, the control unit (6) operates the water delivery system so as to spray water into the drum (3). Thus, by increasing the humidity on the laundry, the glass transition temperature is decreased and the laundry is enabled to be treated at a temperature above the glass transition temperature for a longer period of time. The humidity-dependent glass transition temperature curve is a curve provided for 100% cotton laundry. However, for laundry containing more than 50% of cotton fabric, the results obtained are similar to the glass transition temperature curve given in Figure 2. When water is sprayed into the drum (3) within the drying air temperature and humidity ratio ranges close to the glass transition temperature curve while laundry containing more than 50% of cotton fabric by mass is treated in the laundry dryer (1), the laundry is enabled to be treated at a temperature above the glass transition temperature for a longer period of time so as to reduce wrinkles. As the fabric type changes, the humidity-dependent glass transition temperature curve also changes. Figure 3 shows the humidity-dependent glass transition temperature for a 100% viscose fabric. Figure 3 shows that when there is 35% humidity on a piece of 100% viscose laundry, the fibers on the laundry can easily move at temperatures above 35°C, and when there is 30% humidity, the fibers can easily move at temperatures above 45°C. Figure 4 shows that when there is 8% humidity on a piece of 100% polyester laundry, the fibers on the laundry can easily move at temperatures above 35°C, and when there is 4% humidity, the fibers can easily move at temperatures above 45°C. During a drying process performed at temperatures between 35°C and 45°C, the control unit (6) delivers an amount of water determined according to the weight of the laundry in the drum (3) into the drum (3) when it is determined that cotton laundry is loaded into the drum (3) and when the humidity ratio on the laundry is between 12% and 16% or when it is determined that viscose laundry is loaded

into the drum (3) and when the humidity ratio on the laundry is between 30% and 35% or when it is determined that polyester laundry is loaded into the drum (3) and when the humidity ratio on the laundry is between 4% and 8%. Thus, the laundry is enabled to be treated at a temperature above the glass transition temperature for a longer period of time so as to reduce wrinkles. In a preferred embodiment of the present invention, the control unit (6) delivers water into the drum (3) only once during a single drying process. When the laundry with increased humidity after water is sprayed into the drum (3) reaches the humidity value range upon being subjected to the drying air again, water is not sprayed into the drum for a second time in the same drying cycle.

[0018] In another embodiment of the present invention, the laundry dryer (1) comprises an air distribution system which sends air into the drum (3) at a first air flow rate or at a second air flow rate lower than the first air flow rate. While the first air flow rate is 75 l/s, the second air flow rate is 25 l/s. When the air is delivered into the drum (3) at the first air flow rate, the laundry is dried more quickly. When the air is delivered into the drum (3) at the second air flow rate, a more delicate drying is provided. The air distribution system is controlled by the control unit (6).

[0019] In another embodiment of the present invention, the laundry dryer (1) comprises the control unit (6) which controls the air distribution system so as to send air into the drum (3) at the second air flow rate after the water is delivered into the drum (3). After the water is delivered into the drum (3), the humidity of the laundry increases by a certain amount. The laundry is treated at a temperature above the glass transition temperature for a while more. By delivering the air into the drum (3) at the second air flow rate, the fabric surface of the laundry is enabled to be delicately flattened. After the water is delivered into the drum (3), the control unit (6) operates the air distribution system so as to deliver air onto the laundry at the second air flow rate until the laundry is detected to be dry depending on the value measured by the humidity sensor (5).

[0020] In another embodiment of the present invention, the laundry dryer (1) comprises the air distribution system having a fan (7) which delivers air at the first air flow rate while rotating in one direction and which delivers air at the second air flow rate while rotating in the other direction. By means of the angled structure of the blades of the fan (7), an air flow at the first air flow rate is generated while the motor is rotated clockwise, and an air flow rate at the second air flow rate, which is lower than the first one, is delivered into the drum (3) while the fan (7) is rotated counterclockwise. Thus, two different air flow rates can be obtained by a single fan without requiring a second fan.

[0021] In another embodiment of the present invention, the laundry dryer (1) comprises the water delivery system having a water reservoir (8) which is disposed in the body (2), a spraying line (9) which extends between the water reservoir (8) and the drum (3), a nozzle (10) which is

provided at the end of the spraying line (9) and which sprays water into the drum (3), and a pump (11) which provides the delivery of the water from the water reservoir (8) to the nozzle (10). The water condensed in the air distribution system is collected in the water reservoir (8). By means of the nozzle (10) provided at the end of the spraying line (9), the water collected in the collection receptacle (8) is sprayed into the drum (3). The control unit (6) controls the pump (11) and the nozzle (10) so as to spray water into the drum (3) at predetermined intervals. The control unit (6) determines the amount of water to be delivered into the drum (11) by adjusting the operation time of the pump (11).

[0022] In an embodiment of the present invention, the laundry dryer (1) comprises a flowmeter which is provided in the spraying line (9). Thus, the amount of water to be delivered into the drum (3) can be easily determined.

[0023] By means of the present invention, a laundry dryer (1) is realized, comprising a control unit (6) which, upon determining the fabric type and weight of the laundry, delivers the drying air at temperatures between 35° C and 45° C into the drum (3), which delivers an amount of water determined depending on the weight of the laundry into the drum (3) when the humidity ratio on the laundry falls into the range predetermined for the determined fabric type such that the laundry is treated at a temperature above the glass transition temperature for a while more, and which provides the removal of wrinkles on the fabric surface of the laundry.

Claims

1. A laundry dryer (1) comprising a body (2); a drum (3) which is disposed in the body (2) and wherein the laundry is loaded; a temperature sensor (4) which is provided in the body (2) and which measures the temperature of the drying air in the drum (3); a humidity sensor (5) which is provided in the body (2) and which measures the humidity of the laundry; a water delivery system which sprays water into the drum (3); and a control unit (6) which controls the water delivery system, which determines the weight and textile type of the laundry in the drum (3), and which determines the amount of water to be delivered into the drum (3) depending on the weight of the laundry in the drum (3), **characterized by** the control unit (6) which, when the data received from the temperature sensor (4) is between 35° C and 45° C, operates the water delivery system so as to deliver the amount of water determined according to the weight of the laundry in the drum (3) into the drum (3)

- when it is determined that cotton laundry is loaded into the drum (3) and when the data received from the humidity sensor (5) is between 12% and 16%, and/or

- when it is determined that viscose laundry is loaded into the drum (3) and when the data received from the humidity sensor (5) is between 30% and 35%, and/or
 - when it is determined that polyester laundry is loaded into the drum (3) and when the data received from the humidity sensor (5) is between 4% and 8%. 5
2. A laundry dryer (1) as in Claim 1, **characterized by** an air distribution system which sends air into the drum (3) at a first air flow rate or at a second air flow rate lower than the first air flow rate. 10
3. A laundry dryer (1) as in Claim 2, **characterized by** the control unit (6) which controls the air distribution system so as to send air into the drum (3) at the second air flow rate after the water is delivered into the drum (3). 15
4. A laundry dryer (1) as in Claim 2 or 3, **characterized by** the air distribution system having a fan (7) which delivers air at the first air flow rate while rotating in one direction and which delivers air at the second air flow rate while rotating in the other direction. 20 25
5. A laundry dryer (1) as in any one of the above claims, **characterized by** the water delivery system having a water reservoir (8) which is disposed in the body (2), a spraying line (9) which extends between the water reservoir (8) and the drum (3), a nozzle (10) which is provided at the end of the spraying line (9) and which sprays water into the drum (3), and a pump (11) which provides the delivery of the water from the water reservoir (8) to the nozzle (10). 30 35
6. A laundry dryer (1) as in Claim 5, **characterized by** a flowmeter which is disposed in the spraying line (9). 40

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Figure 1

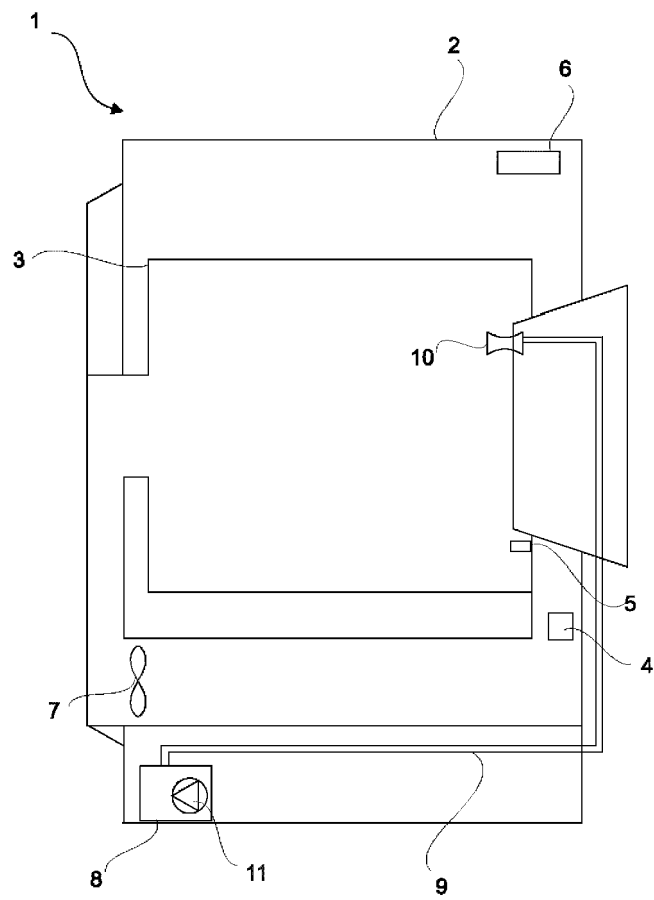


Figure 2

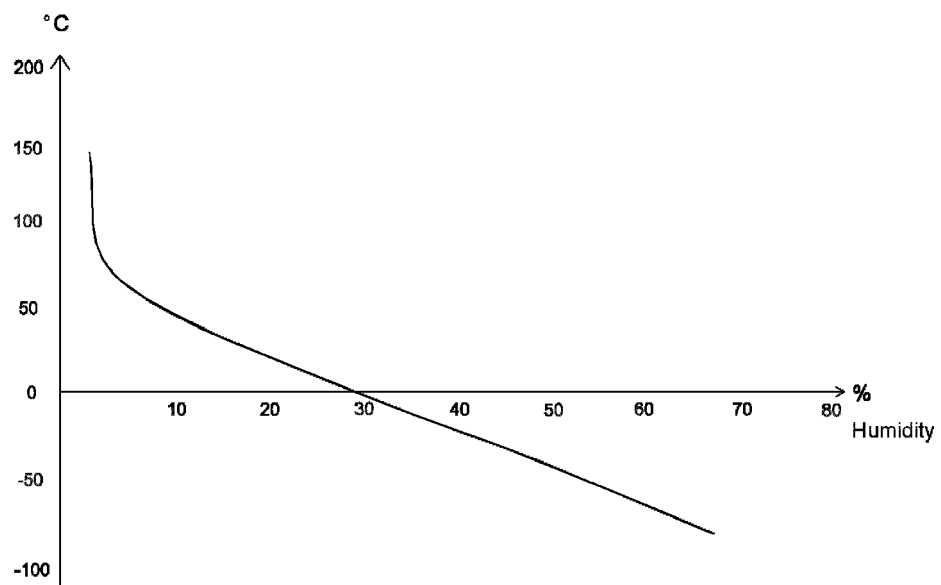


Figure 3

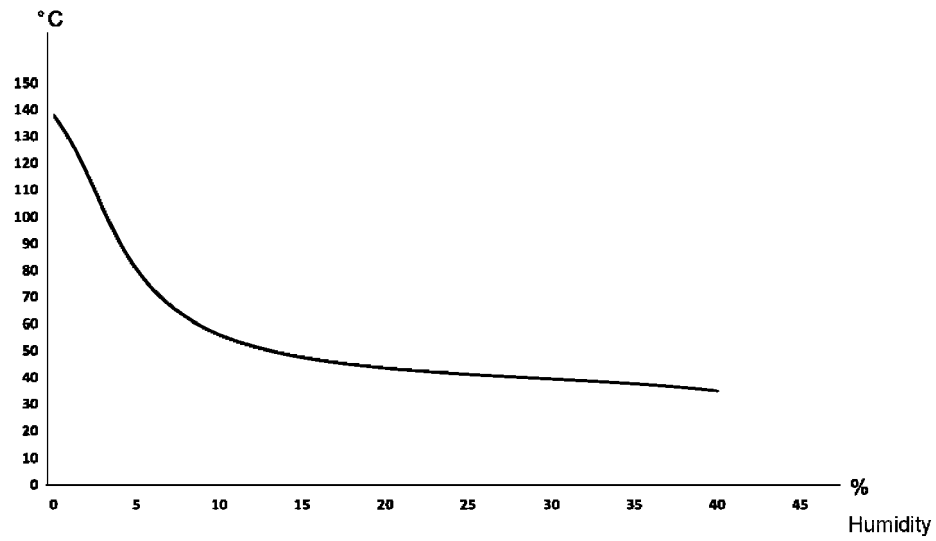
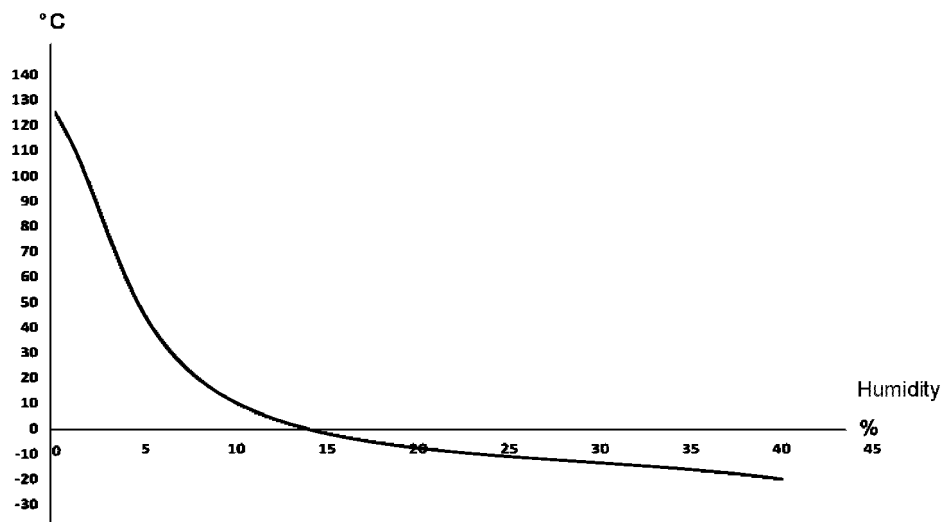


Figure 4





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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 December 2021	Examiner Diaz y Diaz-Caneja
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
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