Reduction clearing and heat setting properties of super hydrophobic dyes for pure polypropylene fibers

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1. Introduction

Polypropylene fiber has good mechanical properties and excellent chemical resistance. It is also known as a floating-on-the-water fiber since the density is 0.90~0.92 and expected for the usage of lightweight sportswear. The fiber can be used at the fields of fast drying and heat insulation material applications because their moisture regain and thermal conductivity is as low as 0.05% and 0.12W/mK. The fiber is known that it is impossible to dye at any dyeing systems because of the extreme hydrophobicity of the fiber. However, it is possible to dye pure polypropylene with super hydrophobic dyes recently developed. Following the dyeing process, after-clearing is generally needed. However, it can cause to reduce fastness due to severely migration. Therefore, reduction clearing and heat setting is essential. In this work, reduction clearing process and heat setting of pure polypropylene are established.

2. Experimental

2.1 Dyeing

The unmodified polypropylene fibers (1.0g) were dyed with 5%owf blue, yellow, and red dyes at a liquor ratio of 50:1. The temperature of dyebath was elevated to 130℃ at a rate of 3℃/min and maintained at this temperature for 60minutes.

2.2 Reduction clearing

After dyeing, the fibers were rinsed in cold water and the different concentration of reduction cleared at 70~80℃ for 20min (Fig.1) using a 50:1 liquor ratio. The reduction cleared dyeing was rinsed in cold water.

2.3 Heat setting

The fibers were subjected to heat setting under, 150 seconds and at temperatures of 130℃~170℃, and then the treated fabrics were measured by a thermal shrinkage ratio.

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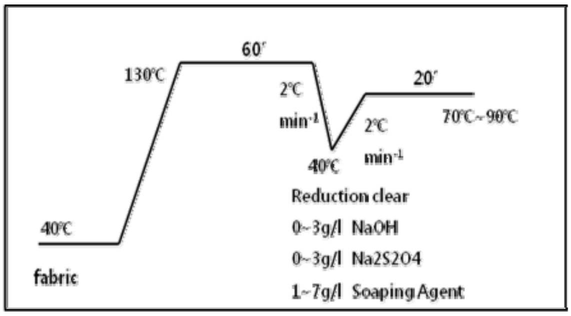

Figure 1. Reduction clearing process.

2.4 Fastness

The dyed fibers were tested for color fastnesses. The wash fastness, rubbing fastness, and light fastness were examined by the procedures of KS K 0430 A-1, KS K 0650, and ISO 015 B02 respectively.

3. Result and discussion

The dyed fibers were treated with different condition of reduction clearing, and then compared to their color values. The dyed fibers were tested under various conditions of concentration and temperature changes on sodium hydroxide, sodium hydrosulfite,

Table 1. Color value of reduction cleared blue fibers

R/C condition (g/l)				Total K/S	L* (D65)	a* (D65)	b* (D65)
NaOH	$Na_2S_2O_4$	Soaping Agent	Temp.				
0	0	1	70℃	404.40	24.11	8.54	-34.00
1	1	1		382.55	24.97	8.21	-34.48
2	2	1		399.45	24.42	8.70	-34.74
3	3	1		399.16	24.49	8.56	-34.83
2	2	1		439.15	23.48	9.34	-35.29
2	2	3		384.04	25.03	8.54	-35.35
2	2	5		407.72	24.38	8.91	-35.38
2	2	7		387.67	25.16	8.89	-36.21
2	2	7	50℃	450.30	23.26	9.39	-35.25
			70℃	399.38	24.96	8.82	-36.53
			90℃	470.54	24.06	10.49	-39.84
2	2	10	50℃	448.94	23.47	9.35	-35.78
			70℃	398.62	25.01	8.73	-36.49
			90℃	443.30	24.77	9.95	-39.87

and soaping agent. Table 1 shows the color values of the blue dye treated with different condition of reduction clearing. The dyes were affected by the soaping agent more than sodium hydrosulfite and sodium hydroxide. The reason was that hydrophobic dyes were solubilized and removed by soaping agent rather than sodium hydrosulfite and sodium hydroxide. As a result, the optimum condition of reduction clearing for super hydrophobic dyes with unmodified polypropylene fibers is same as Table 2.

Table 2. Optimum condition of reduction clearing

auxiliary	amount	temperature	time
NaOH	2 g/l	70℃	20min
$Na_2S_2O_4$	2 g/l		
Soaping Agent	7 g/l		

Dyed fibers were dried at different temperature. The thermal shrinkage was examined by the procedures of KS K 0599 and Table 3 shows the thermal shrinkage of dried fabrics according to condition of heat setting. The thermal shrinkages are nearly unchanged less than 150℃, but they were remarkably increased more than 150℃. Figure 2 shows the change of thermal shrinkage according to condition of heat setting. The thermal migration of dyes on the polypropylene fibers was not showed even at the high temperature. However, the polypropylene fabrics showed high thermal shrinkage at over 150℃. Consequently, the heat setting process must be done at less than 150℃.

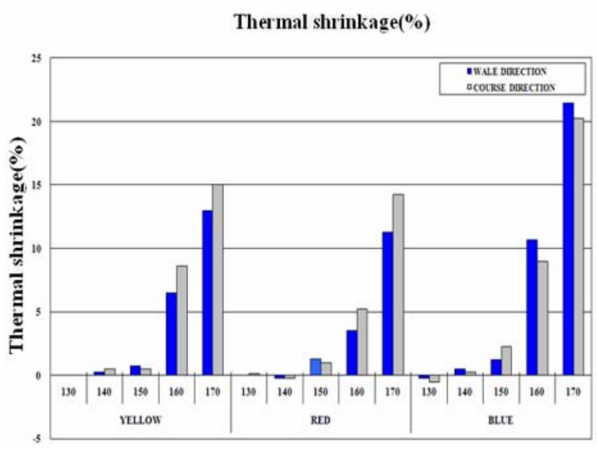

Figure 2. Change of thermal shrinkage according to conditions of heat setting.

Table 3 shows the fastness of dried fibers according to condition of heat setting. Yellow and red dyes did not exhibit differences of the fastness as they did not have migration. The fastness of blue dye was slightly reduced to third rating due to migration of dyes Consequently, pure polypropylene fibers dyed with super hydrophobic dyes can be applied practically.

Table 3. Fastness of dried fibers

Color fastness			Dyes										
			Yellow					Blue					
			130℃	140℃	150℃	160℃	170℃	un-treated	130℃	140℃	150℃	160℃	170℃
Washing	Change in color		4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
	Staining	Acetate	4-5	4-5	4-5	4-5	4-5	4-5	3-4	4-5	3-4	3-4	4
		Cotton	4-5	4-5	4-5	4-5	4-5	4-5	4	4-5	4	4	4-5
		Nylon	4	4-5	4	4-5	4	4-5	3-4	4-5	3-4	3-4	4
		PET	4-5	4-5	4-5	4-5	4-5	4-5	3-4	4-5	3-4	4	4-5
		Acrylic	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
		Wool	4-5	4-5	4-5	4-5	4-5	4-5	3-4	4-5	3-4	3-4	4
Light	Change in color		4	3-4	4-5	4-5	4-5	-	4-5	3-4	4-5	3-4	4
Rubbing	Dry		4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
	Wet		4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

4. REFERENCES

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