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Full Length Research Paper

Application of new reactive and disperse dye on textile dyeing, printing with acrylate Eco friendly copolymers

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This research work examines the process of dyeing polyester/cotton fabrics with a highly effective fiber-reactive and a disperse dyestuffs namely, (E)-4-hydroxy-5-((4-((2-sulfophenyl)amino)-1,3,5-triazin-2-yl)amino)-3-((2-sulfophenyl)diazenyl)naphthalene-2,7-disulfonic acid and (E)-5-((4-nitrophenyl)diazenyl)pyridin-2(1H)-one, respectively in one pot processes of printing and dyeing. It gives special attention to modify the influence of some important parameters such as the pH, the temperature and the concentration of the dye-bath used. The disperse and fiber-reactive dyes were formulated by pigmented printing paste in a specified styrene-acrylic as a polymeric matrices, in two different concentrations of 3 and 5%. Thereafter, it was printed on cotton fabric and dyed on polyester fabric, dried at 95°C in 2 min and fixed at 150°C in 3 min. The characteristics of cured prints such as paste add-on, fastness to washing and dry/wet rubbing were evaluated, together with fabrics stiffness. The highest K/S was obtained and the fastness properties range between good and excellent for samples printed using styrene-acrylic matrices. The lowest K/S was obtained in the case of styrene-ethylacrylate used as a standard commercial binder. Using styrene-2-ethyl hexylacrylate gave K/S better than styrene-butylacrylate for two types of printed fabrics. Dyed textiles thereafter were characterized by good dry-rubbing and washing fastness but medium wet-rubbing fastness properties. The alkaline pretreatment was affected; the adhesion of the earlier mentioned disperses and fiber-reactive dyes in the company of chitin biopolymer, to the susbrate fabrics, which was manifested by the greater color strength. Pretreatment in an alkaline solution containing 10 g/l NaOH was permitted.

Key words: Styrene-acrylic binders, pigment printing of cotton, polyester textile fabrics.

INTRODUCTION

Textile printing is the most versatile and important of the methods used for introducing colour and design to textile fabrics. Considered analytically it is a process of bringing together a design idea, one or more colorants and a textile substrate, using a technique for applying the colorants with some precision (Chiou and Schoen, 2006). Pigment textile printing is not only the oldest but also more than 80% of the printed goods are based on pigment printing to its obvious advantages, such as versatility, ease of near final print at the printing stage itself (Najafi and Aghaee, 2011). Acrylic resins, which have an important commercial application in the paint industry, are prepared through the polymerization of acrylic and meth acrylic acids or their corresponding esters. Thickening agents play a paramount role in the formulation of printing pastes, ensuring through the modulation of the rheological properties, sharp and clean drawing patterns, by preventing dye migration, a homogenous distribution of the printing paste on the screen and its uniform flow through the screen openings. Sodium alginates have become very important for printing paste thickening because of their ready solubility, even after high-temperature fixation treatments (Jorgensen

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and Soucek, 2000). The formulation to be cured or crosslinked by electron beam irradiation usually contains unsaturated monomers (double bonds), oligomers and other additives depending on the desired properties (Krumova et al., 2000). Emulsion polymerization is an important industrial method, because it produces high molecular weight polymers, and because there is no or negligible content of volatile organic compounds (VOC). These emulsions are generally opaque, milky and viscous; but they can also be translucent emulsions with particle sizes ranging from about 8 to 80 m, when a very high surfactant concentration is employed (Adamson, 1990). Reactive textile printing is not only the oldest but also more than 45% of the printed goods are based on pigment printing to its obvious advantages, such as versatility, ease of near final print at the printing stage itself (Adhikari et al., 2008). This reactive printing makes use of mineral turpentine which is involved in making alginate (Wicks and Jones, 2005). The selection of the thickening agent, which in most cases is confined to polysaccharides and their derivatives with high molecular weight, is determined by the fabric to be printed, the printing conditions and above all, the type of dye used. Depending on their chemical structure, dyes may interact with thickening agents, to form complexes or to give a chemical reaction, so causing a variation of the rheological properties of the printing pastes and hence, of their application characteristics (Mooney and Colliod, 1953). Sodium alginates have become very important for printing paste thickening because of their ready solubility, even after high-temperature fixation treatments. The use of synthetic thickening agents and new developments in printing auxiliaries have also contributed to the increasing importance of pigment printing, altogether, environmental aspects such as minimization of formaldehyde emissions and carbon dioxide content must be taken into account (Adamson, 1990). At the same time, novel binder systems allow a much softer handle to be attained (Verbruger and Appl, 1988).

EXPERIMENTAL

Materials

Fabrics

Polyester/cotton fabric its 65/35 blends, enzymatic method with 2 g/l by Baylase AT (Bayer co. Germany) at 70℃ 40 min and then washing hot water with add 0.5 g/l nonionic soap, scoured and bleaching H2o2 35% 4 g/l, NaOH 30% 2 g/l , stabilizer 2 g/l , wetting agents 1 g/l in 90℃ at 45 min and then washing hot water and cold water and air dried at room temperature when finishing in pretreatment dyeing with(E)-4-hydroxy-5-((4-((2-sulfophenyl)amino)-1,3,5-triazin-2-yl)amino)-3- ((2-sulfophenyl)diazenyl)naphthalene-2,7-disulfonic acid and (E)-5-((4-nitrophenyl)diazenyl)pyridin-2(1H) (Figure 1) dyes.

Polyester/cotton fabric, PE/CO 65/35 (120 g/m2), containing in warp and weft disperse/reactive ions PE/Co 65/35 yarns of linear density 10× 2 tex. The samples were washed for 50 min in an aqueous solution containing 2 g/l of wetting agent Diadavin EWN (Bayer. co Germany) with a liquor ratio of 1:30 at 70℃, and then rinsed in cold water and dried at 100℃. In order to improve the adhesion of chitin to the smooth surface of polyester fibres, an alkaline pretreatment in water solution containing 0, 5, 10 and 15 g/l of NaOH for 25 min at 95℃ with a liquor ratio of 1:30 was performed. Subsequently, the samples were rinsed twice in cold water and dried at 100℃. Three chitin samples of different viscosity and different deacetylation degree (Sails Chem. Co Iran) were used.

Dyeing of polyester/cotton fabric

For satisfactory dispersion in the dye bath, the dye were initially finished by mortar milling in the presence of a specially selected dispersing agent, polyester/cotton fabric were dyed in Atlas dyeing machine at a liquor ratio of 1:40 using distilled water. The dye bath was prepared with the dye concentration 2% owf and with 1.5 g/l anionic carrier (Levegal PEW Bayer Co. Germany). The pH was then adjusted, 6.5 and 0.2 mol sodium sulphate solution. Dyeing was started at 45℃ for 15 min, and then the dye bath temperature was raised at a rate of 1.5 to 2℃ /min to 70℃. Dyeing was commenced at 70℃ and then the dye bath temperature was raised by 1℃ /min to 90℃, maintained at this temperature for 60 min and cooled to 60℃. After 30 min at 60℃, 20 g/l of alkali (Na_2Co_3) was added to effect fixation of the reactive dye on cotton and maintained at 60℃ for further 30 min. The dyeing were rinsed and soaped at 95℃ for 10 min with 1.5 g/l soaping agent and then dried at room temperature (Figure 2).

Dye was introduced into the dyeing along with 200 ml buffer solution at various pH values. After the dye batch temperature reached 90℃. Each 2 g cotton and polyester fiber was immersed in the liquor and kept there for 1 h. After this the dyed sample was cotton and polyester were dissolved by calcium chloride/ water/ethanol mixture (1:7:2 molar ratio) and 90% formic acid, respectively, cooled to room temperature and diluted to a total volume of 100 ml. The concentration solution was determined by colorimetry and the amount of dye fixed was calculated. The amount of dye removed from the batch determined by adding the amount of dye extracted to the amount of dye fixed on the fiber.

The reactive /disperse dyes used gave negligible fixation on polyester fiber and so only the unfixed dye was determine by colorimetry of the residual solution.

Printing recipe

Preparation of printing pastes was prepared according to the removed, and the unreacted dye extracted with methanol. The dyed following recipe: Imperon (Pigment) dye 3 to 5%, acraconz F 3%, binder 4%, ammonium sulfate 1%, urea 0.5% and balance to 100% water.

RESULTS AND DISCUSSION

Screen printed cotton and polyester fabrics

The effect of increasing the fixation temperature on the color strength of screen printed on either cotton or polyester upon using EAS as a commercial binder and BAS containing Imperon Brilliant red B of different concentrations 3 and 5% and the time of fixation of 2 min are represented in Figures 5 to 8, respectively. It is clear from the Figures 3 to 4 that the color strength of the printed fabrics (using either 3 or 5% dye) is nearly

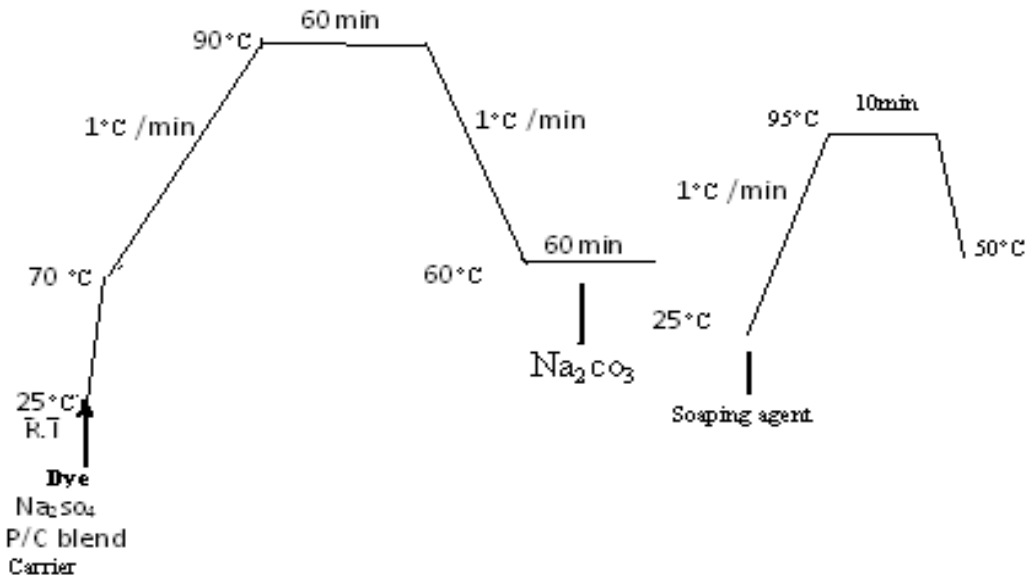

Figure 1. Structure chemical dyes.

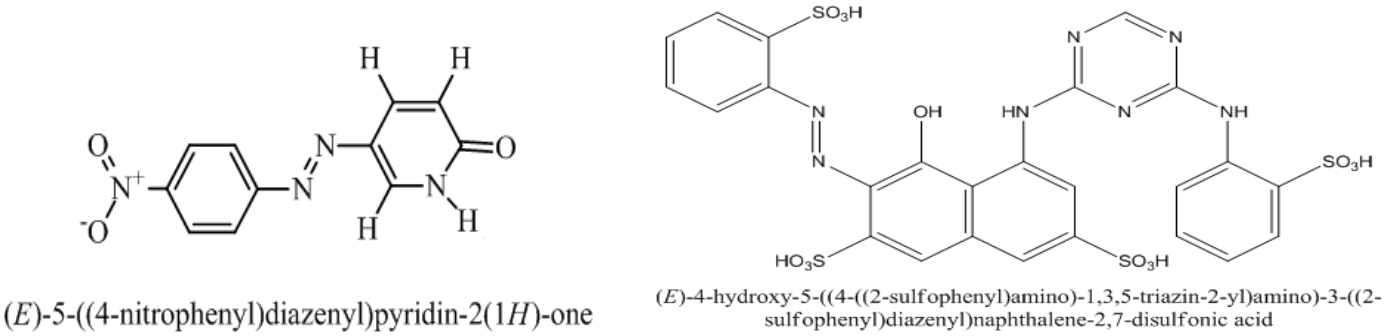

Figure 2. One bath dyeing profile of PE/Co blend with temporarily solubilized disperse/ reactive dyes.

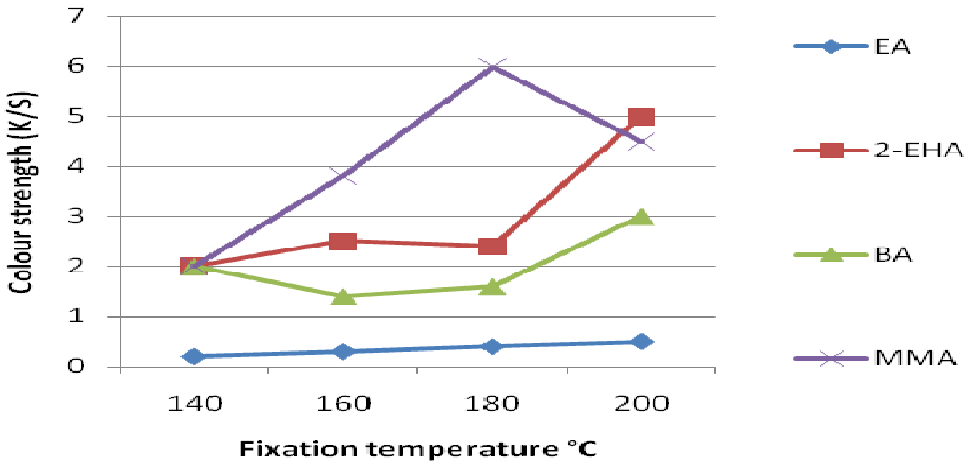

Figure 3. The effect of the type of binders used on the color strength of screen printed cotton fabrics using 3% Imperon Brilliant red B, the time of fixation is 2 min.

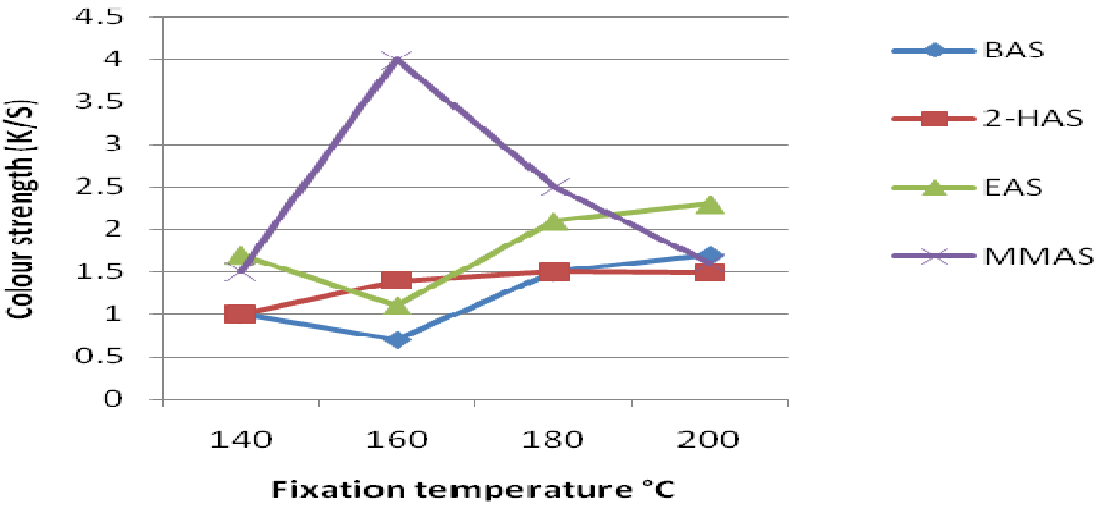

Figure 4. The effect of the type of binders used on the color strength of screen printed cotton fabrics using 3% Imperon Brilliant red B, the time of fixation is 2 min.

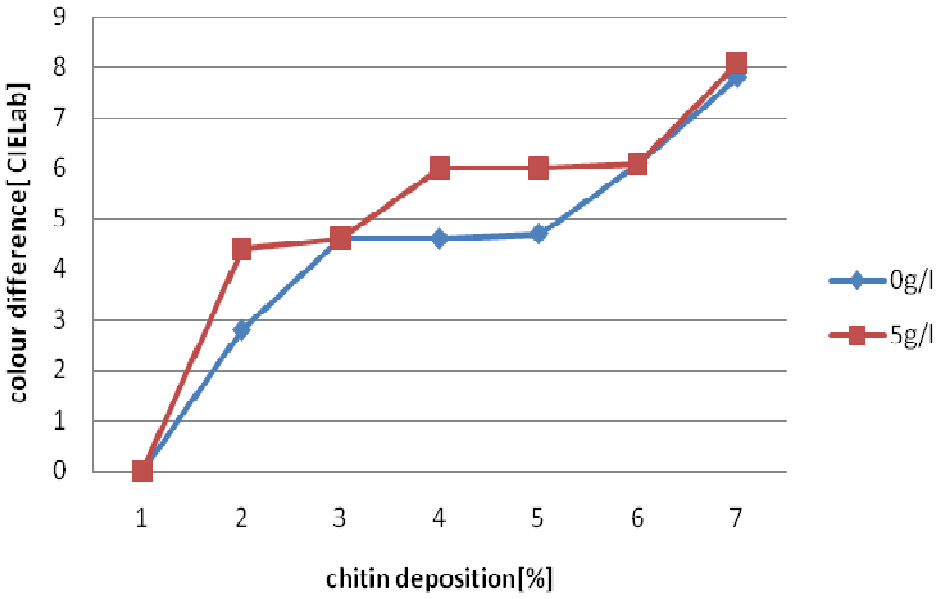

Figure 5. Changes in colour difference of polyester/cotton fabric samples dyed using disperse/reactive Blue after chitin (I) NaOH concentrations 0 g/l and 5 g/l.

comparable. Dye concentration needed to increase in the binder concentration to make fixation to this dye through the polymerization process to this binder.

It is also clear from Figures 3 and 4 that the highest color strength values were obtained in case of using styrene acrylate based as a binder in the printing paste as compared to the results obtained upon using the commercial binder of EA, which gives the lowest value of color strength in case of screen printed cotton fabrics, while in case of using 2-EHA, the K/S values were better than the values obtained in case of using BA. The K/S values of screen printed cotton and polyester fabrics fixed at temperature 16℃ were 0.31, 1.9, 1.77, 6.83 and 0.85, 1.01, 0.65, 4.73 by using E, styrene based on 2-EHA, styrene based on BA, styrene based on MMA a binder in printing paste containing 3% Imperon red B, respectively. This may be due to either the difference in the structure of the binder used or the amount of unsaturat groups found in the binders which is responsible for fixation of the dye through the polymerization process that happened

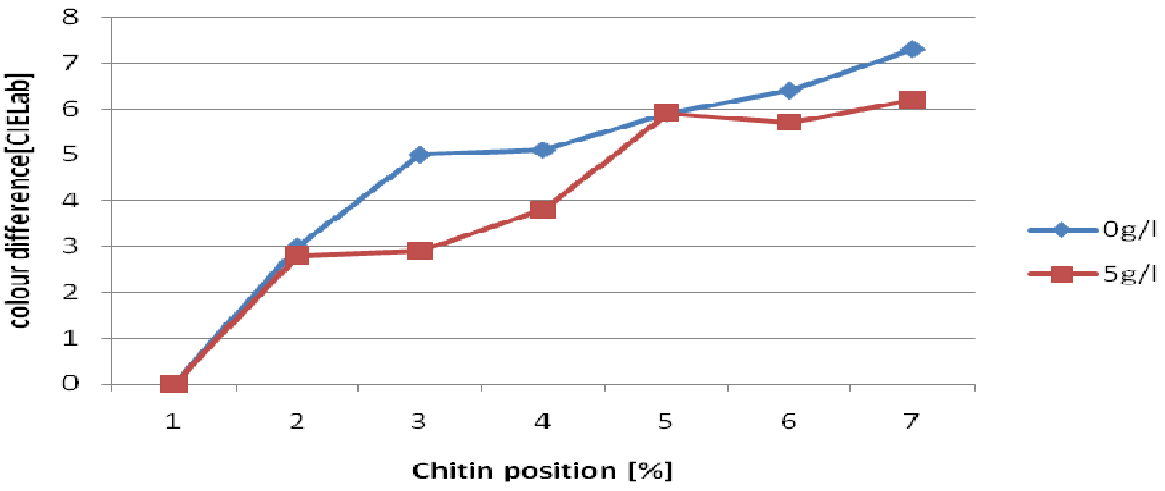

Figure 6. Changes in colour difference of polyester/ cotton fabric samples dyed using disperse/reactive Blue after chitin (II) NaOH concentrations 0 g/l and 5 g/l.

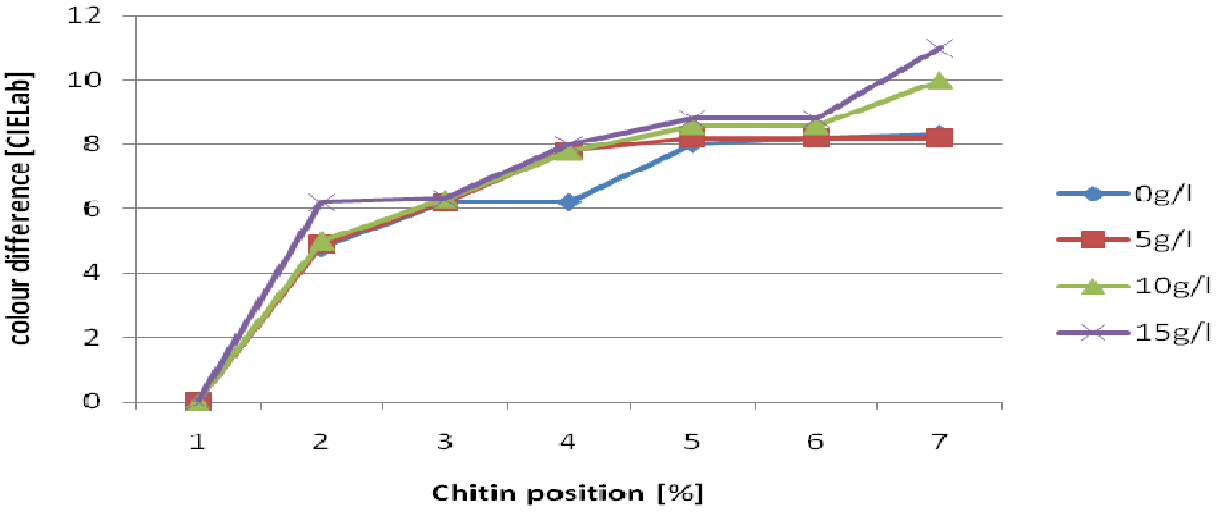

Figure 7. Changes in colour difference of polyester/cotton fabric samples dyed using disperse/reactive Blue after chitin (III) NaOH concentrations 0 g/l and 5 g/l.

to these oligomers, that is binders. The colour strength increases with an increase in chitin deposition independent of the degree of deacetylation. The colour difference between the dyed blank samples and the samples with chitin amount grows significantly, and has a polyester/cotton fabric samples (Figures 3 and 4).

The deacetylation degree of chitin does not essentially affect either the strength of colour of textiles or the colour fastness to rubbing and washing. The viscosity of chitin (which depends on the molecular weight) decides its application properties. The stiffness of the chitin deposited samples increases with an increase in the chitin deposition on textile. According to the data obtained, the polyester/cotton fabrics are best finished by means of disperse/reactive dyestuffs after an alkaline pretreatment in solution containing.

10 g/l of NaOH and followed by impregnation with chitin solution with concentration below 1 to 7% w/v, independent of the chitin characteristic (Figures 5 to 8).

Fastness properties

Table 1 shows the color strength and overall fastness properties of screen printed natural and synthetic fabrics using synthesis styrene acrylate based on EA as a

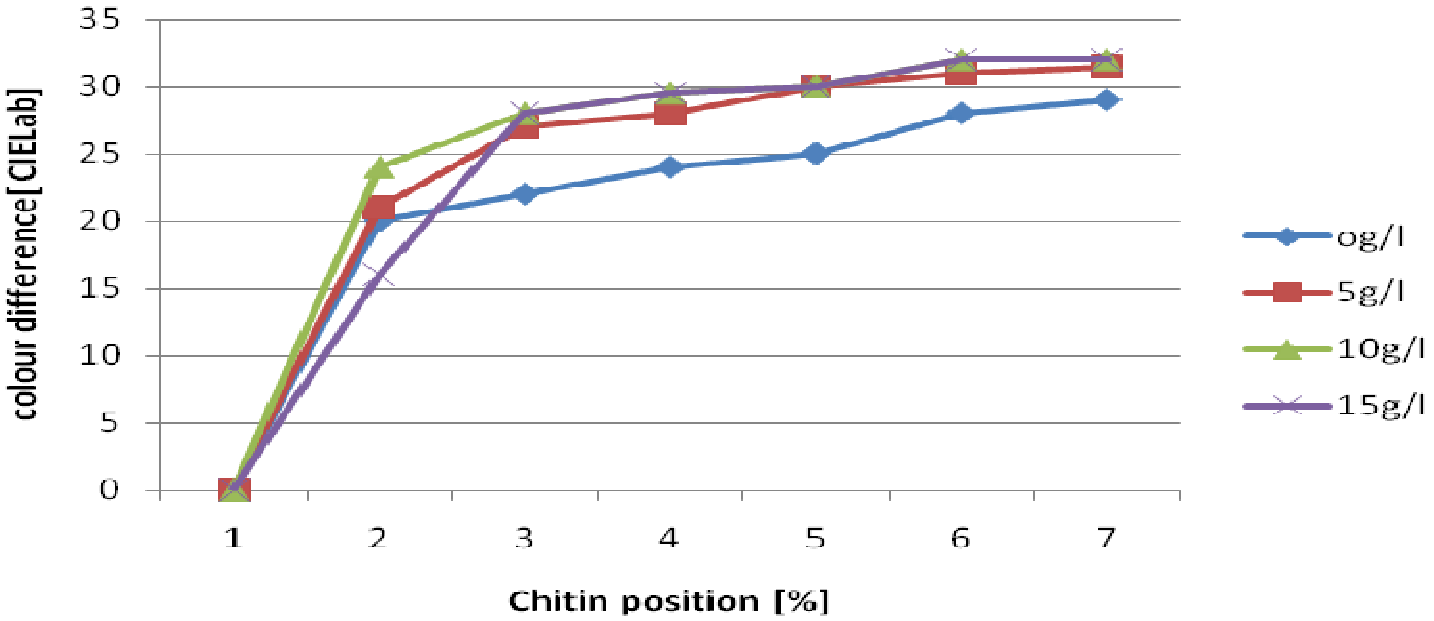

Figure 8. Changes in colour difference of polyester/ cotton fabric samples dyed using disperse/reactive Red after chitin (I) NaOH concentrations 0 g/l, 5 g/l, 10 g/l and15 g/l.

Table 1. Color strength and overall fastness properties of screen printed synthetic fabrics using prepared polyurethane acrylate based on either polyethylene glycol or glycerol ethoxylate-co-propoxylate and/or Ebecryl 2002 as a thermal curable binders in printing paste using 3% Imperon Brilliant red B, the time of fixation is 2 min.

polyester				Cotton			
Washing fastness		Robbing fastness		Washing fastness		Robbing fastness	
Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
3-4	3-4	3-4	3-4	4	3-4	4	3-4
4	4	4	3-4	4-5	4	4-5	4
3	3-4	3-4	3	4	3-4	4	3-4
3	3-4	3-4	3	4	3-4	3-4	3

thermal curable binder used in prepared printing paste containing 3% Imperon Brilliant red B.

It is clear from the data in Table 1 that the K/S and overall fastness properties not only depend on the type of binder used in printing paste but also on the type of textile fabric printed. The highest color strength for cotton and polyester of printed fabric was obtained upon using MMA as a binder in printing paste and the fixation temperature was 16℃ for 2 min, and the lowest color strength in case of cotton and polyester printed fabrics upon using EA the change in color due to washing ranged from poor to good for all printed fabrics. The rubbing, washing and perspiration fastness ranged from good to excellent in case of using prepared binder. This was true irrespective of the nature of the binder used and/or the type of fabric printed.

Conclusions

These results show that some novel prepared aqueous binder of styrene acrylate based on having zero volatile organic compounds can be used safely for preparing printing paste for screen printing of cotton and polyester types of textile fabrics using pigment dyes. The highest K/S is obtained and the fastness properties range between good and excellent for samples printed using methyl metha acrylate styrene (MMA) based, this is true irrespective of the type of printed fabric. The lowest K/S is obtained in case of using ethyl acrylate styrene (EA) as a commercial binder. The binder of 2-ethylhexylacrylate (2-EHA) gives K/S better than the binder of Butyl acrylate styrene (BA) for two the types of printed fabrics. It is possible to polyester/cotton fabrics with disperse/reactive

dyestuffs after chitin treatment. Dyed textiles are characterized by good dry rubbing and washing fastness but medium wet-rubbing fastness properties. The alkaline pretreatment affects the greater adhesion of chitin to the surface of polyester fibres, which is manifested by the greater colour strength. Pretreatment in an alkaline solution containing 10 g/l NaOH is permitted.

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