Study on Test of Color Fastness to Rubbing of Textiles

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Abstract: The textile sample is rubbed with a dry friction cloth and a wet friction cloth respectively to evaluate the staining degree of the friction cloth. The tester for color fastness to rubbing provides two sets of test conditions through two friction heads of optional sizes: one for pile fabrics; The other is used for monochrome fabrics or large-area printed fabrics. Through the analysis of the original test method, the existing problems and defects of the original test method are obtained. A substitute material is used on the tester platform for testing samples, and the fixation method of the tester's samples is improved in a pawn type, so as to solve the problem of uneven staining of friction cloth caused by uneven surface of friction head or friction medium and unilateral wear during friction.

1. Introduction
Color fastness to rubbing of textiles is a common and necessary test method for staining and pigment firmness of textiles. Different fibers, different pigments, Its pigments have different staining and firmness, In the clothing of the daily public, there is often a large area of color fading of some fabrics. When the clothes are scrubbed and rubbed, the overall color tone is inconsistent, which greatly damages the overall beauty of the clothes. Therefore, it is very necessary to test the color staining degree and firmness of textile pigments caused by friction. At present, the method for testing the color fastness of textiles to rubbing is to test the friction resistance of textiles by wrapping friction cloth on the friction head and placing it on a testing instrument padded with 600 mesh water-resistant fine sandpaper or a metal test platform with a diameter of 1mm and a mesh width of about 20mm. The friction cloth tested by this method will often have a deep and a shallow stained surface, which not only cannot well reflect the color fastness to rubbing of textiles under fixed pressure, but also will cause misjudgment of the stained grade of the sample. In order to overcome the defects and existing problems of the existing detection methods and technologies, the author studied a substitute medium and a new design structure for testing the color fastness to rubbing of textiles, and explored and studied the detection method for the color fastness to rubbing of textiles.

2. Equipment and Materials for Testing Color Fastness to Rubbing of Textiles

2.1 Color fastness to rubbing tester (as shown in Fig. 1), with metal friction heads of two optional sizes for reciprocating linear friction motion.

2.1.1 For pile fabrics: The size of the friction head on the rectangular friction surface shall be 19 mm × 25. 4mm. The friction head shall be applied to the downward direction of (9 ± 0.2) N and the linear reciprocating distance shall be (104 ± 3) mm.
2.1.2 For other textiles: The friction head consists of a cylindrical shape with a diameter of \(16 \pm 0.1\) mm, applied with a downward pressure of \(9 \pm 0.2\) N and a linear reciprocating distance of \(104 \pm 3\) mm.

2.2 Cotton friction cloth, in accordance with the national standard GB/T7568.2, is cut into \((50 \text{ mm} \pm 2 \text{ mm}) \times (50 \text{ mm} \pm 2 \text{ mm})\) squares for the friction head of 1.1. 2, and cut into \((25 \text{ mm} \pm 2 \text{ mm}) \times (100 \text{ mm} \pm 2 \text{ mm})\) rectangles for the friction head of 1.1. 1.

2.3 Gray cards shall be used for evaluation of staining, in accordance with GB/T251.

2.4 Water-resistant sandpaper and metal mesh with a diameter of 1mm and a mesh width of about 20mm are replaced by 1cm thick rubber elastic blocks and 6 inverted conical minions with a diameter of 0.5 cm (as shown in Fig. 1).

![Figure 1: Schematic diagram of tester for color fastness to rubbing](image)

3. Sample preparation

3.1 If the tested textile is fabric or carpet, two groups of samples with a size of 50 mm × 140 mm shall be prepared for dry friction test and wet friction test respectively. Each group has two samples, and the length direction of the samples is parallel to the longitude direction or the latitude direction respectively.

3.2 If the tested textile is yarn, weave it into a fabric with a sample size of not less than 50 mm × 140 mm. Or wrap the yarn parallel to the cardboard with the same sample size along the length direction of the cardboard, and make the yarn evenly spread into a layer on the cardboard.

3.3 Before the test, place the sample and friction cloth in the standard atmosphere specified in GB/T6529 for debugging for at least 4h. For fabrics such as cotton or wool, longer moisture conditioning time may be required.

4. Dry and wet friction test

4.1 Dry friction: Place the square of the humidity-adjusted friction cloth (as shown in 1.2) on the friction head so that the meridian direction of the friction cloth is consistent with the running direction of the friction head. The running speed is 1 reciprocating friction cycle per second, with a total of 10 cycles of friction. The motion of friction on the dried specimen was \(104 \pm 3\) mm and the downward
pressure applied was \((9 \pm 0.2)\) N (as shown in 1.1.1 and 1.1.2). Remove the friction cloth, humidify it according to 2.3, and remove any excess fibers from the friction cloth that may affect the rating.

4.2 Wet friction: Weigh the friction cloth after humidity adjustment, immerse it completely in distilled water, and weigh the friction cloth again to ensure that the moisture content of the friction cloth reaches 95%-100%. Then follow 3.1.

5. Drying and evaluation

5.1 Dry the wet friction cloth for evaluation.

5.2 During evaluation, three layers of friction cloth shall be placed on the back of each evaluated friction cloth (as shown in 1.2); Under a suitable light source, use a gray sample card for evaluating staining (as shown in 1.3)

6. Disadvantages of water-resistant sandpaper and metal mesh with a diameter of 1mm and a mesh width of about 20mm

6.1 Colour fastness to rubbing Study on the Fixing Effect of Water-resistant Sandpaper and Metal Mesh with a Diameter of 1mm and a Mesh Width of about 20mm

6.1.1 Solidification Analysis of Water Resistant Sandpaper
The water-resistant sandpaper used for color fastness to rubbing is used to fix the sample and prevent it from moving during rubbing. Water-resistant sandpaper relies on increasing friction resistance to achieve the effect of fixing the sample. The water-resistant sandpaper is static friction relative to the friction head, and the friction head is sliding friction relative to the water-resistant sandpaper. Both of them are doing useful work on each other. The conditions for friction are: the first condition is that the two objects are in contact with each other and have pressure; The necessary condition is that the objects in contact with each other should have relative motion trend or have relative motion. Both the water-resistant sandpaper and the friction head meet the above conditions, That is to say, as the medium for fixing the sample, The water-resistant sandpaper is rubbed with the friction head and the specimen from the beginning to the end of the friction. However, water-resistant sandpaper relies on friction resistance to fix the sample. As the frequency of friction increases, the friction resistance of water-resistant sandpaper decreases due to friction loss. Therefore, water-resistant sandpaper is unstable and unideal as a fixing medium for textile color fastness to friction.

6.1.2 Fixation analysis of metal mesh with a diameter of 1mm and a mesh width of about 20mm
The metal mesh with a diameter of 1mm and a mesh width of about 20mm used for color fastness to rubbing is also used as a medium for fixing the sample to prevent movement during rubbing. Compared with water-resistant sandpaper, metal mesh is not suitable as a fixing medium for textile color fastness to rubbing. First of all, the surface of the metal mesh is smoother than that of the water-resistant sandpaper. Although there are many metal mesh holes, the adhesion to cloth and fibers is not as strong as that of the water-resistant sandpaper. Although the friction loss is slightly lower than that of the water-resistant sandpaper, the fixing effect of the metal mesh surface will be worse than that of the water-resistant sandpaper after long-term use and friction. Secondly, the metal mesh is used as the fixed medium. Due to the concave and convex mesh in the plane, the uniform reciprocating motion of the friction head is not very smooth, and the imagination of sticking occasionally appears. Therefore, it is not ideal to use metal mesh as the fixing medium for the color fastness to rubbing of textiles.

6.2 Colour fastness to rubbing Study on the staining effect of rubbing cloth with water-resistant sandpaper and metal mesh with a diameter of 1mm and a mesh width of about 20mm
6.2. 1 Analysis of color fastness to rubbing and staining effect using water-resistant sandpaper

Water-resistant sandpaper is a hard medium with abrasion resistance. If it is used to fix the sample or as a medium for friction movement with the friction head, it will wear the sample itself and the friction head. The friction head is of metallic nature, Water-resistant sandpaper is an abrasive hard medium with certain friction resistance, If the two hard media carry out sliding friction, the increasing number of friction times will inevitably lead to a rapid decline in the quality of the contact media of the friction, thus affecting the flatness of the friction plane, the downward pressure exerted by the friction, and the uniform stress of the sample on the friction head. According to the friction samples with different thicknesses, two friction cloth will be stained with different shades. The thinner the friction sample, the more obvious the shades of the same friction cloth will be stained. The specific situation is shown in Figure 3 below:

| Table 1 Dark and Light Colors of the Same Friction Cloth |
|--------------------------------------------------------|
| Resistance to dry and wet friction | Cotton corduroy (purplish red) | Wool knitted fabric (brown) | Cotton woven fabric (black) | Polyester woven fabric (black) |
|------------------------------------|-------------------------------|-----------------------------|-------------------------------|-------------------------------|
| Dry friction                       | Meridional direction          | 4                           | 4                            | 4                             | 4-5                          | 3                            | 4                            |
|                                    | Latitudinal direction         | 4                           | 4                            | 4-5                          | 4                             | 4-5                          | 3                            | 4                            |
| Wet friction                       | Meridional direction          | 2                           | 3-4                          | 4                            | 2-3                          | 3                             | 2-3                          |
|                                    | Latitudinal direction         | 2                           | 3-4                          | 4                            | 2-3                          | 4                             | 2-3                          |

To sum up, the thicker the specimen used in the friction test, Friction cloth after friction is not easy to produce the same friction cloth dark staining situation, The thinner the sample, the easier it is to produce different shades of staining on the same friction cloth. In fact, that is to say, the friction between two rigid friction media is more likely to lead to uneven and unbalanced stress on the friction surface, and it is easy to form friction points instead of friction surfaces. Therefore, the use of water-resistant sandpaper for the color fastness to friction of textiles is also defective.

6.2.2 Analysis of color fastness to rubbing and staining effect using metal mesh with diameter of 1mm and mesh width of about 20mm

As for that color fastness of textile to rubbing, it is not ideal to use metal mesh as the medium to fix the sample. In addition to the easy occurrence of jamming and jamming in the friction process, After rubbing, the rubbing cloth will often leave mesh marks, which is extremely easy to cause misjudgment of color fastness grade in the evaluation process. Therefore, the metal mesh with a diameter of 1mm and a mesh width of about 20mm is not ideal for the color staining effect of the rubbing head. Generally, it is not recommended to choose a diameter of 1mm and a mesh width of about 20mm Metal mesh for testing.

7. Improvement of Fixing the Sample of Textile Color Fastness to Rubbing and Improving the Full Contact between the Friction Head and the Sample and Uniform Stress

7.1 The pawn type fixed sample is adopted, i.e. 6 inverted conical pawns with a diameter of 0.5 cm are added to the fixed rotating rod of the sample (as shown in Fig. 2). The pawns can be pushed up and
down, and 6 inverted conical holes with a diameter of 0.5 cm are accurately distributed at the corresponding positions at the bottom, which coincide with the pawns in good condition. In this way, when the sample is clamped on the fixed rotating rod, the sample is locked through 6 inverted conical minions to enhance the fixing force of the sample on the test bench, so that the sample can be well locked in the friction reciprocating process and the phenomenon of sample displacement can be prevented.

![Off-conical pawn 0.5 cm in diameter](image)

**Figure 2** Schematic Diagram of Inverted Conical Pawn

7.2 Insert 1cm thick rubber elastic blocks (as shown in Fig. 3) into the surface layer of the original metal test bed. The adhesive force between the base of the test bed and the friction head is increased, Absorbing the uneven factors on the surface of the sample and the surface of the friction sleeve, Strengthen the uniform stress between the friction head and the sample, make the friction surface of the friction head contact with the sample more appropriately, make the friction cloth obtain more uniform sample staining, eliminate uneven point friction formed by factors such as the friction head, the sample, the test bench, etc., enhance the effect of surface friction, and solve the phenomenon of deep and light staining of the same friction cloth.
| Resistance to dry and wet friction | Cotton corduroy (purplish red) | Wool knitted fabric (brown) | Cotton woven fabric (black) | Polyester woven fabric (black) |
|-----------------------------------|--------------------------------|-----------------------------|-----------------------------|-------------------------------|
| **Dry friction**                  |                                |                             |                             |                               |
| Meridional direction              | 4                              | 4                           | 4                           | 3-4                           |
| Latitudinal direction             | 4                              | 4                           | 4                           | 3-4                           |
| **Wet friction**                  |                                |                             |                             |                               |
| Meridional direction              | 2                              | 3-4                         | 3                           | 3                             |
| Latitudinal direction             | 2                              | 3-4                         | 3                           | 3                             |

8. Conclusion
(1) The color fastness to rubbing of textiles uses water-resistant sandpaper as the medium for fixing samples. With the increasing frequency of use, the repeated rubbing between the friction head and the water-resistant sandpaper reduces the friction resistance of the water-resistant sandpaper, thus making the fixing effect show a decreasing effect; When a metal mesh with a diameter of 1mm and a mesh width of about 20mm is used as the medium for fixing the sample, jamming and settling will occur and the fixing effect is not ideal. Therefore, it is not ideal to use water-resistant sandpaper and metal
mesh with a diameter of 1mm and a mesh width of about 20mm as the medium for fixing the sample to reduce the movement in the friction process.

2) Color fastness to rubbing of textiles using water-resistant sandpaper medium will cause different shades of color staining of the same rubbing cloth during rubbing, while using metal mesh with a diameter of 1mm and a mesh width of about 20mm will also cause mesh marks. Therefore, the above two conditions have certain influence on the evaluation of color fastness to rubbing of textiles.

3) By using 1cm thick rubber elastic blocks and 6 inverted conical minions with a diameter of 0.5 cm (as shown in Fig. 2) instead of water-resistant sandpaper and metal mesh with a diameter of 1mm and a mesh width of about 20mm, it can play a very good role in fixing samples, and can solve the problems of deep and light staining and mesh marks of the same friction cloth.

Authors' background

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