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Research Article

A Comparative Study on Discharge Printing on Cotton and Silk Using Conventional and Ecological Recipe

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Abstract

Textile printing is an ancient art from the Egyptian tomb era to a modern era, which is one of the most important process for the manufacturers. Art being a creative pattern of imagination and immense competition and globalization in the textile world, were the key major concern for the manufacturers is from the customer who are mostly looking for eco-friendly products, textile printing has become more dependable on the science than it was.The discharge printing methods is one of the popular technique used major for its aesthetic attractiveness of the product. Discharge printing has opened the door over past 6-7 years for the mass garment production after developing a dischargeable ink system. Mostly 20-30% of the chemicals are used in one cycle of printing which are hazardous to the environment and some of the chemical methods, toxins like carbon monoxide, sulphur dioxide, zinc oxide and many more which harms the environment. The main objective of the study is to compare the conventional and ecological discharge printing paste by developing a hand screen printing on reactive dyed cotton and silk fabric and tests conducted on the different parameters of the printing paste to understand the effluent level to the environment.

Keywords: Discharge Printing; Ecological Printing; Hand Screen; Reactive Dyes

Introduction

Discharge printing has been around for decades. But only in the past 7-8 years screen printers in the industry have recognized it seriously. In the early years of discharge printing, the finished discharge print needed to be steamed during the drying process. This discouraged the use of discharge systems in the finished garment arena. The newly developed discharge ink systems are chemically reactive and don't need to be seam- neutralized. This advancement opened the door to discharge printing for the average screen printer. Discharge Printing is also called Extract Printing. This is a method of applying a design to dyed fabric by printing a color-destroying agent, such as chlorine or hydrosulfite, to bleach out a white or light pattern on the darker colored ground. In color-discharge printing, a dye impervious to the bleaching agent is combined with it, producing a colored design instead of white on the dyed ground.

Karthikeyan [1] have discussed about replacement of hazardous chemical with eco- friendly enzymes in textile discharge printing. Enzymatic discharging printing carried out with Phenol oxidizing enzyme such as Peroxidase with hydrogen peroxide by selectively discharged reactive dyes from the cotton fabric at selected areas creating a printed surface.Bio-Discharge printing on Cotton knitted fabrics using enzyme and brewer's yeast was studied by Ragheb [2]. Innovative technology to use eco- friendly bio materials comprise Laccase, Valumax A828, Valumax A356 as well as brewer's yeast to replace the hazard chemicals which are used in discharge printing has been done successfully. The effect of technique applied, enzyme concentration, pH of the printing paste, enzymatic treatment time and temperature on as well as the nature of reactive dye used on the colour discharge were studied. Laccase enzyme formulation has been used in discharge printing of cotton fabrics dyed with different reactive dyes and the effect of enzyme conc., pH of the printing paste, treatment time and temperature of enzymatic treatment as well as the viscosity of the printing paste on colour discharge studied by Abd El-Thalouth [3].

Gregory [4] have investigated a process for enzymatic discharge printing of the surface of dyed fabric, especially cellulosic fabric such as denim, including an oxidoreductase and enhancing agent system. Enzymes and their role in Resist and Discharge Printing Styles was reviewed comprehensively by K Haggag [5]. Discharge printing of cotton fabrics with sodium- and zinc formaldehyde sulphoxylate with different fixation conditions was discussed in this study conducted by Yavas [6]. Discharge printing of the real silk fabric was performed with vat dye paste for printing the patterns and vinyl-sulfone reactive dye for the ground by Zhou Qiu-bao [7]. A review by Ramesh Babu [8] discusses cotton textile processing and methods of treating effluent in the textile industry. Wang et al. [9] have demonstrated the removal of organic compounds during treating printing and dyeing wastewater. In the present work,a hand screen was developed, and degree of whitness of discharge printed material, effluent of conventional discharge paste and ecological discharge paste and the tensile strength and abrasion on the printed material were studied.

Materials and Methods

Material

The fabrics used for the study had the physical properties as shown in Table 1.

Table 1: Physical Properties of Cotton and Mulberry Silk used for the study.

Fabric/ properties	EPI	PPI	GSM	Thickness (mm)	Warp count (Ne)	Weftcount (Ne)
Cotton	78	100	85	0.28	54	58
Mulberry Silk	105	115	37	0.12	33.7	59.7

Remazols dyes are based on vinyl sulphone, it as the reactive group and were mainly used in the dyeing. The hand screenof 8”X 6” was prepared with Line artwork monofilament polyester mesh, with floral design on a wooden frame. The conventional discharge print paste was prepared using Zinc oxide, Rangolite C or sufolite, CMC gumming agent. Eco- friendlylogical discharge paste was prepared using formaldehyde free SP245 Ecological discharge paste white, SP246 Reduce powder supplied by M/s Anodalukimya, Turkey (www. anodalukimya.com). The degumming of silk was done using a bath of 1:40 material to liquor ratio. 1gpl of non-ionic wetting agent, 5gpl of soap and 1gpl of soda ash was added to the bath. Dyeing of Cotton and silk with Vinyl sulphone dye was carried out using the receipe (MLR: 1:20, Glauber’s salt: 50gpl, Soda ash: 5gpl, Caustic soda: 1gpl, Soaping: 1gpl soap, Dye 3% owf) and dyeing of silk was done using the receipe (MLR: 1:50, Glaber’s salt: 60gpl, Sodium bicarbonate: 5gpl, Soaping: 1gpl soap, Dye 3% owf)

After printing and drying, steaming was carried out at 105 0C for 2-3minutes. Some samples were cured at 160 0C for 2min. After the printing on samples, effluent of the samples was collected and tested for the following Experiments using standard test methods.

a) Determination of pH of Effluent by pH Meter.

b) Determination of the total, permanent and temporary hardness of effluent samples BY EDTA Method.

c) Determination of the Salinity of Effluent Sample.

d) Determination of the total dissolved solids present in the samples.

e) Determination of the electrical conductivity of effluents.

f) Determination of the total solids present in the samples.

g) Determination of the chemical oxygen demandof the effluent sample (5220 b. Open reflux method).

h) Determination of the breaking strength and Elongation of the given fabric by grab test. (ASTM D5034 - 09).

g) Determination of the resistance to abrasion Martindale tester (ASTM D4966-12).

h) Determination of the degree of whiteness of The discharge printed fabrics (ASTM Method E313-96).

Results and Discussion

pHand Hardness of the Effluent

pH is the negative logarithm of the hydrogen (H’) ion concentration, more precisely hydrogen ion activity. pH of ecological effluent was neutral whereas, pH of conventional effluent was slight alkaline. Though pH value is within permissible level conventional effluent shown higher value than the ecological effluent. The results of pH and hardness is presented in Table 2. The total hardness for ecological effluent was 26ppm where as conventional effluent was 145.3ppm. The permanent hardness for ecological effluent was 17.03ppm and where as conventional effluent result was 116ppm. The temporary hardness of effluent results was 8.7ppm for ecological and for conventional, it was 29.3ppm. Due to the presence of alkaline and sulphonates in effluent, it can be concluded that conventional reading is much higher than ecological reciepe for printing.

Table 2: Characteristics of Effluents.

Effluent Properties	Printing with print paste of	
	Ecological Recipe	Conventional Recipe
Colour	Colorless	Off-white
Odour	Slightly chalk odour	No odour
Turbidity	No turbidity	Slight turbidity
pH	7.2	8.5
Total hardness (ppm)	26	145.3
Permanent hardness (ppm)	17.03	116
Temproray hardness (ppm)	8.7	29.3
Salinity (mg/l)	0.4	1.5
TDS (mg/l)	501	950
Electrical Conductivity (Kohms')	1.07	12.71
Total Solids(mg/l)	4	10
Chemical Oxygen Demand (mg/l)	23	57

Salinity of Effluent

Salinity is a measure of concentration of salts in water. The salinity value for ecological effluent was 0.4mg/l and whereas salinity value for conventional effluent was 1.5mg/l. It could be concluded, due to dissolved salts present more in conventional effluent, it as higher value than ecological effluent.

Dissolved Solids of Effluent

The TDS values of the samples was 501mg/l for ecological effluent and 998mg/l for conventional effluent, which was the higher value than ecological effluent.

Electrical Conductivity of Effluent

Electrical conductivity is the measure of the ability of an aqueous solution to convey an electric current. This ability depends upon the presence of ions, their total concentration, mobility, valence and temperature. The highest value was found in conventional effluent it was 12.71k-ohms and Ecological effluent had least value 1.07 k-ohms.

Total Solids of Effluent

Total dissolved solids (TDS) is defined as all inorganic and organic substances contained in water that can pass through a 2 micron filter. In general, TDS is the sum of the cations and anions in water. The result showed in ecological effluent as the least value that is 4mg/l where as conventional effluent showed higher result as 10 mg/l.

COD of Effluent

The Chemical Oxygen Demand (COD) test measures the oxygen required to oxidize organic matter in water and wastewater samples by the action of strong oxidizing agents under acid conditions. The lowest value was found in ecological effluent and highest value was found in conventional effluent that is 23mg/l and 57mg/l respectively. In conventional effluent due to chemicals like sulphoxylate, carboxymethylate, zinc is present oxygen demand is more.

BreakingStrengthandElongation

In Table 3, the comparison of control sample and ecological and conventional samples are shown for breaking strength and elongation. It is clear that withstanding stress of the load for cotton has decreased in case of ecological and increased in conventional wrap direction and elongation is increased than the control sample in both the samples 10% and 6% respectively. Withstanding stress load in both the samples compared to control sample was similar but in ecological minute various as seen and elongation of both the samples than the control sample as decreased 5% and 7% respectively Withstanding stress of the load for silk has decreased in both the case than control sample by 2kg and elongation was same in ecological warp direction and conventional sample as decreased by 4kg than control sample. Withstanding stress load in both the sample compared to control sample was decreased by 2kg and 3kg respectively and elongation of ecological sample was decreased 13% and conventional sample by 1% increase than the control sample.

Table 3: Breaking strength and Elongation.

Fabric / Printing recipe	Load (kg)		Elongation (%)	
	warp	weft	warp	weft
Silk (control)	11.32	10.56	32.26	32.53
Silk printed with Ecological recipe	10.34	10.22	42.66	28.26
Silk printed with conventional recipe	14.8	10.5	38.93	26.4
Cotton (control)	15.2	14.42	41.33	39.73
Cotton printed with Ecological recipe	13.36	12.18	41.33	26.4
Cotton printed with conventional recipe	13.56	11.42	38.66	40.8

Resistance to Abrasion

Abrasion resistance is the ability of a fabric to resist surface wear caused by flat rubbing contact with another material. Table 4 shows the results in comarison. It is evident that for ecological sample it was 1.43% weight loss than control sample and conventional as 2.02% loss compared to ecological sample that had weight loss lesser than conventional sample. It also shows that ecological sample had 1.94% weight loss than control sample and conventional as 1.02% loss. While comparing the conventional sample weight loss is lesser than ecological sample.

Table 4: Resistance to Abrasion and Whiteness Index.

Fabric / Printing recipe	Weight loss % after abrasion	Whiteness index
Silk (control)	19.56	81.22
Silk printed with Ecological recipe	21.72	66.323
Silk printed with conventional recipe	20.07	79.175
Cotton (control)	9.09	83.06
Cotton printed with Ecological recipe	10.83	81.098
Cotton printed with conventional recipe	11.11	76.98

Whiteness Index

Whiteness is the degree to which a surface is white. Degree of whiteness in cotton ecological sample was higher than the conventional cotton sample. Whereas, degree of whiteness in the conventional silk sample was higher than silk ecological sample

Summary and Conclusion

Ecological discharge paste was ready to use where as conventional paste needs preparation before printing. In both the cases printing was easier but ecological paste needs less efforts while printing compared to conventional paste.To get accurate design and proper discharge of ground fabric in ecological discharge paste right quantity, temperature, duration and method to follow or else yellowing of the fabric in silk was found and right whiteness effect can't be achieved.In the various effluent tests of the ecological effluent sample and conve ntional effluent sample, ecological effluent shows good results compared to conventional. Though conventional was within the permissible limits it was almost to tolerance level and had much higher value than ecological sample. In Chemical Oxygen Demand, hardness of effluent and Total Dissolved Solids, it had very higher value which requires mild treatment before passing effluent to drainage. In the tensile strength test and abrasion resistance test, there was slight various in the ecological and conventional samples compared to control sample this would be due to the application of discharge of dye on the fabric, there would be changes in bonding of fibers and fabric structure. Its observed that ecological discharge paste is better than conventional paste and it can be replaced instead of conventional paste containing hazardous Sulphoxylate Formaldehyde.

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