

Application and Practice of Rubbing Fastness Improver DM-2589N

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Abstract: The purpose of this paper is to introduce the application and Practice of a wet rubbing fastness improver DM-2589N in dark cotton fabrics. Methodology - The influence of DM-2589N mass concentration, baking temperature and time on the rubbing fastness are studied. The effects of DM-2589N on different fabrics, different dyes, and the effects of DM-2589N and other finishing agents in the same bath are studied. Findings - DM-2589N has excellent lifting effect on all kinds of cotton fabrics, and it is suitable for the improvement of rubbing fastness of fabrics dyed with reactive, direct, vulcanized and vat dyes. The optimum process is DM-2589N 40g/L, One dip and one rolling, baking temperature 150°C. Practical implications - The dry and wet rubbing fastness of the finish products can be increased above Grade 3-4, which can meet the first-class quality requirements of customers. Originality/value - The wet-rubbing fastness improver DM-2589N can be used in the same bath with the fixing agent and softener without adjusting the pH value, which can simplify the production process, shorten production time and greatly improve production efficiency.

Keywords: Dyeing and Finishing Agent, Rubbing Fastness, Dyed Textiles, Reactive Dyes, Sulfur Dyes, Direct Dyes, Cellulose Fiber

1. Introduction

The wet rubbing fastness of dyed textiles, especially deep colored cotton fabrics, usually cannot meet the requirements. Especially, the wet rubbing fastnesses of woolen fabrics and corduroy fabrics are lower than the wet rubbing fastness of cloth fabrics of the same color depth. This is mainly due to the fact that in addition to the color transfer in the testing process, the short velvet on the fabric will also be transferred to the friction head. So it is more difficult to improve the wet rubbing fastness of the pile fabric [1-4].

Rubbing fastness enhancers have been developed in China since the 1990s. After decades of development, progresses have been achieved. Although all of the main domestic auxiliaries manufacturers have products on the market, there is a lack of the all-round rubbing fastness enhancer, with remarkably improved wet rubbing fastness of cashmere fabrics, no selectivity in dyes, little effect on the feel of fabrics,

and no need to adjust the pH value of working fluid in use. Some of the rubbing fastness enhancers on the market are only suitable for fabrics dyed by reactive dyes. And some are good for vulcanized, direct dyed fabrics, which need to be adjusted in use. The pH value of the working fluid may have the problem of increased color, while the handle of some finished fabrics is hard [5-12].

The rubbing fastness lifting agent DM-2589N is a special kind of high molecular polymer. It does not need to adjust the pH value of the working fluid in use. By fixing and crosslinking, the direct dyes can be significantly increased by forming films on the fabric. Reactive dyes, sulphide dyes and vat dyes can improve the wet rubbing fastness of fabrics and the wearability of dark textiles. The effects of reactive dyes, sulphide dyes and vat dyes on the wet rubbing fastness of fabrics are significant, and the effects on the color and the feel of fabrics are negligible.

2. Experimental

2.1. Materials and Instruments

Cotton standard lining fabric (Shanghai Institute of Textile Industry Supervision) (Shanghai Institute of Textile Industry), cotton, white, pure cotton, white corduroy, pure cotton, white corduroy (for sale in the market); Cotton poplin plain weaving machine (warp yarn count: 40S, weft yarn count: 40 S), whole cotton twill yarn card (warp yarn number: 32s, weft yarn count: 32s, market).

Reagents and drugs: rubbing fastness promoters DM-2589N, active fixing agent DM-2517, silicone oil, film, DM-2230, homogenate, DM-2230, Nonionic osmotic agent DM-1230 (Guangdong Demei Hi-tech material Co., Ltd); active emerald blue BES150% (C. I. Active blue 21; active Tibetan green BF (multicomponent compound, Zhejiang intercalated soil co., Ltd.); active black RG 100% (C. I. Active black 5), active super red RW 200% (C. I. Active red 264), direct suntan resistance G100% (C. I. Direct black 4BS was 100% (C. I. Direct blue BRL100% (C. I. Direct blue 200; sulfur black 100% (C. I. BR 100% (C. I. Reducing brown 1, reducing black RB 100% (C. I. Reduction Black 9; Sulfide, Sodium Carbonate, Sodium Chloride, anhydrous Sodium Sulfate, Sodium hydroxide, Insurance Powder (marketed).

Equipment: type 1: 101A-3 electrothermal blast dryer (Shanghai Laboratory instrument Factory) Type Mi-ECO-24 all-purpose color test machine, small laboratory rolling mill, Laboratory sample setter (Rapid Company) UltraScan VIS computer colorimeter (USA Hunter Lab), meets the requirements of GB/T 3920-2008 rubbing fastness instrument (Wenzhou Fangyuan instrument Company), perspiration fastness instrument (Wenzhou Fangyuan instrument Co., Ltd.).

2.2. Test Items and Methods

2.2.1. Dyeing Formula and Process

Reactive dyes: 5% (omf), yu powder 80g/L, soda 25g/L, bath ratio 1: 10, 60°C dyeing 60min, water washing, dehydration, drying.

Direct dyes: dye dosage 5% (omf), yu powder 5g/L, bath

ratio 1: 10, 100°C dyeing 60min, wash, dehydration, drying.

Sulphide dye: 6% (omf), sulphide base 5g/L, bath ratio 1: 10, 95°C, dyeing 30min, adding sodium chloride 5g/L to water washing for 30min, then dehydrating in air for 10min, and drying.

Vat dyes: dye dosage of 6% (omf), caustic soda 5g/L, safety powder 10g/L, DM-2230 1.0g/L bath ratio of 1: 10, 60°C reduction 30min, dyeing 40min, wash, hydrogen peroxide 1.0g/L oxidation 10min, washing, dehydration, drying.

2.2.2. Finishing Process of Rubbing Fastness Lifting Agent

The rubbing fastness lifting agent Xg/L, one dip and one rolling, has a rolling surplus rate of (80 ±5) and baking at 150°C for 120s.

2.2.3. Rubbing Colour Fastness [13]

According to GB/T 3920-2008, "Color fastness Test for Textiles."

2.2.4. Fastness to Soaping [14]

According to GB/T 3921-2008, "Test for colour fastness to soaping".

2.2.5. Colour Fastness to Perspiration [15]

According to GB/T 3922-2013, "Textiles color fastness test" test for perspiration fastness.

2.2.6. Fabric Color Difference Value

According to CIE standard, the color difference of fabric was measured by Ultra Scan VIS spectrophotometer at D65/10 of light source, and the value of color difference of fabric was measured by using dyed fabric as reference.

3. Results and Discussions

3.1. Influence of DM-2589N Concentration

The 32s cotton knitted fabric with direct tanning resistance G dyed by active Tibetan green BF, was dipped into the rubbing fastness promotion agent DM-2589N 10, 20, 25, 30, 40, 50g/L, respectively. The color fastness and chromatic difference value E were tested in Table 1.

Table 1. Friction colour fastness and discoloration value of different dosage.

Dosage	Dyeing cotton fabric with active Tibetan blue BF			Direct black G dyed cotton fabric		
	Delta E value	Dry rubbing colour fastness	Wet rubbing colour fastness	Delta E value	Dry rubbing colour fastness	Wet rubbing colour fastness
Blank (0g/L)	0.56	3	1	0.64	3	1
10g/L	0.57	4	2-3	0.69	4	2-3
20g/L	0.68	4-5	3	0.70	4-5	3
25g/L	0.71	4-5	3-4	0.74	4-5	3-4
30g/L	0.70	4-5	4	0.71	4-5	4
40g/L	0.74	4-5	4	0.76	4-5	4
50g/L	0.77	4-5	4	0.75	4-5	4

It can be seen from Table 1 that the wet rubbing fastness of dyed cotton fabrics gradually improved. When the mass concentration of DM-2589N increased from 0g/L to 30g/L, the color fastness to wet friction of dyed cotton fabrics gradually improved. When the mass concentration of

DM-2589N increased from 30g/L to 50g/L, the color fastness to wet friction of dyed cotton fabrics did not increase. The wet rubbing fastness of DM-2589N with mass concentration of 30g/L reached the maximum of 4 grades. This indicates that the optimum mass concentration of DM-2589N is 30g/L.

According to the color difference in Table 1, the rubbing fastness improver DM-2589N has a significant effect on the wet rubbing fastness of cotton fabrics dyed with reactive dyes and direct dyes, and has little effect on the color and light of the fabrics.

3.2. Effect of Baking Temperature

32 S cotton knitted fabric with direct tanning resistance to black G dyeing with active Tibetan blue BF, impregnated with DM-2589N 30g/L, was baked at 130, 150, 160, 170°C for 120s, respectively. The color fastness to wet friction was tested in Table 2 after wetting.

Table 2. Colour fastness to friction at different baking temperatures.

Baking temperature	Dyeing cotton fabric with active Tibetan blue BF		Direct black G dyed cotton fabric	
	Dry rubbing colour fastness	Wet rubbing colour fastness	Dry rubbing colour fastness	Wet rubbing colour fastness
130°C	4-5	3-4	4-5	3-4
150°C	4-5	4	4-5	4
160°C	4-5	4	4-5	4
170°C	4-5	3-4	4-5	3-4

Table 2 showed that when the baking temperature was raised from 130°C to 150°C, the lifting effect of DM-2589N on wet rubbing fastness of dyed fabrics became better. This was mainly because the increase of temperature that is beneficial to the fully film-forming of DM-2589N. When the baking temperature was 170°C, the lifting effect of wet rubbing fastness of fabric slightly decreased compared with that of 150°C and 160°C. In addition, extremely high baking temperature exerted serious damage to cotton fiber and largely affected the color and light of fabric. Therefore, the baking temperature after finishing with improver DM-2589N is determined to be 150°C.

3.3. Effect of Curing Time

32 S cotton knitted fabric with direct tanning resistance to black G dyeing with active Tibetan blue BF, impregnated with DM-2589N 30g/L, was roasted at 150°C for 60, 90, 120, 180s, respectively. The color fastness to wet friction was tested in Table 3 after wetting.

Table 3 showed that when the curing time was extended to 90s, the rubbing color fastness was improved. And when the curing time was up to 120s, there was no improvement in wet rubbing color fastness, which indicated that the wet rubbing fastness lifting agent was fully crosslinked with the fiber at this time. Therefore, the baking time was 120s.

Table 3. Effect of baking time on rubbing colour fastness.

Curing time	Dyeing cotton fabric with active Tibetan blue BF		Direct black G dyed cotton fabric	
	Dry rubbing colour fastness	Wet rubbing colour fastness	Dry rubbing colour fastness	Wet rubbing colour fastness
60 S	4-5	3-4	4-5	3-4
90 S	4-5	4	4-5	4
120 S	4-5	4	4-5	4
180 S	4-5	4	4-5	4

3.4. Lifting Effect of Different Fabric Rubbing Color Fastness

Several common pure cotton fabrics dyed with active Tibetan green BF, direct resistance to sun black G were impregnated with DM-2589N 30g/L, baked at 150°C for 120s. The color fastness to wet friction was tested in Table 4 after wetting.

Table 4. Colour fastness of DM-2589N to friction on different fabrics.

Textile		Dyeing cotton fabric with active Tibetan blue BF		Direct black G dyed cotton fabric	
		Dry rubbing colour fastness	Wet rubbing colour fastness	Dry rubbing colour fastness	Wet rubbing colour fastness
Yarn card	Before finishing	3-4	1-2	3-4	1-2
	After finishing	4-5	4	4-5	4
Popeline	Before finishing	3-4	2	3-4	2
	After finishing	4-5	4-5	4-5	4-5
Cotton standard lining	Before finishing	3-4	1-2	3-4	1-2
	After finishing	4-5	4-5	4-5	4-5
Worsted cloth	Before finishing	3	1	3	1
	After finishing	4-5	4	4-5	4
Garrison cloth	Before finishing	2-3	1	2-3	1
	After finishing	4-5	4	4-5	4
Lamp pile	Before finishing	1-2	1	1-2	1
	After finishing	4	3-4	4	3-4

Table 4 showed that DM-2589N can improve the wet rubbing color fastness of common cotton fabrics (including

pile fabrics) to 3-4 or above. It manifested that DM-2589N can improve wet rubbing fastness of all kinds of cotton fabrics.

3.5. Enhancement Effect of Rubbing Fastness of Fabrics Dyed with Different Reactive Dyes

Active turquoise blue (BES), active Tibetan blue (BF),

active black (RG), super red RW stained 32 S cotton knitted fabrics, baked at 150°C for 120s at 30g/L DM-2589N, were tested for wet friction color fastness and color difference E in Table 5 after wetting.

Table 5. Color fastness to friction of fabrics dyed with different reactive dyes using DM-2589N.

Textile		Delta E value	Dry rubbing colour fastness	Wet rubbing colour fastness
Reactive emerald blue BES dyed fabric	Before finishing	/	3-4	1-2
	After finishing	0.74	4-5	4
Reactive Tibetan blue BF dyed fabric	Before finishing	/	3	1
	After finishing	0.66	4-5	4
Reactive black RG dyed fabric	Before finishing	/	3	1
	After finishing	0.51	4-5	4
Reactive super red RW dyed fabric	Before finishing	/	1-2	1
	After finishing	0.49	4-5	4

Table 5 showed that DM 2589N, a lifting agent for rubbing fastness, can improve the wet rubbing fastness of dyed fabrics with different reactive dyes. But all of them can reach 4 grades, which meet the requirement of wearing. This indicated that DM-2589N was used in the finishing of dark fabrics and had no selectivity for reactive dyes.

3.6. Effect of Direct, Vulcanized, Vat Dyestuff Dyeing

32 S cotton knitted fabrics dyed with direct dyes, sulfur dyes and vat dyes respectively, finished with DM-2589N 30g/L, were tested for color fastness to wet rubbing E as shown in Table 6.

Table 6. Color fastness to friction of direct, vulcanized, vat dyed fabrics with DM-2589N.

Textile		Delta E value	Dry rubbing colour fastness	Wet rubbing colour fastness
Direct black G	Before finishing	/	3	1
	After finishing	0.68	4-5	4
Direct red 4BS	Before finishing	/	4	2
	After finishing	0.75	4-5	4
Direct blue BRL dyeing fabric	Before finishing	/	3-4	1
	After finishing	0.36	4-5	4
Sulphur black	Before finishing	/	1-2	1
	Before finishing	0.28	4	3-4
Vat Brown BR	After finishing	/	3	1
	Before finishing	0.52	4-5	4
Reduced black RB	After finishing	/	2	1
	Before finishing	0.45	4-5	4

Table 6 showed that DM-2589N dyestuff, vulcanized dye and vat dyestuff can improve the dry and wet rubbing fastness significantly; wet rubbing fastness was 3 - 4, dry rubbing fastness was 4-5, and the finishing had little effect on the color and light of the fabric.

3.7. Color Fastness to Friction of Softener and DM 2589N in the Same Bath

On 32 S cotton knitted fabric dyed with active BF, super red RW, the softener 20g/L DM-2589N 30g/L was treated in the same bath. The color fastness to wet friction was tested in Table 7.

Table 7. Colour fastness to friction of softener and DM-2589N in the same bath.

Softener + DM-2589N	Dyeing cotton fabric with active Tibetan blue BF		Reactive Super Red RW dyeing of Cotton fabrics	
	Dry rubbing colour fastness	Wet rubbing colour fastness	Dry rubbing colour fastness	Wet rubbing colour fastness
Blank space	3	1	1-2	1
DM-2589N	4-5	4	4-5	4
Silicon oilDQ-363+DM-2589N	3-4	3	4	3-4
Silicon oil T805+DM-2589N	4	3-4	4	3-4
Silicon oil T618+DM-2589N	4	3-4	4	3-4
Silicon oil 0127+DM-2589N	4-5	4	4-5	4
Film DM-3126+DM-2589N	4	3-4	4	3-4
Silicon oil 6980+DM-2589N	3-4	4	4	3-4

Table 7 showed that the effects of different softeners on the DM-2589N rubbing fastness were different, indicating that DM-2589N had a certain selectivity to softener, in which silicone oil 0127 and DM-2589N in the same bath had no effect on dry and wet rubbing fastness. Dry and wet rubbing color fastness can be raised to level 4, while achieving soft and smooth feel.

3.8. Effect of Active Fixing Agent, Softener and DM-2589N on the Improvement of Friction Color Fastness in the Same Bath

On 32 S cotton knitted fabric dyed with active BF, super red RW, fixing agent DM-2517 10g/L, silicone oil 0127g/L, DM-2589N 30g/L in the same bath, the color fastness of each color fastness was reported in Table 8 and 9.

Table 8. Color fastness to wet friction of fixing agent and DM-2589N in the same bath.

	Dyeing cotton fabric with active Tibetan blue BF		Reactive Super Red RW dyeing of Cotton fabrics	
	Dry rubbing colour fastness	Wet rubbing colour fastness	Dry rubbing colour fastness	Wet rubbing colour fastness
Blank space	3	1	1-2	1
DM-2589N	4-5	4	4-5	4
DM-2517+DM-2589N	4-5	4	4-5	4
DM-2517+ 0127 +DM-2589N	4-5	4	4-5	4

Table 9. Color fastness to soaping and sweat stains with DM-2589N in the same bath.

	Dyeing cotton fabric with active Tibetan blue BF			Reactive Super Red RW dyeing of Cotton fabrics		
	soaping	hidrolic acid	sweat stain	soaping	hidrolic acid	sweat stain
Blank space	1	1-2	1	1	1	1
DM-2589N	1-2	2	2	1-2	2	2
DM-2517+DM-2589N	4-5	4-5	4-5	4-5	4-5	4-5
DM-2517+ 0127 +DM-2589N	4-5	4-5	4-5	4-5	4-5	4-5

Table 8 / 9 showed that the rubbing fastness lifting agent DM 2589N was treated in the same bath with the fixing agent DM 2517 and the silicone oil 0127. The three processes of hand feeling finishing, fixing and wet rubbing finishing are combined into one process. After finishing, the fastness to rubbing, soaping and perspiration can reach grade 4 or above, It simplifies the production process of dyeing plant and helps to improve production efficiency.

4.1. Dyeing Plant Production Process

4.1.1. Use of Fabric and Additive Formulations

Table 10. Use of fabrics and Additives.

Fabric varieties and colors	Dyeing factory H		Dyeing factory C	
	Black cotton cloth with big eyes and single bead	Black cotton left twill double garb cloth	Blue long-staple cotton yarn flat print	Dark red mercerized yarn
Cloth weight	23 pieces of cloth, weight of cloth: 540.76kg	9 pieces of cloth, weight of cloth: 246.99kg	4 pieces of cloth, weight of cloth: 96.40kg	46 pieces of cloth, weight of cloth: 1019.10kg
DM-2589N	30g/L	40g/L	30g/L	30g/L
Silicon oil 0127	15g/L	15g/L		
Nonionic permeant DM-1230			3g/L	3g/L
Rolling surplus rate	78.5%	83.2%	85.6%	81.4%

4.1.2. Production Engineering

The machine was impregnated and rolled and baked at 150°C. The speed of the machine was between 15 to 20 m/min.

4.2. Results of Mass Production

Observe the cloth effect of the above four kinds of fabrics and test the color fastness and the color difference value of the friction. The recorded results were reported in Table 11.

Table 11. Production results.

		Black bead cloth	Black cloth	Treasure blue flat grain	Dark red flat grain
Dry rubbing colour fastness	Before finishing	2	1-2	1-2	1-2
	After finishing	4-5	4-5	4-5	4-5
Wet rubbing colour fastness	Before finishing	1-2	1	1-2	1
	After finishing	4	3-4	3-4	3-4
Value of chromatism		0.48	0.53	0.57	0.61
Oil spot condition		not have	not have	not have	not have

4. Production Practice of Dyeing Factory

The technical indexes of DM-2589N met the requirements of production, and then the samples were produced in 2 printing and dyeing factories in Guangdong area. Production and use of equipment: Hong Kong CHTC Fong's Industries Company Limited Men Fushi molding machine.

	Black bead cloth	Black cloth	Treasure blue flat grain	Dark red flat grain
Color spot	not have	not have	not have	not have
Feel	good	good	secondary	secondary

4.3. Large Production Result Analysis

The large production practice showed that the rubbing fastness lifting agent DM-2589N significantly improved the friction color fastness of dyed fabrics. Meanwhile, the production continuity was good, the reproducibility was good, and the finishing had little influence on the color and light. The same bath finishing with silicon oil 0127 not only improved the quality of the processed cloth seed, but also simplified the production process and the comprehensive economic benefit.

5. Conclusion

The main results were as follows:

(1) DM-2589N was used in the finishing of dark fabrics. It had no selectivity for dyes, and can improve the wet rubbing fastness of reactive dyes, direct dyes, sulphide dyes and vat dyes to 3 or higher grade. DM-2589N was used in the finishing of various dark cotton fabrics such as yarn card, poplin, plain fabric, bead cloth, abrasive cloth, sanitary cloth and pile fabric. It had excellent effect on improving the wet rubbing color fastness of fabric, and had little influence on the color and feel of fabric.

(2) DM-2589N had no phosphorus, formaldehyde, heavy metal, organohalide and REACH regulations. The pH value of the working solution was not adjusted when it was put into use. It combines hand feeling, fixing and wet rubbing with fixing agent DM-2517 and silicone oil 0127 in the same bath finishing process. After the same bath finishing, the color fastness of the fabric to friction, soaping and perspiration can reach grade 4 or more, which not only improves the wearing performance of the dark fabric, but also simplifies the production process of the dyeing plant, and has good economic and social benefits.

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