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Fabric Moisture Uniform Control to Study the Influence of Air Impingement Parameters on Fabric Drying Characteristic

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TITLE:

Fabric Moisture Uniform Control to Study the Influence of Air Impingement Parameters on Fabric Drying Characteristics

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KEYWORDS:

fabric, drying, moisture content, air impingement, heat setting, temperature field, air nozzle

SUMMARY:

Presented here is a protocol that guarantees uniform distribution of initial moisture inside of a fabric and investigates the effects of hot-air thermodynamic parameters (velocity, temperature, and direction) and thickness on the fabric's drying characteristics (e.g., temperature variation) under the condition of air impingement.

ABSTRACT:

Impinging dryness is now a widely used and effective way for fabric drying due to its high heat and mass transfer coefficient. Previous studies on fabric drying have neglected the contributions of moisture uniformity and diffusion coefficient to the drying process; though, they have recently been shown to have a significant influence on drying characteristics. This report outlines a step-by-step procedure to investigate the effects of air impingement parameters on a fabric's drying characteristics by controlling the uniformity of its area moisture distribution. A hot air blower unit equipped with an angle adjustable nozzle is used to generate air flow with different velocities and temperatures while the drying process is recorded and analyzed using an infrared thermograph. In addition, a uniform padder is adapted to ensure the fabric's moisture uniformity. Impinging drying is studied under different initial conditions by changing the air flow temperature, velocity, and direction, then the applicability and suitability of the protocol are evaluated.

INTRODUCTION:

Impinging drying is a very effective drying method due to its high heat, mass transfer coefficient, and short drying time. It has attracted extensive attention due to its numerous applications including chemical industry, food[1], textile, dyeing[2], paper making[3,4], etc. Now, impinging drying is widely used for its enhanced transport characteristics, especially for the drying of textiles in the heat setting process[5].

Fabric is impinging dried by the nozzle array for the heat setting. Nozzle layout affects the uniformity of drying temperature, which has a significant influence on the fabric properties, drying efficiency, and on the fabric surface directly. Thus, it is necessary to understand temperature distribution on the textile surface to design a better nozzle array. There has been little investigation in this field at the present, though there has been plenty of research on heat and moisture transfer performance of the fabric drying process so far. Some research has mainly focused on the natural evaporation of a textile under a specified heat source, in which the impinging drying process was not involved in these studies[6,7]. Some have focused on heat and moisture transfer of the textile with hot air drying, but the textile moisture and temperature were assumed to be uniform in these studies[8-11]. Furthermore, a few of these studies attempted to obtain the temperature distribution variation with time for studying the heat and moisture transfer of the textile under impinging drying.

Etemoglu et al.[2] developed an experimental set-up for obtaining temperature variation with the time of the fabric and total drying time, but this set-up is limited to single-point temperature measurements. The initial moisture content distribution in the fabric is also neglected in this type of research. Wang et al.[12] intended to obtain temperature distribution on the fabric by pasting thermocouples on the textile surface at various points, but surface temperature distribution was not able to be accurately obtained with their method. Obtaining temperature distribution at the air impingement area on a fabric with even humidity distribution is important for industrial printing and dyeing production, and it will provide better guidance on the distribution and arrangement strategy for object drying with a multi-nozzle[13]. The following procedure provides details to study the heat and moisture transfer of a fabric during the impinging drying process. The initial moisture content is well-controlled to be evenly distributed, while the surface temperature at every point of the fabric is obtained via the experimental set-up.

The experimental set-up consists of a hot air blower unit, infrared thermograph unit, uniform padder system, and other auxiliary devices. The hot air blower unit supplies the hot air with a specified temperature and velocity in an adjustable direction according to the experimental requirements. The infrared thermograph unit records the temperature history of each impinging drying process; thus, the temperature at each pixel point of the recorded video can be extracted with a supporting post-processing tool. The uniform padder system controls the even distribution of moisture content at every point of the fabric. Finally, the influence of air impingement parameters on fabric drying characteristic with fabric moisture uniform control method are investigated. The process can be carried out in a reproducible fashion following the standard protocol described below.

PROTOCOL:

1. Experimental rig set-up

Note: See **Figure 1**.

1.1. Hot air blower unit

1.1.1. Ensure that the hot air blower is connected to the air nozzle through a high temperature resistant silicone pipeline that is heat-insulated with asbestos material. Gradually adjust the air nozzle to the desirable incline angle to control the air flow direction. For this work, the incline angle, α, varied between 60° and 90°.

1.1.2. Switch on the air blower fan and the resistance wire.

NOTE: The order in which the fan and resistance wire are turned on cannot be reversed.

1.1.3. Set the outlet temperature of the hot air blower by gradually adjusting the current through the resistance wire with the controller of the air blower, and measure the air flow temperature using the digital temperature sensor. For this work, the hot air temperature, *T*, varied between 70 °C and 130 °C.

1.1.4. Measure the air flow velocity at the outlet of the air nozzle using the handheld multifunctional anemometer at room temperature (RT). For this work, the hot air velocity, V_a, varied between 8–20 m/s. For accurate measurement of the air velocity, the probe should be perpendicular to the direction of the airflow.

1.1.5. Gradually adjust the rotation speed of the air blower fan with the frequency converter to obtain the desired air flow velocity. Cover the air nozzle with a high thermal resistance board to disperse the heat flow to avoid thermal damage to people or devices.

1.2. Infrared thermograph unit

1.2.1. Fix the infrared thermograph onto the support frame directly above the air nozzle with about a 1 m distance. Connect the infrared thermograph with the computer using the net cable. Power on the infrared thermograph and open the operation software of the infrared thermograph on the computer. Select the connection mode as Ethernet so an IP address is assigned automatically to the infrared thermograph by the computer, and the object temperature can be read in real-time with the infrared thermograph.

1.2.2. Fix a piece of standard fabric sample over the air nozzle with the needle plate fixture and adjust the distance between the air nozzle and sample to the desired value. In this work, 30 mm is used, which is 3x the diameter of the nozzle.

1.2.3. Adjust the focus of the camera and set basic parameters via the computer. Open the "parameters" dialog box, set the temperature unit to °C, set the thermal radiance to 0.95, set the ambient relative humidity to 50%, set the ambient temperature to 25 °C, and set the distance between the measured object and camera to 1.5 m. This will ensure that the measured temperature is correct.

1.2.4. As the tested fabric sample is prepared, fix it at the same location as the standard fabric sample, then record the temperature of the fabric with the computer as a video.

1.3. Uniform padder system

1.3.1. Make sure the uniform padder is connected to the air compressor through the pipeline. Power on the air compressor and set its maximum output pressure to 0.8 MPa.

1.3.2. Manually adjust the pressure regulators to control the air pressure to the couple of the clamp cylinders, which are connected to the upper roller of the padder, so that residual moisture in the fabric can be controlled. Ensure that the pressure on both sides of the roller are equal so that the moisture content of the fabric distributed over each area is even.

1.3.3. Power on the padder, make sure the roller can rotation freely, then put the saturated fabric sample with sufficient moisture absorption onto the upper roller of the uniform padder, so that the tested fabric can be squeezed through the roller couple and moisture distribution inside the fabric can be controlled to be uniform.

1.3.4. Power off the padder.

1.4. Weight and thickness measuring unit

1.4.1. Place an electronic scale on a horizontal platform and tare it. Place standard weights on the balance for calibration so that the specimen can be accurately weighted.

1.4.2. Cut out a rectangular fabric sample with a width and length of 10 cm and 31 cm, respectively. Power on the thickness testing instrument (see **Table of Materials**) and connect it to the computer. Place these fabric samples on the test platform of the FTT. Open the operation software of the FTT, click "start" on the operation interface, then automatically test the thickness of the fabric by the FTT and record it on the operation interface.

1.5. Drying stove unit

1.5.1. Power on the drying stove and make sure no samples are in the drying room. Set the drying stove to a high temperature (120 °C is used in this work) for 30 min to evaporate the moisture absorbed by the inner wall of the stove.

1.5.2. Preheat the drying stove to the desired temperature (45 °C is used in this work) so that the stove can be used directly for drying fabric samples.

2. Testing specimen and the manufacturing process

2.1. Cut out square fabrics of 250 mm x 250 mm from the same fabric used for the rectangular fabric sample with scissors and a triangle ruler for the manufacturing of test specimens (area of the fabric = 6.25×10^4 mm^2). Put the fabric specimens into the drying stove to evaporate the resident moisture absorbed from environment so that their net weight can be obtained.

2.2. Take out one piece of fabric specimen from the drying stove, then measure the initial weight, W_0, of the sample with the electronic balance.

2.3. Immerse the fabric sample in water for 5 min to ensure that the fabric absorbs the moisture until saturation. Tile the saturated fabric sample onto the upper roller of the uniform padder to obtain the desired even initial moisture content.

2.4. Power on the padder and set an initial pressure with the pressure regulators. As the tiled sample passes through the roller couple, power off the padder and remove the sample from the padder.

2.5. Measure the weight of the wet fabric sample, W_1, of the sample with the electronic balance. The residual moisture of the fabric can be calculated as $C = (W_1 - W_0)/W_0$, and the area average moisture content in the fabric can be calculated as $W_a = (W_1 - W_0)/A$.

2.6. If the desired moisture content, C_d, is not obtained, dry the rollers with a towel or paper towel first, and then repeat steps 2.4–2.5 until C_d is set.

2.7. If necessary, cut out a sample strip from the same fabric used for preparing the testing specimen, then measure and record its thickness.

3. Data acquisition, post-processing, and analysis

3.1. As done in step 1.1, set the outlet temperature and velocity of the air blower to the desired values and cover the nozzle with the high thermal resistance board. Once the tested fabric sample is prepared (section 2), fix it with the needle plate fixture for sequence testing and power on the infrared thermograph. Start to record the sample temperature.

3.2. Remove the covered board that the hot air can impinge on the lower surface of tested sample directly. Observe changes in the drying temperature of the fabric on the computer during the drying process. When the drying temperature increases to a steady value and lasts for approximately 30 s, which means the sampled fabric is dry to the target status, stop recording. Take the sample away from the fixture and cover up the nozzle with the high thermal resistance board again.

3.3. If necessary, set the target analysis area with a supporting post-processing tool for the infrared thermograph (for data plotting, saving, etc.) so that the drying features (normally how the temperature varies with time) of that point of the tested fabric can be obtained.

3.4. If necessary, navigate the video to the portion of different drying stages and save the video frame as a colorful image. Then, the area of the region dried by hot air can be calculated by the image processing method according to the following steps[14]. First, gray the colorful image with the weighted average method to grayscale the image, then binarize the obtained grayscale image with the OSTU method by setting the threshold to the grayscale value in which the temperature in the image is close to the hot air temperature. Thus, the area of the dried region can be calculated on the binarization image.

3.5. Repeat steps 3.1–3.4 and record the drying characteristics of each fabric sample by adjusting the air flow velocity, temperature, direction, as well as fabric material, physical parameters, etc.

3.6. Observe all differences under varying air temperature, air velocity, airflow direction, and fabric thickness.

REPRESENTATIVE RESULTS:

The data presented in **Figure 2** are typical temperature contours for cotton fabric at different drying stages under the condition that air velocity and temperature at the nozzle outlet are 20.0 m/s and 120 °C, respectively. It can be figured from **Figure 2A,B,C,D** that under the air impingement drying, temperature decays from the center to the periphery and forms sets of concentric circles. Meanwhile, temperature decays dramatically at the edge of the direct impingement area. The temperature distribution along an arbitrary trajectory can be drawn with the special supporting post-processing tool for the infrared thermograph. **Figure 2E** shows temperature along the fabric's horizontal center line at different stages in a typical drying process. This is caused by the fabric's high diffusion coefficient or thermal resistance in a horizontal direction, and even by extension of the drying time to 50 s; as shown, the temperature near the edge of the impingement area increases very little compared to that of the steady state (see **Figure 2C**; the drying process reaches steady state at approximately 20 s).

The historical data at each point of the video can also be plotted out with the post-processing tool. **Figure 3** illustrates some typical results measured at the center point of the impingement area under different initial conditions. **Figure 3A,B** shows the influence of air temperature and velocity on the drying process. Normally, the higher the temperature or velocity, the faster the fabric to be dried; however, air temperature influenced the temperature both at the constant-rate state and steady state, while air velocity only influenced the steady state temperature. **Figure 3C** shows the drying process for fabrics with the same initial area average moisture content when thickness is different. The uniform padder is important for controlling the moisture distribution in every corner of the fabric to be uniform. As the saturated moisture content of a thin fabric is apparently lower than that of a thicker one, then the desirable moisture content, C_d, of the thicker fabric in this situation is very difficult to set. Thus, the specimen should be processed with the padder two or more times.

Figure 3C reveals that the higher diffusion coefficient of thicker samples slows down the drying process. This is important for a multi-nozzle drying process because a designed system is always used to dry fabric with the same material but with different thickness. **Figure 3D** shows the drying process under different airflow directions, while **Figure 3E** shows the temperature contour under a steady state at 60 s. As revealed in **Figure 2,** the fabric temperature changes little after reaching the steady state, and the dried area can be calculated with the image processing method based on the temperature contour. The binarization results are shown as **Figure 3F**, in which the area in white represents the dried area and the ratio of these five states from 65° to 90° is 0.61:0.81:1.07:1.02:1.01:1. This is also caused by the fabric's high diffusion coefficient and fluid thermodynamic parameters in a horizontal direction, which is important in strategies for setting the drying time.

FIGURE LEGENDS:

Figure 1: Experimental rig. Shown is a schematic representation of the experimental rig, consisting of the hot air blower unit for supplying impingement air with different temperatures, velocities, and directions. Also represented is the uniform padder system used for controlling the even distribution of moisture content in every area of the fabric, infrared thermograph unit for recording the temperature history of each impinging drying process, and some auxiliary devices for measuring fabric weight, fabric thickness, and so on. The obtained results are then analyzed on the computer system.

Figure 2: The temperature contour of cotton fabric at different drying stages. Temperature contours are shown under the conditions V_a = 20.0 m/s, T = 120 °C, and C_d = 70%. **Figure 2A** shows the temperature contour at t = 0 s, while **Figure 2B,C,D** shows those at t = 5 s, 20 s, and 50 s. Legends P01, P02, P03, and P04 in each image show the temperature variation at different sampling points on the fabric in digital form. **Figure 2E** illustrates the temperature distribution along the horizontal fabric center line at different times.

Figure 3: Typical results measured at the center point of the impingement area under different initial conditions. Figure 3A shows the influence of air temperature at V_a = 20.0 m/s and C_d = 70%. **Figure 3B** shows the influence of air velocity at T = 120 °C and C_d = 70%. **Figure 3C** shows the influence of fabric with the same initial area average moisture content, W_a, of 48 g/m^2; however, their thickness was different at V_a = 20.0 m/s and T = 120 °C. **Figure 3D,E,F** show the influence of airflow direction at V_a = 20.0 m/s, T = 120 °C, and C_d = 70%.

DISCUSSION:

This section provides a few tips necessary to ensure reliable quantitative results. First, the fabric specimens must be kept completely dry to ensure the initial weights are correct. This is achievable through the drying process (i.e., using a suitable drying stove). If possible, an environment humidity that is kept constant benefits the experiment.

Secondly, the fabric specimens must be well-processed to ensure that the moisture at each region of the fabric is uniform. This can be done by manually processing with a uniform padder or similar process. The key for operating the uniform padder is to make sure that the air pressure supplied to the clamping cylinders on both sides of the upper roller are equal, which prevents a press force difference to the fabric.

Appropriate calibration of the infrared thermograph must be ensured to obtain an accurate temperature. Meanwhile, the temperature recording process is launched manually and several seconds ahead of removal of the high thermal resistance board, so users are also required to estimate how many frames should be skipped. This may vary among individuals, so several trial tests for practicing are recommended before taking actual measurements.

One limitation of the technique is that the fabric specimens are dried under an open environment, and the desired surrounding temperature and humidity cannot be set; thus, the experimental results do not directly reflect the drying processes under actual working conditions of a heat setting. The test rig is to be further improved for future work.

The reported procedure provides details to study the heat and moisture transfer of the fabric during the impinging drying process. The initial moisture content is well-controlled to be uniform, while the surface temperature at every point of the fabric is obtained via the developed set-up.

In summary, the procedure outlined in this report can be used to study the effects of air impingement parameters on a fabric’s drying characteristics by controlling the fabric moisture to a uniform status. It should be noted that the moisture distribution is normally ignored in current research of different fields, but it significantly influences the drying process and drying results. It is recommended that all steps of this protocol are performed in an environment without air convection to avoid any ambient-related degradation.

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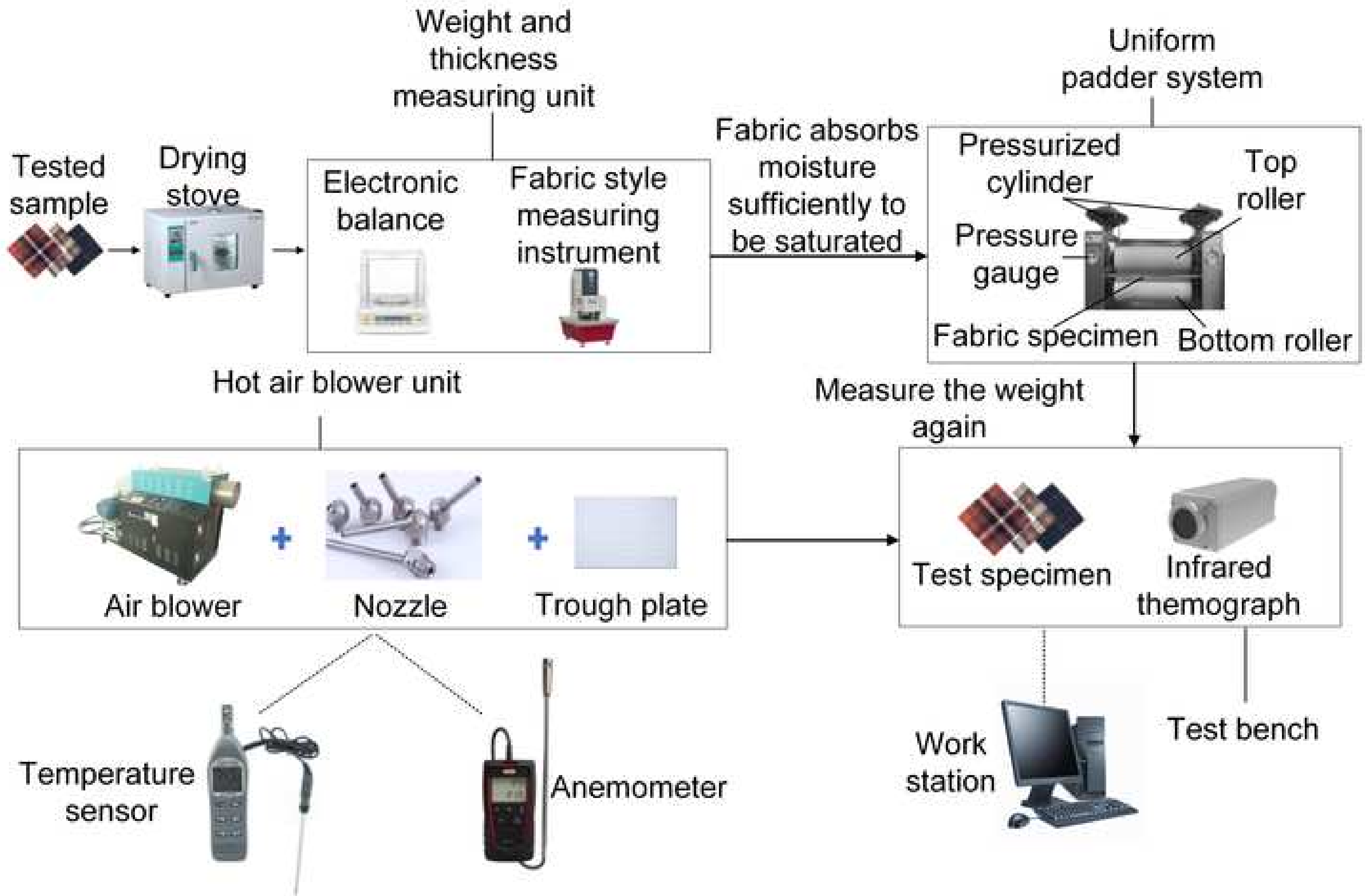
DISCLOSURES:

The authors have nothing to disclose.

REFERENCES:

1. Wang, G., Deng, Y., Xu, X. Optimization of air jet impingement drying of okara using response surface methodology. *Food Control.* **59**, 743-749 (2016).
2. Etemoglu, A. B., Ulcay, Y., Can, M., Avci, A. Mathematical modelling of combined diffusion of heat and mass transfer through fabrics. *Fibers and Polymers.* **10** (2), 252-259 (2009).
3. Di, M. P., Frigo, S., Gabbrielli, R., Pecchia, S. Mathematical modelling and energy performance assessment of air impingement drying systems for the production of tissue paper. *Energy*. **114** (2), 201-213 (2016).
4. Xiao, H. W. et al. Drying kinetics and quality of Monukka seedless grapes dried in an air-impingement jet dryer. *Biosystems Engineering*. **105** (2) 33-240 (2010).
5. Gu, M. Study on optimum temperature value setting for the heat-setting process based on PSO. 3rd International Conference on Advances in Energy, Environment and Chemical Engineering. (2017).
6. Aihua, M., Yi, L. Numerical heat transfer coupled with multidimensional liquid moisture diffusion in porous textiles with a measurable-parameterized model. *Numerical Heat Transfer Part A - Applications*. **56** (3), 246-268 (2009).
7. Angelova, R. A. et al. Heat and mass transfer through outerwear clothing for protection from cold: influence of geometrical, structural and mass characteristics of the textile layers. *Textile Research Journal*. **87** (9), 1060-1070 (2017).
8. Wei, Y., Hua, J., Ding, X. A mathematical model for simulating heat and moisture transfer within porous cotton fabric drying inside the domestic air-vented drum dryer. *The Journal of The Textile Institute.* **108** (6), 1074-1084 (2016).
9. Cay, A., Gurlek, G., Oglakcioglu, N. Analysis and modeling of drying behavior of knitted textile materials. *Drying Technology.* **35** (4), 509-521 (2017).
10. Neves, S. F., Campos, J. B. L. M., Mayor, T. S. On the determination of parameters required for numerical studies of heat and mass transfer through textiles – Methodologies and experimental procedures. *International Journal of Heat and Mass Transfer*. **81**, 272-282 (2015).
11. Sousa, L. H. C. D., Motta, Lima O. C., Pereira, N. C. Analysis of drying kinetics and moisture distribution in convective textile fabric drying. *Drying Technology*. **24** (4), 485-97 (2006).
12. Wang, X., Li, W., Xu, W., Wang, H. Study on the Surface Temperature of Fabric in the Process of Dynamic Moisture Liberation. *Fibers and Polymers*. **15** (11), 2437-40 (2014).
13. Qian, M., Wang, J. H., Xiang, Z., Zhao, Z. W., Hu, X. D. Heat and moisture transfer performance of thin cotton fabric under impingement drying. *Textile Research Journal.* https://doi.org/10.1177/0040517518807446 (2018).
14. Rafael C. G., Richard, E. W. Digital image processing: 3rd edition. NJ, Englewood Cliffs:Prentice-Hall, 2007.


Weight and thickness measuring unit
Uniform padder system
Tested sample
Drying stove
Electronic balance
Fabric style measuring instrument
Fabric absorbs moisture sufficiently to be saturated
Pressurized cylinder
Top roller
Pressure gauge
Fabric specimen
Bottom roller
Hot air blower unit
Measure the weight again
Air blower
Nozzle
Trough plate
Test specimen
Infrared themograph
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Anemometer
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Figure

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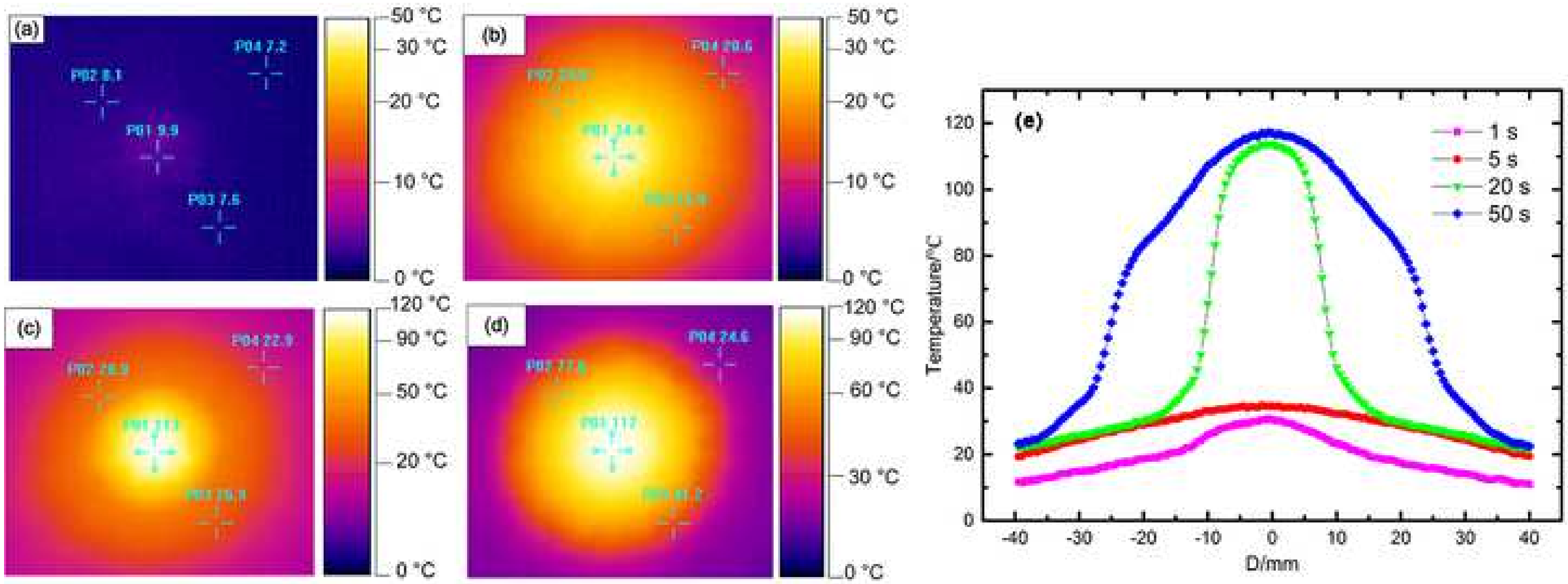

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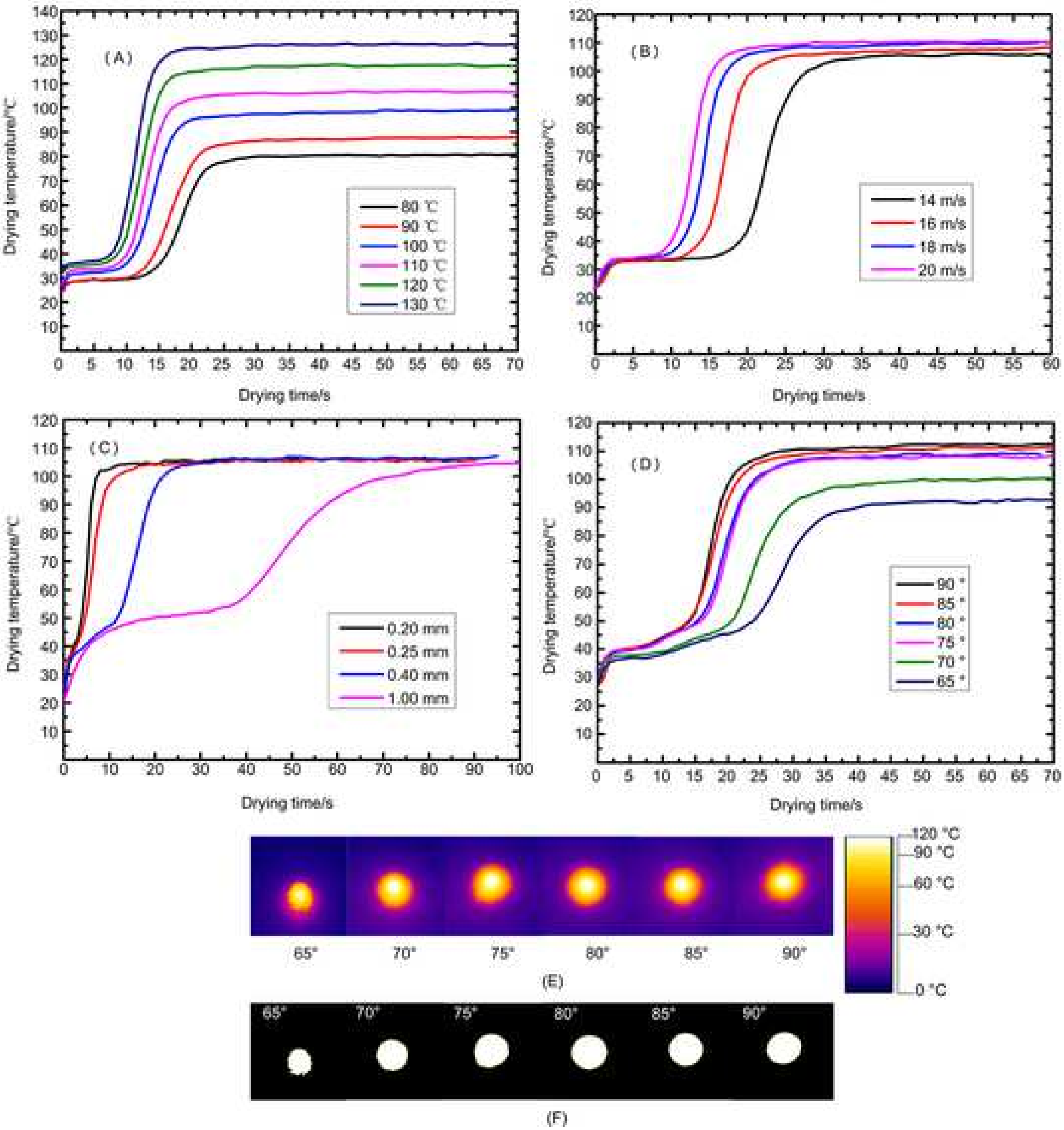

Name of Material/ Equipment	Company	Catalog Number
Air Blower	Zhejiang jiaxing hanglin electromechanical equipment co., Ltd.	HLJT-3380-TX10A-0.55
Anemometer	KIMO	MP210
Drying stove	Shanghai Shangyi Instrument Equipment Co., Ltd.	DHG 101-0A
Electronic Balance	Hangzhou Wante Weighing Instrument Co., Ltd.	WT1002
Fabric Style Measuring Instrument	SDL Atlas	M293
Fabric Touch Tester	SDLATLAS Ltd .	
High thermal resistance board	Baiqiang	
High-temperature resistant silicon pipeline	Kamoer	18#
Infrared Thermogragh	Hangzhou Meisheng Infrared Optoelectronic Technology Co., Ltd.	R60-1009
Padder	Yabo textile machinery co., Ltd.	
Personal Computer	Lenovo Group.	L460
Temperature Sensor	Taiwan TES electronic industry co., Ltd.	1311A

Comments/Description

Air Volume: 900 m^3/s;

Measurement range: 0-40 m/s; Accuracy: ±0.1 m/s

precision: 1 °C; Temperature control range:10-300 °C

Precision: 1 °C; Range: 100 g

Fabric thickness tester
Flame resistance, Heat resistance is greater than 200 °C

Temperature range: -60-200 °C

Temperature measuring range: -20-410 °C; Maximum measuring error: ±2 °C

Roller pressure: 0.03-0.8 MPa; Stable pressure; Easy adjustment

resolution: 1 °C; Temperature measuring range: -50-1350 °C

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Signature:	Qian Miao	Date:	Dec. 8, 2018

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Journal Name: JoVE
Manuscript Number: JoVE59522
Manuscript Title: Fabric Moisture Uniform Control to Study the Influence of Air Impingement Parameters on Fabric Drying Characteristic

Answers to Editor's Comments

The authors truly appreciate the editor for your time and feedback. We have made several major revisions along with your guidelines to improve the quality of the paper. Please find the detailed answers to the editor's comments below.

Editor(s)' Comments to Author:

Comments to the Author

1. Summary: "obtain the even initial moisture distribution inside the fabric" and "fabric drying characteristic" are unclear.

Answer: Thanks for your suggestion. The summary of the manuscript has been modified thoroughly.

All the changes were highlighted by using red text in the revised manuscript.

2. 1.2.1: "the camera is just rightly hovering over the center of the air nozzle" is unclear.

Answer: The sentence has been modified in the revised manuscript.

3. 1.2.2: How exactly is the IP address assigned? Is there e.g. an interface on the thermograph?

Answer: Thanks for your suggestion. Yes, there is an interface on the thermograph, and the operation software is on the computer. The IP address is assigned automatically by the computer. The content in 1.2.2 has been amended and combined with 1.2.1 in the revised manuscript.

4. 1.2.4: How exactly are the parameters set? Please include specific instructions like 'click', 'select', etc.

Answer: Open the parameters set dialog box, set the temperature unit as ℃, set the thermal radiance as 0.95, set the ambient relative humidity as 50 %, set the ambient temperature as 25 ℃ and set the distance between the measured object and the camera as 1.5 m. The content for the parameter set has been added in the revised manuscript.

5. 1.4.2: The fabric described here does not appear to be 'L'-shaped but rather a rectangle. Also, how is the thickness measured?

Answer: Thanks for your suggestion. The 'L-shaped' fabric is used for the thickness measurement while the rectangle fabric is used for drying experiments. They are from the same fabric, so the thickness of the rectangle fabric can be obtained by measuring the thickness of the 'L'-shaped fabric. The corresponding content has been amended in 1.4.2 and 2.1.

The thickness measurement method is as follow: Make L shape fabric samples with width and length set to be 10 cm and 31 cm from a big fabric, respectively. Power on Fabric Touch Tester (FTT) of SDLATLAS Ltd. for fabric thickness measuring and connect it with the computer. Place these fabric samples on the test platform of the FTT. Open the operation software of the FTT, click 'start' on the operation interface, then automatically test the thickness of the fabric by the FTT and record it on the operation interface.

6. 3.6: This is vague-which conditions?

Answer: Thanks for your suggestion. The content of 3.6 has been modified as 'Observe all differences under different air temperature, different air velocity, different airflow direction and different fabric thickness'

Journal Name: JoVE
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Answers to Editor's Comments

The authors truly appreciate the editor for your time and feedback. We have made several major revisions along with your guidelines to improve the quality of the paper. Please find the detailed answers to the editor's comments below.

Editor(s)' Comments to Author:

Comments to the Author

1. There are still many unclear points (some are commented on in the manuscript); please proofread thoroughly.

Answer: Thanks for your suggestion. The manuscript has been proofread thoroughly.

All the changes were highlighted by using red text in the revised manuscript.

2. It is currently unclear how exactly you get from the protocol to the results-there is only a vague reference to an 'image processing method' in step 3.5. Is this the method described in reference 13? At least, you need to explicitly mention this in the protocol and/or results via citations; brief descriptions of how this was done may be helpful as well.

Answer: The method is not the one described in reference 13. The description of the method has been added in the manuscript, and a new reference has also been added in the revised manuscript.

3. Please combine all panels of each figure into a single image file (note that we do not have a page size limit on figures); there should be 3 total.

Answer: Thanks for your suggestion. The panels have been combined into 3 image files named Figure 1, Figure 2, and Figure 3 in the revised manuscript.

4. Figure 1: Some captions are running into each other (e.g., 'Electronic balance' and 'Fabric style measuring instrument'); please make sure captions are distinct. Also, please correct 'anemomter' to 'Anemometer' (including capitalization of the 'A').

Answer: The mistakes in Figure1 have been corrected in the revised manuscript.

5. Figure 2: What are the crosshairs and 'P01' etc. values? Please explain in the legend. Also, is the 'center line' horizontal or vertical?

Answer: Thanks for your suggestion. 'P01, P02, P03, P04' are IDs of the sampling points at different positions on the fabric. The values such as 113, 28.9 are the temperature of the sampling points. The explanation of the crosshairs and 'P01' etc are also added in the Figure Legends of revised manuscript.

The 'center line' is horizontal and the content has been added in the line 204 of the revised manuscript

6. Figure 3: What temperature were the experiments depicted in panels B-F performed at?

Answer: Thanks for your suggestion. The experiments depicted in panels B-F performed at 120 ℃. The temperature and other experimental parameters are added in Figure Legends.

7. Some materials seem to be missing from the Table of Materials, namely, the high-temperature resistant silicon pipeline in 1.1.1 and the high thermal resistance board in 1.1.5. Please check that all materials in the protocol are in the Table of Materials.
Answer: Thanks for your suggestion. The missing material has been added in the Table of Materials.

Journal Name: JoVE

Manuscript Number: JoVE59522

Manuscript Title: Fabric Moisture Uniform Control to Study the Influence of Air Impingement Parameters on Fabric Drying Characteristic

Answers to Reviewers' and Editor's Comments

The authors truly appreciate the reviewers and editor for your time and feedback. We have made several major revisions along with your guidelines to improve the quality of the paper. Please find the detailed answers to the reviewers' and editor's comments below.

Editor(s)' Comments to Author:

Comments to the Author

1.Please take this opportunity to thoroughly proofread the manuscript to ensure that there are no spelling or grammar issues. The JoVE editor will not copy-edit your manuscript and any errors in the submitted revision may be present in the published version.

Answer: Thanks for your suggestion. The language has been carefully checked and the grammar errors as we found have been corrected in the revised manuscript.

All the changes were highlighted by using red text in the revised manuscript.

2. Affiliations: Please provide an institutional email address for each author.

Answer: The institutional email address for each author has been provided in the revised manuscript.

3. Please add a Summary section before the Abstract section to clearly describe the protocol and its applications in complete sentences between 10-50 words: "Here, we present a protocol to …"

Answer: The Summary section has been added before the abstract section of the revised manuscript.

4. Please upload each Figure individually to your Editorial Manager account as a .png, .tiff, .pdf, .svg, .eps, .psd, or .ai file.

Answer: Each Figure has been uploaded to Editorial Manager as individual file.

5. Figure 1: Please fix the typo "measuringunit".

Answer: The typo "measuringunit" has been modified as "measuring" in Figure 1 of the revised manuscript.

6. Figure 2: Please add a label to the right panel. Please include a space between numbers and their units (1 s, 5 s, 20 s, 50 s).

Answer: The label has been added to the right panel in Figure 2. A space between numbers and their units has been also added in the revised manuscript.

7. Figure 3: Please include a space between numbers and their units (80 °C, 14 m/s, 0.20 mm, etc.). Please describe panel F in the figure legend.

Answer: A space between numbers and their units is added in the revised manuscript. The figure legend is also added in panel F.

8. Please add more details to your protocol steps. There should be enough detail in each step to supplement the actions seen in the video so that viewers can easily replicate the protocol. Please ensure you answer the "how" question, i.e., how is the step performed? Alternatively, add references to published material specifying how to perform the protocol action. See examples below.

Answer: More details to protocol steps has been added in the revised manuscript.

The changes were highlighted by using red text in the revised manuscript.

9. 1.3.4: When and how is the fabric tested?

Answer: When the fabric adsorbed water until saturated for 5 minutes, the fabric starts to test. Power on the padder, make sure the roller can rotation freely and then the saturated fabric sample was put between the two roller of the padder, and moved with the roller. Then the water is squeezed out from the fabric and the moisture content distribution become even.

The content is added in the revised manuscript.

10. 1.4.2: When is the specimen measured? Please mention it.

Answer: W_0 of the specimen is the initial weight of dry fabric, and measured at the beginning of the experiments. W_1 is the initial weight of wet fabric and measured after the specimen went through the roller couple of the uniform padder system.

11. 1.4.3: Please describe how to measure the fabric thickness.

Answer: Power on fabric style measuring instrument for fabric thickness measuring, and connect the computer to the machine. Make L shape fabric samples with width and length set to be 10 cm and 31 cm, respectively. Place fabric samples on the FTT and then test and record the thickness of the fabric.

The content has been added in the revised manuscript.

12. 1.5.3: Are the fabric samples placed in the drying stove? Please mention such details.

Answer: No. The drying stove is set to the desired temperature before experiments, and then when the test specimens are all prepared, they can be put into the stove for drying at a time directly.

13. 2.1: What is used to cut?

Answer: The scissors is used to cut the fabric.
The content is added in the revised manuscript.

14. 3.2: This statement is unclear.
Answer: The statement has been modified in the revised manuscript.

15. Please combine some of the shorter Protocol steps so that individual steps contain 2-3 actions and maximum of 4 sentences per step.
Answer: The shorter Protocol has been combined in the revised manuscript.

16. Please apply single line spacing throughout the manuscript, and include single-line spaces between all paragraphs, headings, steps, etc.
Answer: The single line spacing has been applied throughout the manuscript in the revised manuscript.

17. After you have made all the recommended changes to your protocol (listed above), please highlight 2.75 pages or less of the Protocol (including headings and spacing) that identifies the essential steps of the protocol for the video, i.e., the steps that should be visualized to tell the most cohesive story of the Protocol.
Answer: The Protocol has been highlighted by brighting the text with yellow color in the revised manuscript.

18. Please highlight complete sentences (not parts of sentences). Please ensure that the highlighted part of the step includes at least one action that is written in imperative tense. Notes cannot usually be filmed and should be excluded from the highlighting.
Answer: The complete sentences has been highlighted in the revised manuscript.

19. Please include all relevant details that are required to perform the step in the highlighting. For example: If step 2.5 is highlighted for filming and the details of how to perform the step are given in steps 2.5.1 and 2.5.2, then the sub-steps where the details are provided must be highlighted.
Answer: The relevant details that are required to perform the step has been highlighted in the revised manuscript.

20. Discussion: Please describe the significance with respect to existing methods.
Answer: In this report, we develop an experimental procedure in detail to study the heat and moisture transfer of the fabric during the impinging drying process. Previous studies on fabric drying have neglected the contributions of moisture uniformity and diffusion coefficient to the drying process, while they have recently been shown to have a significant influence on the drying characteristics. In this report, the initial moisture content can be well controlled to be even, while the surface temperature at every part of the fabric can be obtained with the developed experimental set-up.

21. Please ensure that the references appear as the following: [Lastname, F.I.,

LastName, F.I., LastName, F.I. Article Title. Source. Volume (Issue), FirstPage – LastPage (YEAR).] For more than 6 authors, list only the first author then et al. Please do not abbreviate journal titles. See the example below:

Bedford, C.D., Harris, R.N., Howd, R.A., Goff, D.A., Koolpe, G.A. Quaternary salts of 2-[(hydroxyimino)methyl]imidazole. Journal of Medicinal Chemistry. 32 (2), 493-503 (1998).

Answer: The references have been amended in the revised manuscript.

22. Table of Materials: Please ensure the Table of Materials has information on all relevant supplies, reagents, equipment and software used, especially those mentioned in the Protocol. Please sort the items in alphabetical order according to the name of material/equipment.

Answer: The Table of Materials has all information and the items in alphabetical order have been sorted according to the name of material/equipment in the revised manuscript.

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author

1.Line 112, Protocol 1.2.4: The distance between the air nozzle and the fabric is an adjustable parameter during the experiment. If possible, the authors should specify what distance they used.

Answer: The authors appreciate the reviewer's interest in the paper and thank you for your valuable suggestions. In this paper, firstly the even initial moisture content was obtained by using a uniform padder system, then the effects of hot air velocity, hot air temperature, airflow direction, and fabric thickness on the drying performance of the fabric were studied. During the course of the experiments, the distance between the air nozzle and the fabric is a definite value. In this manuscript, it is set as 30 mm, which is 3 times the diameter of the puzzle.

2. Line 152, Protocol 2.4: What was the time necessary to saturate the cotton fabric samples? This information would be interesting to replicate the experiment.

Answer: Thank you for your valuable suggestions. The cotton fabric was immersed into water **for 5 minutes** to ensure that the fabric adsorbs the moisture sufficiently and saturates.

3. Line 157, Protocol 2.7: What is A in the equation: W_a=(W_1-W_0)/A ?

Answer: *A* is the area of the fabric，$A = 6.25 \times 10^4$ mm^2**.** It is shown in protocol 2.1.

4. Line 160, Protocol 2.8: What was the initial desirable moisture content the authors

set?

Answer: The authors appreciate the reviewer's interest in the paper. To study the effects of fluid flow and its parameters on the drying process for various fabric samples, the initial moisture content of different fabric should be specified as the same value. Thus, at the beginning of the experiments, a fixed value of the initial moisture content is set. In the protocol 2.8, the desirable moisture content was the set value by experiment design. And the desirable values in protocol 2.8 were obtained through protocol 2.6 and 2.7. In this manuscript, the initial moisture contents are specified in the Figure Legends.

5. Line 171, Protocol 3.4: What was the final moisture content on the fabric? Did the authors measure the weight of the fabric during the drying process until the target status was reached?

Answer: The authors appreciate the reviewer's interest in the paper. From Figure 3a – 3d, it can be found that the trend curve of the drying temperature of fabric versus the drying time includes four stages. The moisture mainly vaporized at the second stage where the drying temperature keeps at a lower constant value. When the fabric is almost dried out, the drying temperature rises quickly to a higher steady value. When this situation lasts for approximately 30 s, we can conclude that the fabric has become totally dried, and the final moisture content at this region of the fabric is closed to be zero. For more details, please refer to our previous study published online (*Qian, M., Wang, J.H., Xiang, Z., Zhao, Z.W., Hu, X.D. Heat and moisture transfer performance of thin cotton fabric under impingement drying. Textile Research Journal. (2018). https://doi. org/10.1177/0040517518807446.*).

It is very hard to measure the weight of the fabric during the drying process. The mass of the moisture fabric itself is usually very small, less than 10 g for example, not to mention the water evaporated during the drying process, less than 1 g for example. What makes this more complex is that during the drying process, the hot air blew to the fabric generates an unavoidable large disturbance on the measurement results that accurate results are difficult to be obtained. Thus, the authors did not measure the weight of the fabric during the drying process.

6. Line 177, Protocol 3.7: I suppose the water evaporated during drying process is calculated as: ΔW= W_2-W_1, where W_1 is the initial saturated fabric mass and W_2 is the final mass (after fabric was dried).

Answer: Thank you for your useful suggestions. In the revised manuscript, the equation has been modified as $\Delta W = W_2 - W_1$, where W_1 is the initial saturated fabric mass and W_2 is the final mass (after fabric was dried).

7. Line 258: It is important to specify the room temperature and air humidity during the experiments, even if the authors could not control these parameters.

Answer: Your suggestion is very useful for improving my quality of the manuscript. The authors will specify the room temperature and air humidity during the experiments.

8. Line 219: Authors should emphasize that not only the diffusion coefficient of the fabric is related to the dried area, but also the fluid flow and its parameters (e.g. air velocity, nozzle geometry etc).

Answer: Thanks for your useful suggestion. Indeed, not only the diffusion coefficient but also the fluid flow and its parameters are related to the dried area. In the revised manuscript, the effect of the fluid flow and its parameters is emphasized.

9. Line 235, Figure 3: Figure 3A is showing influence of air temperature and 3B is showing influence of air velocity.

Answer: The authors appreciate the reviewer's interest in the paper and thank you for your valuable suggestions.

Reviewer: 2

Comments to the Author

1. Line95-96, please specify the size difference between the diameter of the nozzle and handheld multifunctional anemometer probe. Please also specify the distance between the outlet of the nozzle and the probe.

Answer: The authors appreciate the reviewer's interest in the paper and thank you for your valuable suggestions. The diameter of the nozzle is 10 mm, and the diameter of the anemometer probe is very small, less than 1mm, so the size difference between the diameter of the nozzle and handheld multifunctional anemometer probe is 8 mm.

When measuring the air flow velocity, the probe contacts the nozzle outlet to ensure accurate measurements.

2. As the hot air temperature between 70 and 130 ℃, does the temperature effect on the accuracy of the anemometer?

Answer: Thanks for the reviewer's useful suggestion. The air velocity was measured at specified room temperature, did not measured under different hot air temperature, so the accuracy of the anemometer is reliable.

3. Please add a colorbar in Fig.2 to show the temperature values.

Answer: Thanks for your suggestion. In the revised manuscript, the colorbar has been added to show the temperature values in Fig.2.

4. Could you please add another figure to demonstrate the fabric moisture changes against drying time?

Answer: Thanks for your suggestion. It is very hard to measure the weight of the fabric during drying process. The authors did not measure the fabric moisture changes against drying time via experiments, thus this figure did not been added in revised manuscript.

Reviewer: 3

Comments to the Author

1. The paper contains many grammatical errors. The text, in general, is very fragmented and therefore very hard to follow.

Answer: The authors appreciate the reviewer's interest in the paper and thank you for your valuable suggestions. The language has been carefully checked and the grammar errors have been corrected in the revised manuscript.