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Dispersion stability of super hydrophobic dyes for pure polypropylene fibers

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1. Introduction

Polypropylene fibers have a number of attractive properties when compared to synthetic fibers. Polypropylene fiber has the strength of 4.5~9.0g/d and the elasticity of 25~60%, which are comparable to those of polyester and nylon fibers in terms of their application to apparel and industrial aspects. In addition, the fiber has excellent chemical resistance as well. They are also known as a floating fiber since the density is 0.90~0.92, the lowest of all kinds of fibers, and expected for the usage for light weight sportswear. Polypropylene fiber can be used in the fields of fast drying and heat insulation materials as moisture regain and thermal conductivity are as low as 0.05% and 0.12W/mK respectively. It has been generally considered that the polypropylene fiber was impossible to dye at any dyeing systems because of the extreme hydrophobicity of the fiber. In order for the dyes to be applied practically it is necessary to be dispersed with dispersing agents. If dispersion is not stable, the dyes would be deposited which causes unlevel dyeing. Therefore dispersion stability during dyeing is critically important. The aim of this work is to investigate the dispersion stability of super hydrophobic dyes for pure polypropylene fibers.

2. Experimental

2.1 Ball milling process

The super hydrophobic dyes were ball-milled by a laboratory milling apparatus comprising 2mm alumina balls and appropriate dispersing agents for 10 hours. The amount of dyes and dispersing agents were summarized in Table 1.

2.2 Analysis of particle size

After milling, the dye dispersion was analyzed to obtain average particle size and its distribution using a particle size analysis.

2.3 Dispersion stability

The dispersion stability was investigated by the procedure of AATCC 146-2001. The dispersion was heated to 130℃ and maintained at this temperature for 40minutes (Figure 1). After cooled down to 98℃, the dispersed solution was filtered through decompression device and measured by the time required. And then a rating on dispersion state of dyes was decided by filter paper.

Table 1. Milling conditions

Dye	amount of dye	amount of water	Milling conditions
Blue (Oil Blue N)	1g	30ml	2mm Alumina beads 60ml, Stirrer rotating speed of 500 rpm
Red (hexyl)			
Yellow (hexyl)			

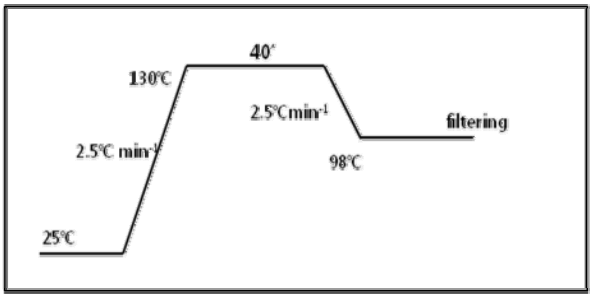

Figure 1. Test profile of dispersion stability.

3. Result and discussion

The average particle size and filtering time for different type of dispersing agent were presented at Table 2. Considering both filtering time and average particle size in Table 2, a lignin dispersing agent can be selected for the optimum agent. Therefore, the lignin dispersing agent was used in the subsequent experiments. Table 3 shows the dispersion stability according to the amount of the lignin dispersing agent for a blue dye. Table 4 shows the effect of co-dispersing agent on dispersion stability for red and yellow dyes.

Table 2. Dispersion stability according to the dispersing agents

Dispersing agent	Filtering time (sec)	Rating	Residue grade	Average particle size
Naphthalene 2g	441	E	1	460
Lignin 2g	198	E	1	269
Pigment 2g	560	E	1	286
DodecylBenzene SulfonicAcid 2g	80	c	1	472

Table 3. Dispersion stability according to the amount of the lignin dispersing agent

Dispersing agent	Filtering time (sec)	Rating	Residue grade
Blue			
Lignin 2g	32	B	3
Lignin 3g	40	B	4
Lignin 4g	90	D	2
Lignin 5g	34	B	3

Table 4. Effect of co-dispersing agent on dispersion stability

Dispersing agent	Filtering time (sec)	Rating	Residue grade
Red Lignin 4g,Tween20 1g	17	A	3
Yellow Lignin 4g, Tween20 1g	19	A	3

Table 5 shows the average particle size of dye dispersion. According to Table 5, all dyes exhibit smaller than 500nm of particle size, which means that the dispersion obtained by the milling process can be used practically.

Table 5. particle size of dye dispersions

Color	Particle size	Ultrasonic waves
Blue	294	10min
Red	226.3	10min
Yellow	189.4	10min

Table 6 shows stability of dye dispersion. In order for dyes to be applied practically the dyes should have dispersion stability of higher than B-4. Since dye dispersions of super hydrophobic dyes in this study have ratings of A-6, they can be used in the practical dyeing process.

Table 6. Dispersion stability

Color	Rating
Blue (2g/l)	A-5
Red (2g/l)	A-5
Yellow (2g/l)	A-5

4. Conclusion

The dispersion stability of super hydrophobic dyes for pure polypropylene fibers was investigated. As the results, the dispersion stability of the blue dye was obtained at lignin (5g), in the same manner both red dye and yellow dye were stabilized with lignin 4g, Tween 20 1g. Under a given condition milled dyes have A-5 on dispersion stability.

5. REFERENCES

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