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EFFECTS OF DIFFERENT FINISHING AGENTS ON COLOR STRENGTH VALUES OF SUBLIMATION TRANSFER PRINTING OF COTTON FABRICS

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Abstract: *Sublimation transfer printing is based on printing the disperse dyestuff onto the transfer paper and contacting the printed transfer paper with the fabric under temperature and pressure. The dispersed dyestuff in the transfer paper is transferred to the fabric by passing from the solid phase to the gas phase with temperature. Sublimation transfer printing has some advantages such as low investment cost compared to conventional printing machines, less space requirement, etc. However, sublimation transfer printing is only suitable for synthetic fibers, especially polyester fibers. This limits the use of this type of printing. In recent years, research on the possibilities of using sublimation transfer printing in the printing of natural fibers has been increasing. The present work investigated silicone agents for the sublimation transfer printing of cotton in terms of color and fastness properties. The process variables were also investigated, such as printing temperature and time. In this study, hydrophobic macrosilicone, hydrophobic microsilicone, hydrophilic macro silicon, hydrophilic microsilicone, dimethylol dihydroxy ethylene urea, and fluorocarbon were used. Two concentrations of finishing agents were applied (30 g/l before printing and 15 g/l before printing + 15 g/l after printing). Three different printing times (30 sec., 50 sec. and 90 sec.) and temperatures (180ºC, 200ºC and 220ºC) were also applied. Color strength values of printed fabrics were investigated.*

Key words: *silicone, dimethylol dihydroxy ethylene urea, fluorocarbon, dispers dyes, cotton, sublimation printing.*

1. INTRODUCTION

Recently, sublimation transfer printing has attracted attention due to advantages such as, simplicity of process, space requirement, and relatively investment cost. The process is based on the transfer of dispersed dye in the vapor form from paper to fabric. Sublimation transfer printing was first discovered coincidental by a researcher name was Kartaschoff, who was from Celanese, during a set of experiments with disperse dyes and acetate fibers However process has important limitations that disperse dyes have no interaction with natural fibers. A few studies were done at using sublimation transfer printing for cellulosic fibers. Three prominent processes are focused by researchers. The first one is changing the ink formulation using appropriate polymers, the second one is using a sandwich layer, which is a film, and the third one is modifying the cellulose using resins, finishing agents , etc [1-4]. Cellulosic/polyester fibre blends, such as linen/polyester and cotton/polyester, also had been attracted by researches due to the difficult applicability of disperse dyestuffs [5,6]. Recently, nano-level coating processes such as layer - by - layer offer the opportunity to apply in this area [7].

2. EXPERIMENTAL

2.1 Material

In this study, 100% cotton, 240 g/m^2 unit weight 2x2 panama woven fabric was used. The fabric was provided to be ready for dyeing. Untreated packing paper, which had 50 g /m^2 unit weight, was used as a transfer printing paper. Inks (CMYK) were provided by Dyestar. The silicones were kindly supplied by Rudolf Duraner, which are listed in Table 1.

Table 1: Silicones

Trade Name	Chemical Structure	Function	Curing Conditions
RUCOFIN GWE	Polysiloxane compound nonionic	Hydrophobic macrosilicone	2 min. at 150ºC
RUCOFIN GWS	Polysiloxane compound nonionic	Hydrophobic microsilicone	1 min. at 170ºC
RUCOFIN GES	Quaternized Polysiloxane compound cationic	Hydophilic microsilicone	3 min. at 150ºC
RUCOFIN GSQ 200	Polysiloxane mixture cationic	Hydrophilic macrosilicone	3 min. at 150ºC
RUCON FAS	Dimethylol dihydroxy ethylene urea	Crosslinking agent	1 min. at 170ºC
RUCOSTAR EEE6	Fluorocarbon dendrimers	Fluorocarbon	2 min. at 150ºC

2.2 Methods

Application of finishing agents was done by the padding method using a vertical flouard (Ataç, Turkey). The take up value was 90%. After padding, all samples were dried at 105 ºC using a laboratory type oven. The pH of the distilled water to be used before the process was adjusted to pH 4.5 with acetic acid. Two experimental sets were formed. The first set was the application of finishing agent at 30 g/l concentration before printing and the second set was application at 15 g/l concentration before and after printing. Printings were made at different temperatures and times to investigate the influence of these variables on the print quality. Therefore, printings were applied at 3 different temperatures such as 180ºC, 200ºC and 220ºC. Variables were 30 seconds, 50 seconds, and 90 seconds for time. The printing process was done only the top plate, which was heated in the sublimation test equipment with SDL Atlas M2478 iron. The color strength of the printed fabrics was determined according to Kubelka-Munk formula (1) using a Minolta (3600D) spectrophotometer (D65, 10º).

$$K/S = (1-R)^2/2R \qquad \textbf{(1)}$$

3. RESULTS AND DISCUSSION

Color strength (K/S) values of untreated printed fabrics are depicted in Figure 1. The highest value was obtained at 200 ºC and 90 s.; however, all values were observed below 1. This situation is well known because of no affinity of disperse dyes to cellulose.

Figure 2 shows the color strength values of hydrophilic microsilicone -treated fabrics. The results were higher than the untreated fabrics and the highest value was obtained at 200 ºC and 90 sec.

in the case of 30 g/l concentration of finishing agent. Color strength values of hydrophilic macrosilicone - treated fabrics are depicted in Figure 3. The highest color strength value was obtained in the case of 30 g/l finishing agent concentration (before printing), 30 sec. printing time and 200ºC printing temperature. The differences between macro and microsilicone are not significant.

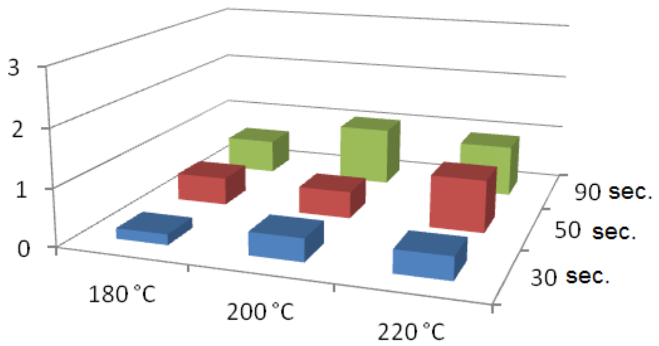

Fig. 1: K/S of Untreated Fabrics

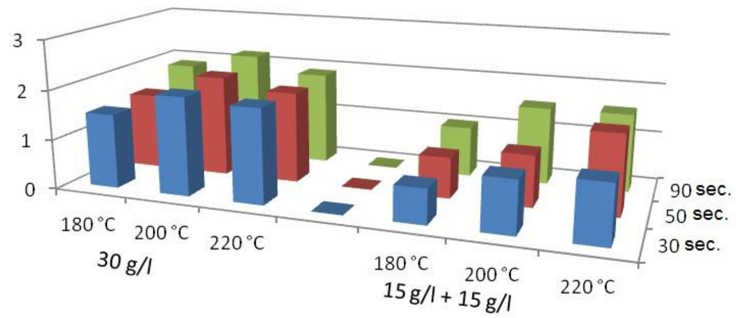

Fig. 2: K/S of Hydrophilic Micro Silicone Treated Printed Fabrics

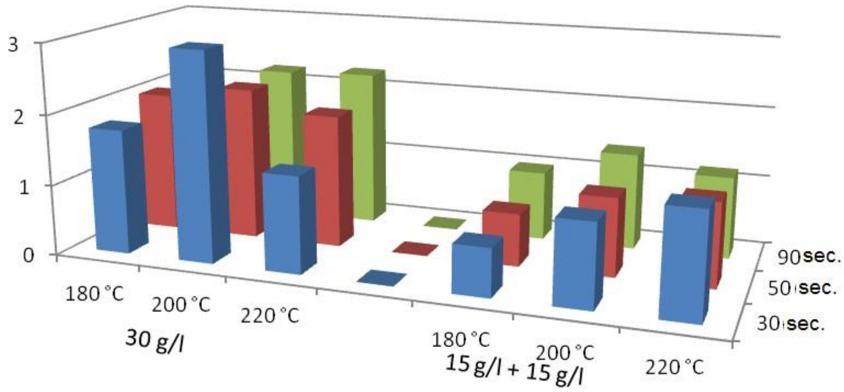

Fig. 3: K/S of Hydrophilic Macro Silicone Treated Printed Fabrics

Hydrophobic macrosilicon applied samples are exposed to sublimation transfer printing with different concentrations, temperature and process time. K/S values of the samples after printing are given in Figure 4. When the values are examined, the effects on K/S of concentration difference of these two values are found to be lesser than the sample hydrophilic finishing treatment applied. The highest K/S value is obtained from the concentration 15 g/L+15 g/L. printing conditions in 220°C and 30 seconds. K/S values of the that is hydrophobic microsilicon applied samples after sublimation transfer printing are given in Figure 5. The highest K/S value is obtained from the concentration 15 g/L+15 g/L in 200°C and 90 seconds.

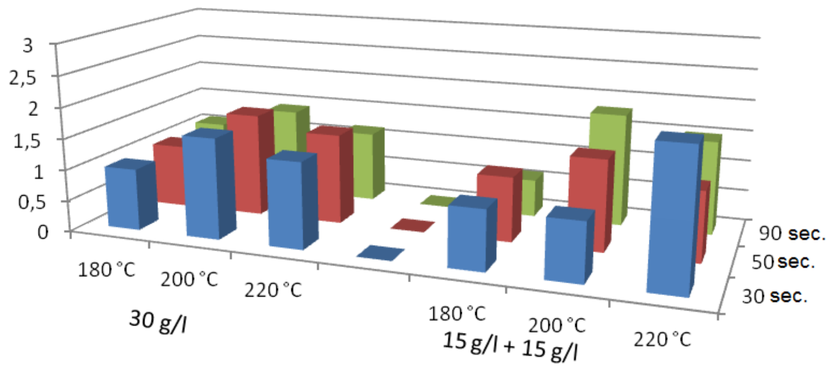

Fig. 4: K/S of Hydrophobic Macro Silicone Treated Printed Fabrics

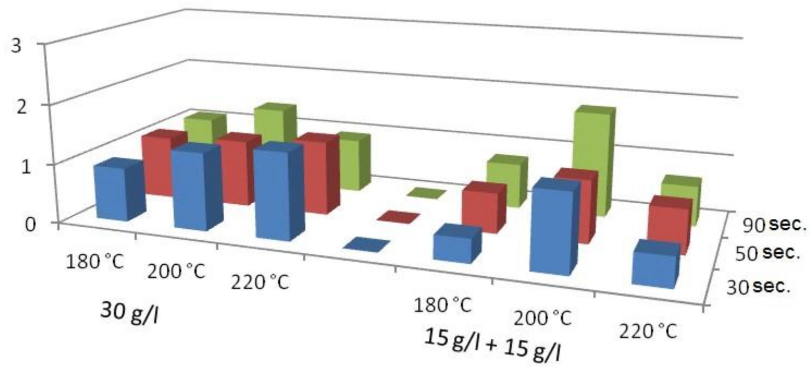

Fig. 5: K/S of Hydrophobic Micro Silicone Treated Printed Fabrics

K/S values of the RUCON FAS, which is a crosslinking agent (DMDHEU) applied samples after sublimation transfer with different concentrations, temperature, and process time, are given in Figure 6. The optimum process temperature is determined as 200°C. The highest K/S value is obtained in 30 g/L concentration and 90 seconds printing time.

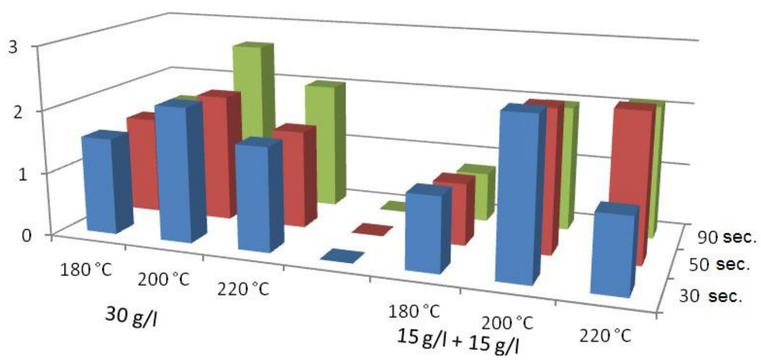

Fig. 6: K/S of DMDHEU Treated Printed Fabrics

K/S values of the RUCOSTAR EEE6, which is a fluorocarbon agent applied sample after sublimation transfer printing with different concentrations, temperature, and process time, are given in Figure 7. The highest K/S value was obtained in 30 g/L concentration, 220°C process temperature, and 30 seconds printing time

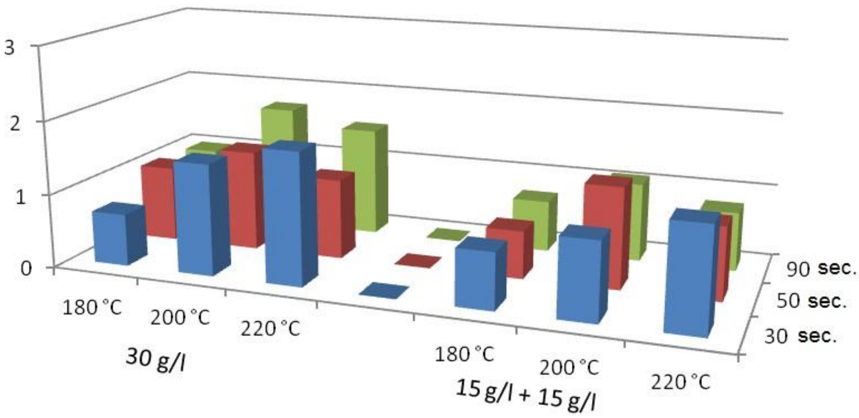

Fig. 7: K/S of Fluorocarbon Treated Printed Fabrics

4. CONCLUSIONS

The reformative effect in color strength (K/S) of the finishing processes is stated when the color yields of the samples (K/S) values were compared with control samples. K/S values of samples treated with especially, hydrophilic silicone and DMDHEU, were determined markedly better according to other samples.

The highest K/S value of the sublimation transfer printing the samples treated with DMDHEU was measured in 200°C, 90 seconds and 30 g/L specific temperature, time and concentration, respectively. However, the highest K/S value of the sublimation transfer printing those samples treated with hydrophilic silicone was measured in 200°C, 30 seconds and 30 g/L. Based on these measurements, the optimum sublimation printing process temperature can be evaluated as 200°C. The optimum sublimation printing process time varies according to the type of finishing treatment. Among the applied finishing treatment concentration, 30 g/L was chosen as the most suitable one.

Especially in the last 20 years, the use of inkjet printing systems in the textile industry has been increasing. Although only applicable for 100% polyester and high polyester content blended products, the fact that sublimation transfer printing has relatively low investment costs, requires very little space, and the method is fast indicates that research on the printing of natural fibers with sublimation transfer printing will increase in the future.

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