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(54) **METHOD OF DRYING**

(57) A method of drying a wet fabric in a dryer comprising the steps of; a) attaching a humidity sensor to the fabric; b) placing the fabric in the dryer; c) starting the drying process; d) measuring the equilibrium relative humidity of the fabric using the humidity sensor and e) stopping the drying process when a predetermined level of the equilibrium relative humidity is achieved.

EP 3 444 396 A1

Description

TECHNICAL FIELD

[0001] The present invention is in the field of drying fabrics. In particular, it relates to a method of drying fabrics measuring equilibrium relative humidity of the fabrics to determine the final point of the drying process. The method involves time and energy savings and provide good care of the fabrics.

BACKGROUND OF THE INVENTION

[0002] Drying of fabrics is a very intensive time- and energy-consuming process. There is a desire to control the time required by drying not only for energy saving reasons but also for fabric finishing and longevity. Over drying in the dryer can promote fabric damage. For example, in the case of towels, the optimum moisture content of a finished towel seems to be 4 to 6% water by weight, calculated on bone-dry weight, not air-dry weight. Towels dried beyond this level will pick-up moisture from the air in the laundry or in the hotel guest's room, so over drying wastes both money and time.

[0003] Once the fabrics become over-dried, they do not contain enough water for evaporative cooling to occur and the temperature at the fabric level starts to increase markedly. Studies have shown that fabric exposed to high temperatures will exhibit a peeling of primary walls, which exposes the cellulosic secondary wall. Consequently, fabrics overdried at high temperatures will show much lower tensile strength. This in turn, will give increase lint formation and can negatively impact fabrics appearance, and softness. Over-drying can also give rise to yellowing of whites and reduce the amount of perfume left on fabrics.

[0004] Once fabrics are bone dry, they do not have any moisture that would dissipate the static charge that is generated when the textile brushes against the dryer's metal cage. As a result, the towel surface attracts every particle from the drying airstream leading to progressive greying. This seems to contribute to greying and dingy aspect of towels.

[0005] Drying appliances aim to optimise and automate the drying process. Often the drying cycle will terminate and often the load will be under-dried or over-dried.

[0006] Dryers use sensors that read different physical parameters such as moisture, temperature, resistance, etc. Usually the sensors are placed in the dryer, for example in the air outlet or attached to the dryer wall. During the course of the work leading to this invention it was found that sensors in these locations do not provide a reading representative of the local condition experienced by the fabric and therefore are not very accurate in predicting the degree of dryness of the fabrics.

[0007] There is a need for an improved drying process that requires less time and energy consumption and care for the fabrics.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 shows the relative humidity of cotton and polycotton versus drying time measured on the fabrics, the drum and the outlet vent of the dryer.

SUMMARY OF THE INVENTION

[0009] According to a first aspect of the invention, there is provided a method of drying a wet fabric in a dryer, the method comprising the steps of:

a) attaching a humidity sensor to the fabric;
b) placing the fabric in the dryer;
c) starting the drying process;
d) measuring the equilibrium relative humidity of the fabric using the humidity sensor; and
e) stopping the drying process when the equilibrium relative humidity is below a predetermined level.

[0010] As it has been stated herein above the humidity in the dryer is not the same as the humidity of the fabric. The humidity measured in the outlet vent of the appliance, will only partly reflect the amount of water that is being removed from the fabric. Other important parameters that are independent from how dry the fabric is also include: the humidity of the incoming air, the air flow through the drier. So typically, for the drying process to be effective the outlet air humidity will always be lower than that of the fabric, which until dry will be at 100%.

[0011] Similarly, with temperature, the outlet ait temperature will be mostly influenced by the incoming air temperature, whereas the fabric will undergo evaporative cooling for as long as there is free water present in the fabric.

[0012] Therefore, both the equilibrium relative humidity and the temperature show a profile much closer to that of the incoming air than that of the fabric surface. Additionally, when different fabric types are present in the same load, the appliance read is only capable of reading the effects of the average drying process and incapable of resolving what is happening on a fabric by fabric basis.

[0013] The predetermined equilibrium relative humidity of each fabric can be assessed by subjecting each fabric to drying and take it out at different times and manually feeling the fabric.

[0014] Preferably, the drying process should be stopped when the relative humidity of the fabric measured in the dryer is less than 80%, more preferably less than 60% but no less than 40%, preferably no less than 50%. It has been seen that fabrics taken from the dryer having an equilibrium relative humidity below 80% will feel dry. The equilibrium relative humidity should preferably be greater than 40%, more preferably greater than 50% to prevent over drying of the fabric that can give rise to deterioration of the fabric.

[0015] Different types of fabrics require different amount of time to dry, thus, in the case of loads comprising different types of fabrics, it is beneficial to have sensors on the different fabrics, thus each fabric can be taken out of the dryer as soon as it reaches the required level of dryness avoiding under and/or over drying and to reduce the time and energy required for the drying of the total load.

[0016] Any sensor capable of measuring equilibrium relative humidity is suitable for use herein. Preferred for use herein are portable digital hygrometers.

[0017] Preferably, the humidity sensor is detachable and is attached to the fabric prior to going in the dryer. It can be attached by fastening means such a tie cable, elastic band, a clip, etc

[0018] Alternatively, the attachment point can be designed to be an intrinsic feature of the fabric, as for example, a dedicated pocket.

[0019] The humidity sensor would preferably communicate to an electronic device and would send the equilibrium relative humidity readings, preferably wireless, more preferably by a radio signal, such as Bluetooth or Wi-Fi or any other form of radio communication.

[0020] In a preferred embodiment the humidity sensor communicates with the dryer and sends a signal when the predetermined relative humidity is achieved to turn the dryer off.

[0021] Preferably, the electronic device would send a signal to the user, more preferably an auditory or visual signal to indicate that the fabric has reached the predetermined equilibrium relative humidity.

DETAILED DESCRIPTION OF THE INVENTION

[0022] The present invention envisages a method of drying fabrics. The method involves the use of humidity sensors attached to the fabrics to measure the equilibrium relative humidity of fabrics. The method of the invention helps with fabric longevity, care of the fabric and perfume retention and allows for a faster drying process.

[0023] Any dryer can be used to put into practice the method of the invention. The method of the invention allows for the design of more simple dryers, all the complex electronics and sensors in the dryer can be replaced by placing the humidity sensors on the fabrics and this would give a more accurate picture of the drying process than the picture provided by sensors in the dryer. Thereby saving time and providing better care for the fabrics.

[0024] The method of the invention is suitable for domestic drying and commercial drying.

Humidity sensor

[0025] The sensor measures the equilibrium relative humidity (eRH) that is the relative humidity (RH) of air in equilibrium with the fabric. The sensor is preferably a digital hygrometer and preferably the readings is transmitted in digital format to an electronic device to do the monitoring and inform the user when the predetermined eRH has been reached so the user can take the fabric out of the dryer.

[0026] Suitable digital hygrometers to use herein include SensorPush Wireless Hygrometer and any other hygrometer than can do real time reading and monitoring of eRH.

[0027] The sensor sends the readings in real time to an electronic device. The sensor constantly monitors and records eRH and streams data to any Bluetooth-connected iOS or Android device. The device provides notification to the user.

[0028] For commercial uses, where the load type and weight are standard, it is possible to use a device that records all the data in memory to be analysed at the end of the drying process. Once the optimal drying time for a given condition has thus been determined, it can be used for all subsequent drying of the identical load.

[0029] In this case a hygrometer such as iButtons: Hygrochron DS1923 that only record the data, rather than broadcast it would be suitable.

Fastening means

[0030] The sensor should be detachable and attached in close contact to the fabric by any fastening means. Fastening means include clips and/or pins that can be part of the sensor casing. Other fastening means include adhesive tape, Velcro, elastic bands, etc.

Electronic device

[0031] The sensor can send digital data to an electronic device, preferably via radio signal, for example, via Bluetooth or wifi. The electronic device can be any device capable to communicate with the sensor and to inform the user when the pre-established equilibrium relative humidity has been achieved.

Dryer

[0032] Any dryer can be used in the method of the invention. In a preferred embodiment the humidity sensor sends a signal to the dryer and the dryer stops when a predetermined relative humidity is achieved.

Example

[0033] A fabric load comprising a mixture of cotton and polyester was dried dry in a gas heated commercial tumble dryer (Electrolux T5250) after being washed in a washing machine. The load consisted of 3 kg of Knitted Cotton (244.96 g/m2) and 2 kg of Knitted polycotton 50.5%PE 49.5% Cotton (231.09 g/m2).

[0034] Hygrochron DS 1923 sensors were used to measure and record the humidity within the drum of the dryer, at the outlet vent and fixed directly on the wet fabrics. Sensors were set to record data every 30 seconds.

[0035] After the sensors were secured in their respective positions, and the load was placed into the dryer, the latter was set to run for a fixed period (40 min) longer than the expected drying time.

[0036] A DS1402D reader with One wire viewer software was used to download the recording of said hygrocrons. The humidity was then plotted *vs* time.

[0037] For the polycotton, drying was achieved after 15 minutes whereas for cotton 22 minutes were necessary. The graph below demonstrates that the hygrometer can measure the local condition of the fabric and is able to distinguish between the 2 fabric types.

[0038] Additionally, the drop in RH is very sharp which makes it very easy to detect the point at which drying has ended. This is particularly important when comparing to the data recorded in the appliance which shows an "average" condition that is far from is experienced by the fabric itself.

[0039] The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm".

Claims

1. A method of drying a wet fabric in a dryer comprising the steps of:

   a) attaching a humidity sensor to the fabric;
   b) placing the fabric in the dryer;
   c) starting the drying process;
   d) measuring the equilibrium relative humidity of the fabric using the humidity sensor; and
   e) stopping the drying process when a predetermined level of the equilibrium relative humidity is achieved.

2. A method according to claim 1 wherein the predetermined level of equilibrium relative humidity of the fabric is less than 80%.

3. A method according to any of claims 1 or 2 wherein the predetermined level of equilibrium relative humidity of the fabric is less than 60%.

4. A method according to any of the preceding claims where the predetermined level of equilibrium relative humidity of the fabric is more than 40%.

5. A method according to any of claims 1 or 2 wherein the predetermined level of equilibrium relative humidity of the fabric is less than 80% and more than 50%.

6. A method according to any of claims 1 or 2 wherein the predetermined level of equilibrium relative humidity of the fabric is less than 60% and more than 50%.

7. A method according to any of the preceding claims where the fabric comprises a plurality of fabrics.

8. A method according to the preceding claim wherein the plurality of fabrics comprises fabrics of different types and wherein different sensors are attached to different types of fabrics.

9. A method according to any of the preceding claims wherein the humidity sensor is a portable digital hygrometer.

10. A method according to any of the preceding claims wherein the humidity sensor is attached to the fabric by fastening means.

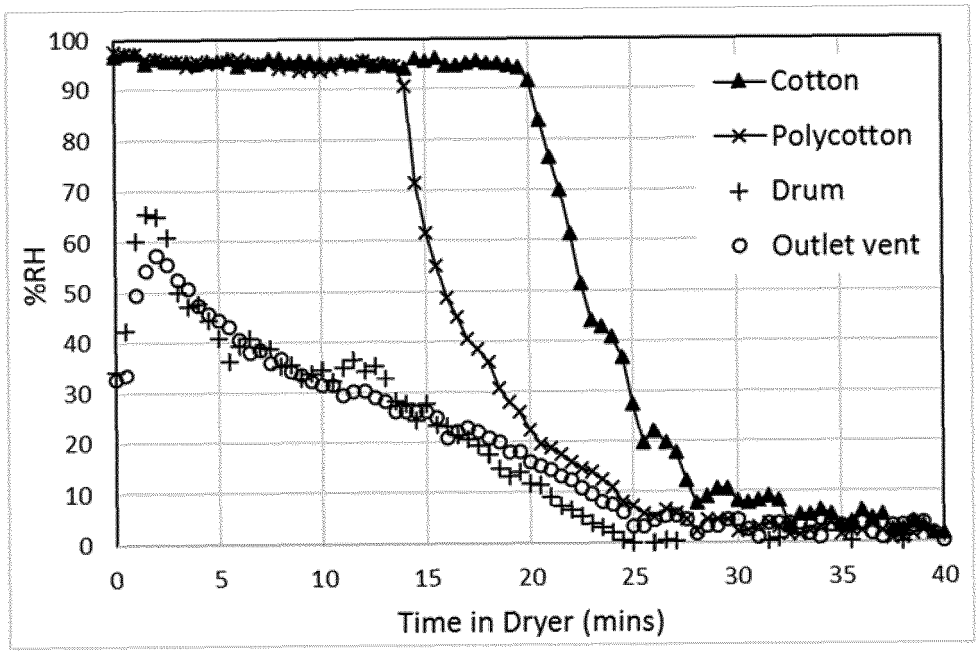
11. A method according to any of the preceding claims wherein the humidity sensor communicates with an electronic device.

12. A method according to any of the preceding claims wherein the humidity sensor communicates with the dryer and the dryer turns off when the predetermined level of equilibrium relative humidity is achieved.

13. A method according to claim 11 wherein the electronic device is a smart phone, a tablet or a computer.

14. A method according to any of claims 8 or 9 wherein the electronic device communicates when the predetermined equilibrium relative humidity has been reached.

15. A method according to the preceding claim wherein the communication is done by means of a visual and or auditory signal.


100
90
80
70
60
50
40
30
20
10
0
%RH
0
5
10
15
20
25
30
35
40
Time in Dryer (mins)
Cotton
Polycotton
Drum
Outlet vent

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 6850

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 225 267 A1 (WHIRLPOOL CO [US]) 24 July 2002 (2002-07-24) * paragraphs [0001], [0006], [0010], [0011], [0013], [0015], [0022]; claim 1; figures 1,2 *	1-15	INV. D06F58/28 F26B21/08 G01N27/04 D06F39/00
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A	US 5 756 986 A (GUSTAFSON AKE [CH]) 26 May 1998 (1998-05-26) * column 3, line 22 - column 4, line 67; figures 1,2 *	1,10,11, 13	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 January 2018	Kising, Axel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 18 6850

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