Application of Bolaform Electrolytes as Auxiliaries of Cotton Dyeing

Kunihiro Hamada, Shinkichi Shirakami, Ryuji Yamada, and Yuichi Hirata

Faculty of Textile Science and Technology, Shinshu University
3-15-1 Tokida, Ueda, Nagano 386-8567, Japan
E-mail: khamada@shinshu-u.ac.jp

1. INTRODUCTION

Reactive, direct, vat dyes, and so on are used for the dyeing of cellulosic fibers such as cotton and rayon. In the dyeing process, many amounts of inorganic salts are used as dyeing auxiliaries in order to enhance dye uptake, dyeing rate, and levelness. The reduction of dyeing auxiliaries is expected, and novel ones are necessary to be developed.

On the other hand, bolaform electrolytes, which have two ionic groups as terminals, have been studied as auxiliaries for the acid dyeing of silk, wool, and nylon 6 [1-4]. As a result, they enhanced the dye uptake even in pure water, and made it possible to carry out the dyeing without any acids.

In this context, the effects of the cationic bolaform electrolytes were applied to the dyeing of cotton with direct and reactive dyes. The effects of the bolaform electrolytes as dyeing auxiliaries are discussed to be compared with those of inorganic salts such as sodium sulfate and sodium bromide.

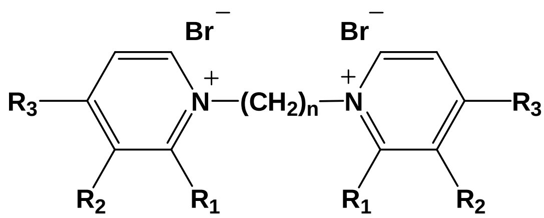
2. EXPERIMENTAL

2.1. Materials

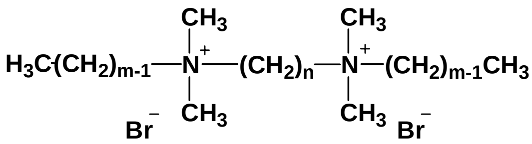
Various kinds of bolaform electrolytes shown in Fig. 1, DCPyn（n = 2, 4, 6, 8, 10）、DCxAPy6（x= o, m, p）、DCmHyPy6, and Cn-m（n=2, 3, 4, 6, 8, 10, 12、m=2, 3, 4, 6）were used. Two kinds of direct dyes, C. I. Direct Blue 1 and Co-tsPc, and a reactive dye, C. I. Reactive Orange 16 shown in Fig. 2 were used. C. I. Direct Blue 1 and C. I. Reactive Orange 16 were purchased from Tokyo Kasei Kogyo Co. Ltd. and kindly supplied by Sumika Chemtex Co., Ltd., respectively, and purified. Co-tsPc was kindly supplied by Daiwabo Co. Ltd. and used without further purification. Scoured cotton fiber was kindly supplied by Nikka Chemical Co. Ltd. Inorganic salts (Na_2SO_4 and NaBr) were purchased from Wako Pure Chemical Industries, Ltd.

2.2. Dyeing

The dyes were sorbed by soaking about 50 mg of the cotton fiber in aqueous dye solutions. The dye sorption was carried out in both the absence and presence of the bolaform electrolytes or inorganic

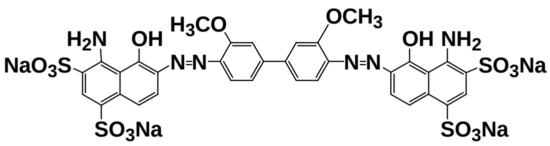


DCPyn : R_1=H、R_2=H、R_3=H
（n=2, 4, 6, 8, 10）
DCoAPy6 : R_1=NH_2、R_2=H、R_3=H
DCmAPy6 : R_1=H、R_2=NH_2、R_3=H
DCpAPy6 : R_1=H、R_2=H、R_3=NH_2
DCmHyPy6 : R_1=H、R_2=OH、R_3=H

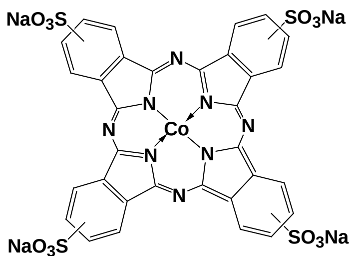


DCn-m
(n=2, 3, 4, 6, 8, 10, 12、m=2, 3, 4, 6)

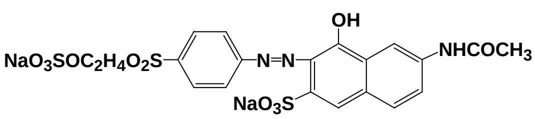
Fig. 1 Bolaform electrolytes used.



C. I. Direct Blue 1



Co-tsPc



C. I. Reactive Orange 16

Fig. 2 Dyes used.

salts at a given temperature for a desired time. After the sorption, the dyed fiber was removed from the dye bath, rinsed in cold water, blotted with filter paper to remove the remaining dye solution from the fiber surface, and dried in a desiccator with silica gel. The direct dyes sorbed by the cotton fiber were extracted with 25 mL of 25 % aqueous pyridine solution and its concentration was determined spectrophotometrically. In the case of the reactive dye, the surface dye concentration was measured using microscopic UV-VIS spectrophotometer and *K*/*S* values were calculated using Kubelka- Munk equation.

2.3. Color Fastness to Washing

Color fastness to washing was measured on the basis of JIS 0844 test method. The *K*/*S* values after washing were determined using microscopic UV-VIS spectrophotometer.

3. RESULTS AND DISCUSSION

3.1. Sorption Behavior of Direct Dyes

Dependence of the amounts of dye sorbed on bolaform electrolytes concentration was determined. As a result, the dye uptake in lower concentration region for the bolaform electrolytes was much larger than that for the inorganic salts. However, in higher concentration region, the opposite behavior was observed.

For further discussion, the sorption isotherms were determined and analyzed using bimodal sorption equation. The analysis using the bimodal sorption equation gives three kinds of sorption parameters, the number of binding sites for the Langmuir type sorption, *S*, the intrinsic binding constant for the Langmuir type sorption, K_L, and the partition coefficient, K_P. These parameters determined for the sorption of C. I. Direct Blue 1 for the cotton fiber are shown in Figs. 3 and 4. The number of binding sites for the Langmuir type sorption in the presence of the bolaform electrolytes having pyridinium cations was much larger than those in the addition of the inorganic salts. The *S* values were also affected by the length of the spacer alkyl chain. Furthermore, the intrinsic binding constants for the Langmuir type sorption, K_L, in the presence of the bolaform electrolytes were larger than those in the addition of the inorganic salts, whereas for the partition coefficients, K_P, the opposite results were obtained. This suggests that the addition of the bolaform electrolytes changes the sorption mechanism from partition to Langmuir sorption type. The use of the bolaform electrolytes as dyeing auxiliaries supplies the binding sites in the cotton fiber and the direct dyes are bound with the binding sites.

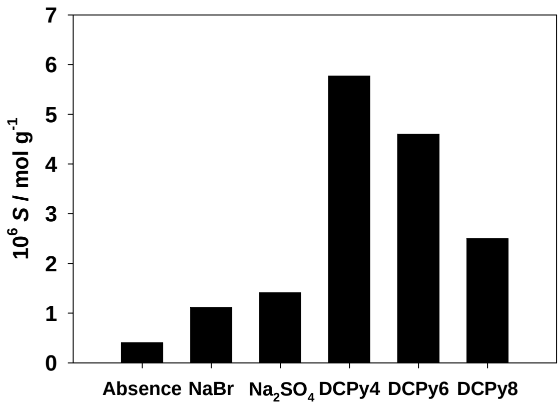


Fig. 3 Number of binding sites for Langmuir type sorption, *S*, of C. I. Direct Blue 1 at 80 ºC.

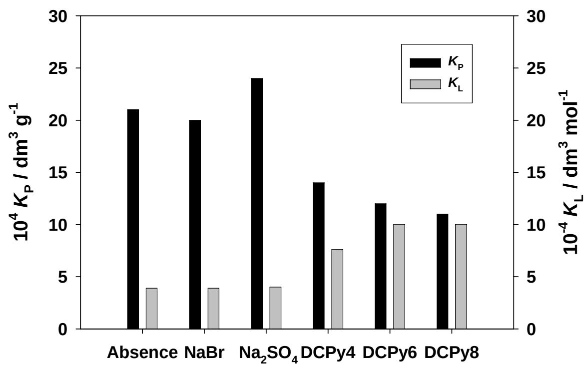


Fig. 4 Partition coefficient, K_P, and intrinsic binding constant for Langmuir type sorption, K_L, of C. I. Direct Blue 1 at 80 ºC.

3.2. *K*/*S* Values of Cotton Fibers Dyed with Reactive Dyes

The effects of the bolaform electrolytes on the dye uptake for reactive dyeing were similar to those for direct dyeing.

3.3. Fastness

Color fastness to washing for the cotton fiber dyed using the bolaform electrolytes was higher than that using the inorganic salts.

4. REFERENCES

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