pH Control for Dyebath Reuse in Dyeing of Nylon with Binary Mixtures of Acid Dyes

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1. Introduction

There are many advantages of dyebath-reuse, including less water to heat, less effluent to treat, and a reduced consumption of energy, dyes, and chemical auxiliaries. Because of the potential economic and environmental advantages involved in this process, clearly it is deserving of further investigation. Dyebath-reuse using pH-sliding system has been investigated in the dyeing of polyamide with a single acid dye in a previous study.

The present study was undertaken to investigate dyebath-reuse using pH-sliding system in the dyeing of polyamide with binary mixtures of acid dyes. The dyeing properties, fatness and colour reproducibility were compared between the pH-sliding agents.

2.Experimental

2.1. Dyebath pH Control System

Dyebath pH was controlled by four pH sliding systems. The optimum concentrations of each acid donor were determined by comparing the pH control ability at various concentrations of each acid donor in previous work (AS : 2.0g/l, GBL, EL and DET : 0.1%v/v).

2.2. Dyebath-reuse Procedure

After dyeing, the fabrics were removed, the dyebaths were analysed colorimetrically to determine the quantities of two dyes necessary to reconstitute the bath, and the residual dyebath was left to cool to room temperature. At the end of each cycle, the dyebath was replenished with 20 ml of water containing the necessary amount of dyes, levelling agent and acid donors to compensate for evaporation and fibre drag-out losses. The addition of auxiliaries at the level commensurate with the fresh water necessary to keep a stable liquor ratio in the original volume has been found sufficient to allow several cycles of reuse, as Carr and Cook reported. Thus the levelling agent was added to the spent dyebath at a constant fraction (0.5 g/l) of their mass in the initial run without detailed analysis of exhaustion. Assuming that acid donors would be hydrolysed completely during the dyeing time, a constant amount of acid donors were replenished at the end of each cycle without considering residual amounts of acid donors in the spent dyebath. This dyebath-reuse sequence was repeated nine times (ten dyeings in total). The initial pH of the dyebath containing AS or hydrolysable organic esters (GBL, EL and DET) were adjusted to 8.0 with a dilute solution of sodium carbonate after each dyeing.

3. Results and Discussion

This study has demonstrated that the use of hydrolysable organic esters as acid donors for pH control offers distinct advantages in the dyeing of polyamide with a reused dyebath. Compared with ammonium sulphate, the hydrolysableorganic esters gave stable and more effective pH control, and more stable and higher exhaustion values in the dyebath-reuse system (Figures 1 and 2). A comparison of CIELab values showed that dyeing reproducibility was better when the hydrolysable organic esters were used in the reused dyebaths, than when ammonium sulphate was used.

In addition, hydrolysableorganic esters showed much lower levels of salt present in the residual dyebath than when ammonium sulphate was used. However, there were no observable differences in the levelness of dyed samples among the four acid donors in the laboratory-scale dyeing. In order to better evaluate the levelling properties, it would be necessary to determine the levelness of dyed fabrics obtained from pilot-scale dyeings. The colour fastness of all the samples were good and similar, irrespective of the pH control system and dyebath-reuse number. There was no deterioration in the colourfastness of the dyed fabrics over 10 cycles of dyebath-reuse (Figure 3).

Of the three hydrolysable organic esters, ethyl lactate showed less amount of alkali required to re-adjust the initial pH of the reused dyebath than γ-butyrolactone and ethyl tartrate (Figure 4). Considering the pH control ability and chemical cost together, it seems to be most feasible to use ethyl lactate as a pH control agent in the dyebath-reuse system.

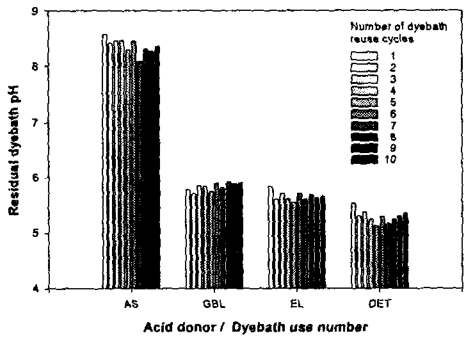

Figure 1 Residual dyebath pH with number of dyebath-reuse cycles

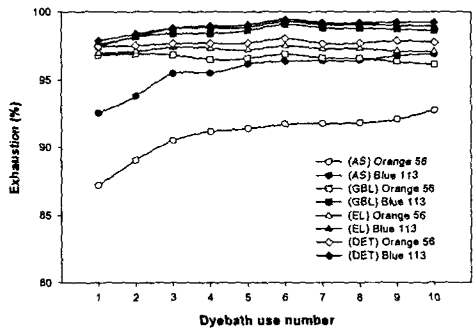

Figure 1 Exhaustion (%) of dyed fabrics with number of dyebath-reuse cycles

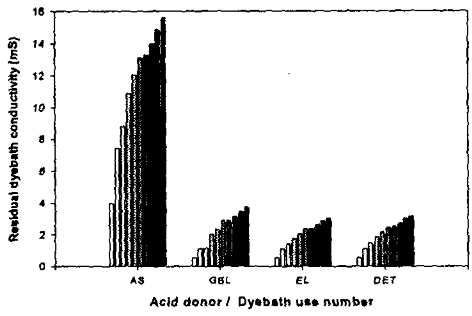

Figure 3 Residual dyebath conductivity with number of dyebath-reuse cycles

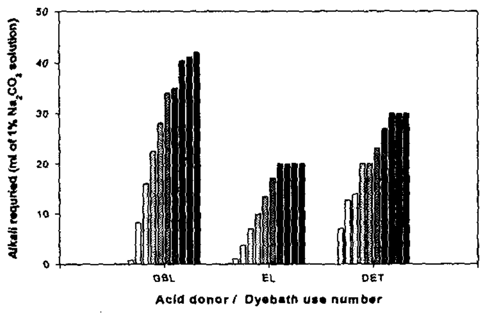

Figure 4 Amount of alkali required for the adjustment of dyebath pH to 8.0