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Effects of Pigment Printing on Cotton Knitted Fabric with Different Natural and Synthetic Thickening Agents

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KEYWORDS

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ABSTRACT

Printing in textiles is an important part of designing and embellishing textile material either with dyes or pigments in printing paste. This research work evaluates the effects of printing with three types of natural and synthetic thickeners on the fastness properties of cotton fabric with two different hues of pigment. Pretreated cotton knit fabrics were treated for printing. Printing was carried out in a flat screen-printing method on the cotton fabrics individually and in equal ratios. The printed samples were then assessed for bursting strength, colorfastness to washing, colorfastness to rubbing, and colorfastness to perspiration. Finally, after analyzing the test results, it was established that the properties of the fabrics printed with Zamoprint PT 300E synthetic thickener and Tamarind seed powder natural thickener were better than those printed with other thickeners. Satisfactory performance was also achieved with starch and Lutexal-HIT-Plus thickeners.

1. INTRODUCTION

The application of color to the design of textile materials is a pristine desire of mankind. Ancient civilizations characterize themselves and set themselves apart from others through the use of color and design. Textile printing has been using printing for a long time [11]. Printing is a process of localized application of the colorant to the selected areas of the substrate. According to Brunello, the earliest dyed cotton was found in the Indus Valley originating from around 3000 BCE. The oldest printed textiles which survived these days are China's three-color silk prints, dating back to 220 BCE [1]. The art and science of printing on textile materials can better be described as transferring desired designs onto their surfaces [13]. An extension of stencil printing is called screen printing which was found in Japan during the 17th and 18th centuries [2, 3].

Cotton is a natural, staple fiber that is consisting of pure cellulose as the main chemical component. By twisting, cotton fiber is continually converted into yarn or thread and most commonly printed substrate [4]. Pigments are substances in special forms. They are essentially water-insoluble and the mechanical dispersal there is done to alter the color and light scattering properties. The block printing method was used by the ancient Chinese to color textiles using pigments [10]. To limit the coloring matter to the design area, it is applied with a thickening agent, which can be either a natural or synthetic polymer. Thickeners are high molecular weight compounds that provide stickiness and plasticity to the print paste and maintain the design outlines of the print by giving high viscosity to the paste. Their primary function is to stick the dye molecules in the desired location until the transfer is done [9]. It is important to have good stability in keeping (physico-chemical stability) of a thickener. Fractionation can be done on aqueous paste of high molecular weight thickeners Thickeners are the crucial component of print paste that gives the print paste proper viscosity. The application of synthetic thickeners in the printing industry causes many harmful effects on the environment. As environmental-friendly natural thickeners are widely distributed throughout the plant kingdom. The ingredients of natural thickeners are purely natural, non-allergic, and non-toxic to the human body and have no health hazards [5]. A successful screen printing with natural color and natural thickening agents on silk fabric was shown in the study [6] conducted by Sudha Babel and Rupali Gupta. The study of Katia Lacasse showed that long-chain polymers bearing carboxylic groups partially cross-linked are synthetic thickeners. This study also provides that these thickeners are in liquid, or aqueous form, neutralized with ammonia, and with a solid content of approximately 25% [7]. The efficacy of tamarind kernel powder for pigment printing on cotton fabric as a natural thickener in comparison with synthetic thickening agents was found in another study by Supaluk Tepparin Porntip Sae-be et al [8].

2. Materials and Methods

2.1 Materials

2.1.1 Substrate

A single jersey white color cotton knit fabric with a mass per unit area of 145 gm/m2 was used for printing. The fabric specifications were course per inch 12, wales per inch 15 with yarn count 20s.

2.1.2 Pigment and Thickener

Imperon Red KB of Archroma brand and Bezaprint Black DW of CHT brand were used as a pigment for screen printing. Zamoprint pt-300E from Zamson , Lutexal-HIT-Plus from Archroma, and Tubivis-Star of CHT brand were used as a synthetic thickener whereas guar gum, starch, and tamarind seed powder were selected for pigment printing of cotton fabric as a natural thickening agent.

2.1.3 Recipe for Printing

2.1.3.1 Recipe for Red Hue (For Natural Thickener)

Axuprint Golden yellow NM3-15 gm
Imperon Red KB-15 gm
Printofix binder-200 gm
Acrafix ff (Fixing agent)-20 gm
Natural Thickener (Guar gum/Starch/Tamarind seed powder)- 20 gm
Ammonia-10 gm
Waker (Anti-foaming agent)-0.5 gm
Tobisoft ps (Softener)-10 gm
Water-x gm
pH-8
Viscosity-1100 cps

2.1.3.2 Recipe for Black Hue (For Natural Thickener)

Bezaprint Black DW -30 gm
Imperon Blue KB -10 gm
Imperon Green KG -5 gm
Printofix binder-200 gm
Acrafix ff (Fixing agent)-20 gm
Natural Thickener (Guar gum/Starch/Tamarind seed powder)- 20 gm
Ammonia-10 gm
Waker (Anti-foaming agent)-0.5 gm
Tobisoft ps (Softener)-10 gm
Water-x gm
pH-8
Viscosity-1100 cps

2.1.3.3 Recipe for Red Hue (For Synthetic Thickener)

Axuprint Golden yellow NM3-15 gm
Imperon Red KB-15 gm
Printofix binder-20%
Acrafix ff (Fixing agent)-2%
Synthetic Thickener (Zamoprint PT 300E / Lutexal HIT Plus / Tubivis Star)- 2%
Ammonia-1%
Waker (Anti-foaming agent)-0.05%
Tobisoft ps (Softener)-1%
Water-x%
pH-8
Viscosity-1100 cps

2.1.3.4 Recipe for Black Hue (For Synthetic Thickener)

Bezaprint Black DW -30 gm
Imperon Blue KB -10 gm
Imperon Green KG -5 gm
Printofix binder-20%
Acrafix ff (Fixing agent)-2%
Natural Thickener (Guar gum/Starch/Tamarind seed powder)- 2%
Ammonia-1%
Waker (Anti-foaming agent)-0.05%
Tobisoft ps (Softener)-1%
Water-x %
pH-8
Viscosity-1100 cps

2.2 Methods

2.2.1 Printing technique

The flat screen printing technique was applied to the cotton fabric. The screen-printing machine consists of an in-feed device, a glue trough, a rotating continuous flat rubber blanket, flat-bed print table harnesses to lift and lower the flat screens, and a double-blade squeegee trough. The in-feed device allows for precise straight feeding of the textile fabric onto the rubber blanket. The exerted pressures must be kept as constant as possible.

2.2.2 Bursting strength test (ISO 13938-2)

A bursting strength test was conducted to measure the strength of the material when it is stressed in all directions simultaneously [12]. To perform this test, the sample is clamped over a rubber diaphragm and the specimen within 20 ± 3 s under a constant rate of fluid pressure. Two sizes of specimen either 30mm in diameter or 113mm in diameter area were stressed here. Another test is carried out without a specimen and records the extension of the rubber diaphragm. Also were recorded the required pressure value and the deducted value from the earlier reading of the test.

2.2.3 Color fastness to washing (ISO 105 C06)

The process is 30 minutes of mechanical wash at 40˚ C in 4 gm/l, ECE reference detergent, and 1 gm/l sodium perborate solution with 10 steel balls & multifiber adjacent fabric (DW).

2.2.4 Color fastness to rubbing (ISO 105 X 12: 2016)

Crock meter (16mm diameter and force 9 N) covered with the cotton rubbing cloth was employed to perform the rubbing fastness of the printed sample. The sample was rubbed 10 times in 10 seconds. Color change and staining of color on the undyed fabric were assessed with a grey scale.

2.2.5 Color fastness to perspiration (ISO 105 E04: 2013)

The specimen was kept in a dish and the two dishes of acidic & alkaline solutions were taken in where the M: L was at 1:20. The sample was kept for 30 minutes. A glass plate was also imputed on the composite specimen for 15 minutes. The excess solution was put out. The composite specimen & glass plate were inserted into the incubator maintaining (37±2) ˚C temperature and with 12.5 KPa pressure for 4 hours. The specimen was dried (Temp ≤ 60˚C).

3. Results and Discussion

3.2 Test result of bursting strength

From the result, it has been seen that

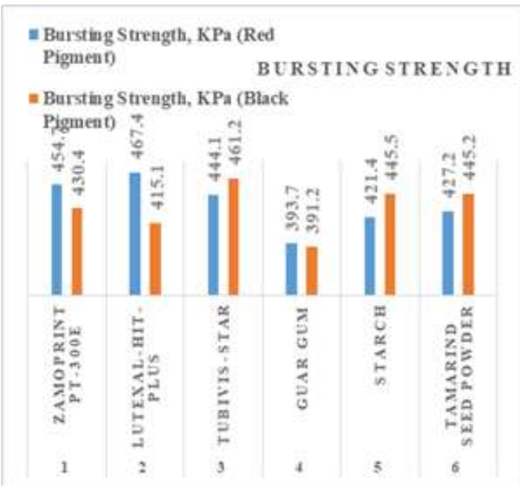

Fig. 1: Result of bursting strength.

Lutexal-HIT-Plus synthetic thickener and Tamarind seed powder natural thickener used red pigment printed sample requires more load to burst out. On the other hand, Tubivis-Star and starch thickener used black pigment printed sample requires more load to burst out. The bursting strength of the fabric coated using synthetic thickener is always higher than the fabric coated with natural thickeners. The fabric's bursting strength may be increased by the fiber with higher elongation due to its tensile characteristics. The synthetic thickener in the print paste-coated fabric has a higher elasticity than the natural thickener used in the printing recipe.

3.3 Test result of color fastness to wash

Test results of washing fastness for color change of natural and synthetic thickening agents were 4/5 and color staining was achieved between 4/5 among all the printed samples. A superior washing fastness property was obtained for these six samples. Although pigments usually cannot diffuse into the fiber core, they can be fitted into the cracks and shielded by the binder layer [15]. The thickening molecule should have control over the free water intake and not carry the dye beyond the limits of the impression (rinsing) [9].

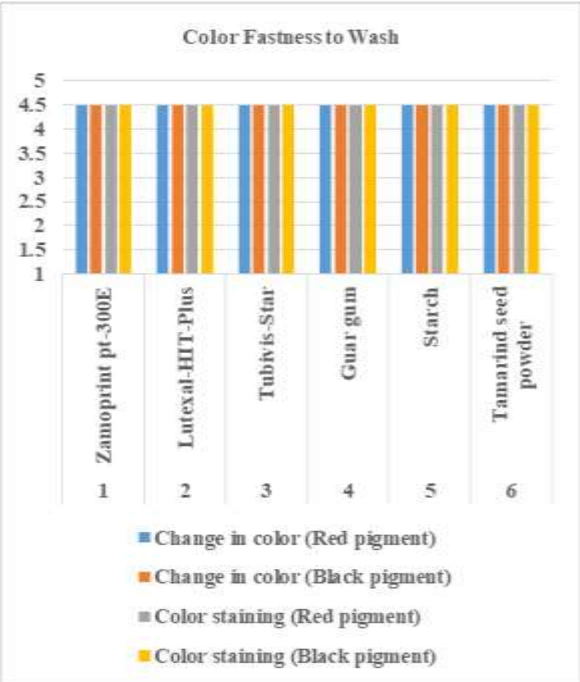

Fig. 2: Colorfastness to wash of all printed samples.

3.4 Test result of color fastness to rubbing

Assessment results of flat screen-printed cotton samples for rubbing fastness grades against dry and wet rubbing were found very good to excellent. And wet rubbing fastness was found good for synthetic thickener Zamoprint pt-300E and Lutexal-HIT-plus. Natural thickener tamarind seed powder performed good results in dry rubbing and a fair grade rating of wet rubbing was seen in red pigment printed samples. The thickener forms a stable paste viscosity that plays a significant role in binding pigments to the fabric. This stability in paste also allows an even output measured throughout the screen. Here the binding agent with various thickeners also makes it possible to obtain good rubbing results.

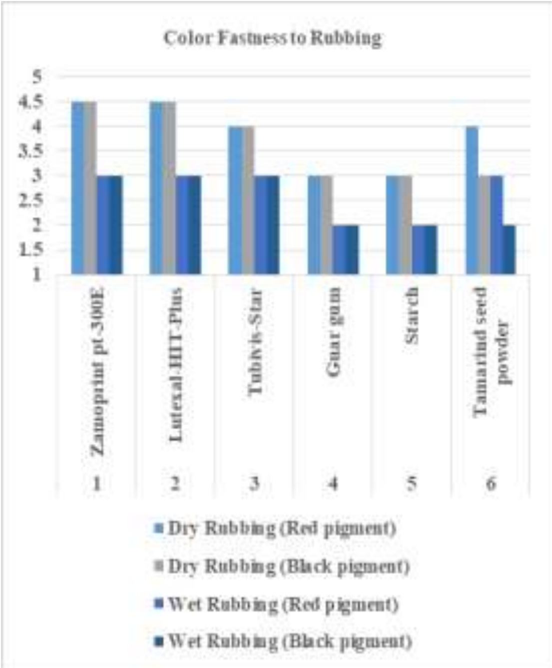

Fig. 3: Colorfastness to rubbing of all printed samples.

3.5 Test result of color fastness to perspiration

Nearly all screen-printed cotton samples exhibited good to excellent fastness ratings during acidic and alkaline perspiration tests in the grey scale.

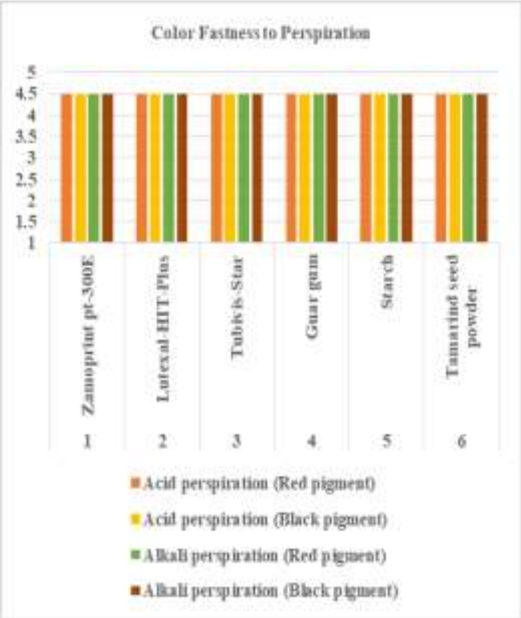

Fig. 4: Colorfastness to perspiration of all printed samples.

4. CONCLUSION

The results from the screen-printed samples it is clear that in terms of rubbing fastness, washing fastness, perspiration fastness, and bursting strength synthetic thickeners give a superior quality of print over natural thickeners. Among three different types of synthetic thickener, Zamoprint pt-300E provides excellent results but Lutexal-HIT-Plus also provides satisfactory performance. And Tamarind seed powder gives better performance among three different natural thickening agents. But Tamarind seed powder was used on cotton fabric as a natural thickening agent whose properties were nearly the same as printing with synthetic thickeners. The result of starch was also given an average with others. Maintaining the appropriate viscosity of print paste helps in binding the pigments and also improves the fastness results. Low viscosity resulted in driving problems during squeeze print paste through the screen. In this work, 1100 cps viscosity was kept for screen printing. The effect of viscosity in the printing paste solution may change the shade of the printed cloth. Thickeners help to hold the accurate viscosity in the paste that resists spreading and maintaining the outlines of the design under high pressure. Synthetic thickener Zamoprint pt-300E and natural thickener Tamarind seed powder assist to produce a thick paste in printing solution with other printing ingredients in this pigment printing work with stable viscosity that was founded from the results.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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