

Polyvinyl alcohol as an aftertreatment. Part 1: Initial studies

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Abstract

The fastness, to repeated washing at 50 °C, of three acid dyes on nylon 6,6 was improved by an aftertreatment with polyvinyl alcohol. Whilst aftertreatment reduced the lightness and chroma of red and, in particular, yellow dyeings, it had little effect on the colour of black dyeings; the extent of this shade change did not increase significantly with increasing amounts of PVA used. PVA imparted a yellow colouration to undyed fabric but the extent of this shade change was much lower than that imparted by the same concentration of tannic acid.

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1. Introduction

Although nylon, the first commercially available, wholly synthetic fibre, continues to enjoy widespread textile usage, the relatively low wet fastness of acid dyes on the substrate necessitates the use of an aftertreatment in order to secure satisfactory wet fastness levels. In the classical, two-stage, *full backtan* aftertreatment that comprises tannic acid and potassium antimony tartrate (tartar emetic), the high M_r gallotannin is adsorbed onto the dyed nylon via protonated amino end groups in the nylon fibre and sequential treatment of the tanned dyeing with potassium antimony tartrate results in the formation of an insoluble metal complex *in situ* at the surface of the dyed nylon which physically resists diffusion of dye from the dyed fabric during washing. In view of the marked toxicity of tartar emetic, previous research [1] showed that a tannic acid/enzyme aftertreatment was comparable to three established aftertreatments (syntan, full backtan and a modified full backtan) in improving the fastness to repeated washing of three acid dyes on nylon 6,6. The optimum application conditions for the tannic acid/enzyme system were determined [2] and the effectiveness of four protease enzymes when used in combination with tannic acid, in

improving the fastness to repeated washing of five commercial acid dyes on nylon 6,6, was demonstrated [3]. Subsequently, a single-stage aftertreatment that involved the application of tannic acid was found to be very effective in improving the fastness of five acid dyes to repeated washing at 40 °C; however, the aftertreatment was less effective in the cases of repeated washing at 50 °C and 60 °C [4].

Despite the effectiveness of the new tannic acid and the tannic acid/enzyme systems in improving the wash fastness of acid dyes nylon 6,6, as tannic acid imparts a yellowish brown hue to dyeings [5], it was decided to determine if the high M_r gallotannin could be replaced by a low cost, readily available, water-soluble polymer; in this context, polyvinyl alcohol (PVA) was selected for use. This part of the paper concerns the use of PVA as an aftertreatment of nylon 6,6 which had been dyed with three commercial acid dyes; as the single-stage aftertreatment with tannic acid had been found [4] to be less effective at wash temperatures above 40 °C, it was decided to undertake this initial part of the study using a wash temperature of 50 °C.

2. Experimental

2.1. Materials

Knitted nylon 6,6 fabric of 78f/68 dtex per filament and amino end group (AEG) content 45 meq kg⁻¹ was kindly

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Table 1
Dyes used

Commercial name	Type	C.I. generic name
Nylanthrene Black C-DPL	Non-metallised acid	None ascribed
Neutrilan Red K-2G	Unsulphonated 1:2 pre-metallised	None ascribed
Nylanthrene Yellow C-3RL	Non-metallised acid	Acid Orange 67

supplied by DuPont (UK). The fabric was scoured before use by treatment in a solution of 3 g dm^{-3} Sandozin NIN (a non-ionic surfactant supplied by Clariant UK) and 1 g dm^{-3} Na_2CO_3 at 60°C for 30 min. The scoured fabric was rinsed thoroughly in tap water and allowed to dry in the open air. The three commercial acid dyes used (Table 1), which were kindly supplied by Yorkshire Chemicals, were selected on the basis that they displayed moderate fastness on nylon 6,6 to the repeated washing protocol employed in this work at the depths of shade employed (2% omf in the cases of the red and yellow dyes and 6% omf in the case of the black dye). A commercial sample of Textan 3 (tannic acid) was kindly provided by OmniChem-Ajinomoto and Celvol 540 (87–89% hydrolysed PVA) was obtained from Celanese chemical; all other chemicals were laboratory grade reagents.

2.2. Dyeing

The dyes were applied using the equipment described earlier [1] using the method shown in Fig. 1; the pH was adjusted using McIlvaine buffer [6]. The dyeings were rinsed thoroughly in tap water and allowed to dry in the open air.

2.3. PVA aftertreatment

The aftertreatment method is given in Fig. 2; the equipment described earlier [1] was used, the application pH (pH 3) being adjusted using McIlvaine buffer. The aftertreated samples were removed, rinsed thoroughly in tap water and allowed to air dry.

2.4. Treatment with nylon 6,6 with tannic acid and PVA

Samples of nylon 6,6 were treated with 1.5, 5 and 10 g l^{-1} tannic acid (at pH 6) or PVA (at pH 4) using the method shown

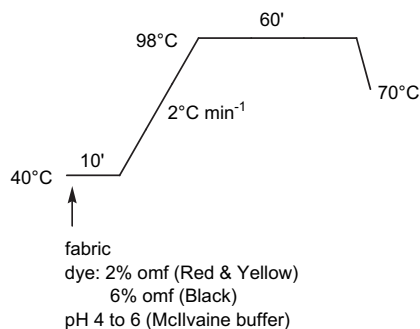


Fig 1. Dyeing method.

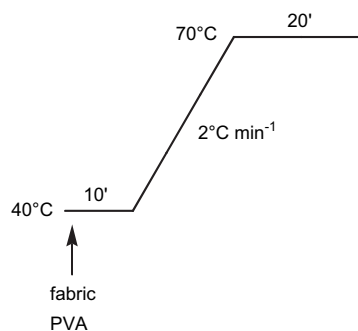


Fig 2. After treatment method.

in Fig. 3, the application pH having been adjusted using McIlvaine buffer. The treated samples were removed, rinsed thoroughly in tap water and allowed to air dry.

2.5. Colour measurement

All measurements were carried out using the equipment and procedures described earlier [1].

2.6. Wash fastness

The wash fastness of the dyed samples was determined using the ISO CO6/B2S (50°C) test method [7] used but was modified in that dyeings were subjected to five, consecutive wash tests and, at the end of each wash test, the washed sample was rinsed thoroughly in tap water (but was not dried) and a fresh sample of SDC multifibre strip was used to assess the extent of staining for each of the five wash tests.

3. Results and discussions

As mentioned, the three dyes were selected for use because each displayed moderate fastness to washing on the knitted nylon 6,6 fabric substrate used in this work. This is clearly evident from the colorimetric data presented in Table 2 and the reduction in colour strength (K/S values) which the dyeings underwent (Fig. 4) as a result of having been subjected to five repeated washes; the shade changes observed for the three dyes can be attributable to loss of dye from the dyeings rather

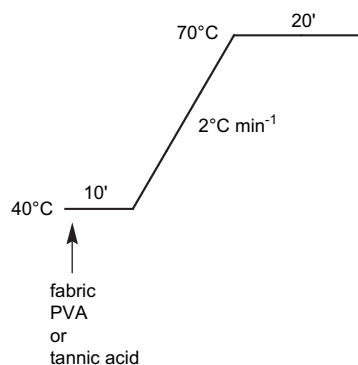


Fig 3. Treatment method.

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