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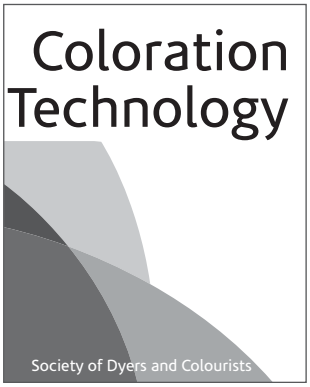
One-bath union dyeing of a modified wool/acrylic blend with acid and reactive dyes



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Pretreated wool/acrylic fibre was obtained by a facile amidoximation process. Fibre characterisation (nitrogen content, tensile strength, shrinkage, infrared spectra and X-ray diffraction) proved the success of the pretreatment. Union dyeing of wool/acrylic fabrics with acid and reactive dyes, namely CI Acid Red 40, CI Acid Blue 25, CI Reactive Red 194 and CI Reactive Blue 25, was obtained using a one-bath dyeing process. Different factors that may affect the dyeability of the blend fibre, such as dyebath pH, liquor ratio, temperature, time and dye concentration, were evaluated with respect to the dye exhaustion, fixation, colour strength, levelling and fastness properties. Excellent to good fastness was obtained for all samples, irrespective of the dye used. The result of the investigation offers a new viable method for union dyeing of wool/acrylic fibres in a one-dyebath process.

Introduction

Acrylic fibre is a less expensive alternative to wool and has, in many respects, replaced wool [1]. The outstanding chemical and physical properties of acrylic fibres, such as high strength, good abrasion and insect resistance, have led to many applications in apparel as well as in the production of wool/acrylic fibres, which are widely used in knitwear.

Conventionally, acrylic fibres, which are spun from a copolymer of acrylonitrile containing 1–15 percentage mass of several vinyl comonomers containing carboxylate or sulphonate groups, are dyed with cationic dyes [2,3]. Anionic dyes, namely acid and reactive dyes, are not normally used for acrylic coloration as these dyes suffer from being not substantive for the fibres as a result of the repulsive effects that occur between the anionic groups present in the fibres and those present in the dye molecules. In contrast, wool fibres are conventionally dyed with acid and reactive dyes because of the presence of functional groups, such as amino groups in the fibres, which would interact mainly with ionic and covalent bonds with these dyes, respectively [4]. Therefore, the dyeing of wool/acrylic fibres is traditionally conducted in a two-bath process, one for acid dyeing and the other for cationic dyeing of wool and acrylic components, respectively.

Alternatively, a one-bath dyeing method using one dye would be of interest, as it offers the desired union shade, together with energy saving. In this regard, a recent work has been reported using monofluorotriazine reactive cationic dyes [3]. In the interest of making acrylic fibre less hydrophobic, anionic dyeable and thus amenable for union dyeing of wool/acrylic blend in a one-bath dyeing process using one type of anionic dyes (acid or reactive dyes), it was thought that the partial conversion of nitrile groups present in the fibre into amidoxime groups would render the fibre more hydrophilic by virtue of its content of amidoxime groups. The pretreatment process is mild and efficient and is safely conducted in an aqueous solution of salt reagents at a nearly neutral pH [5]. The amidoxime groups (active dye sites) have a proven effectiveness in increasing the substantivity of acrylic fibre toward anionic dyes at an acidic pH [5–7].

However, to the best of our knowledge, the studies of one-bath union dyeing of modified wool/acrylic fibre blends with anioinic dyes have not been reported in the literature. In a continuation of our interest in exploring the dyeability of modified acrylic fibres, we report in this work the union dyeing of wool/acrylic fibres with acid and reactive dyes in a one-bath dyeing process, as this has the potential to save energy and materials and with a better environmental impact. The blank and different modified samples of wool/acrylic fibres containing different nitrogen contents are presented. Different factors affecting dyeability and fastness properties are thoroughly investigated. The effect of the pretreatment on the fine structure of the fabric using X-ray diffraction and its correlation with the colour strength of the dyed fabrics is also investigated.

Experimental

Materials

Wool/acrylic fabric

The wool/acrylic fabric used in this study was a 33/67 wool/acrylic blend, twill weave fabric (2/2) of equal warp and weft (24 threads/inch), supplied by Misr El-Mehalla Co. (Egypt). The fabric was soaped with 2 g/l of nonionic detergent (Hostapal CV; Clariant, Egypt) at 60 °C for 30 min, thoroughly rinsed and air-dried.

