The Study of the Affect Factors on the Color Fastness of Inkjet Printing Ink

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Abstract

The color fastness is one of the most important performance indicators of the inkjet printing ink, and its level directly affects the quality of inkjet printing. Currently, color fixing problem of the inkjet printing is a major technical task of the development of inkjet printing technology. In order to get a kind of inkjet printing ink with good soaping color fastness and rubbing fastness, ink samples were prepared by using different types of fixing agent to study the effect of the kinds and content of the fixing agent on the soaping color fastness and rubbing fastness. By changing the baking conditions, the influences of baking time and baking temperature of fixing agent on the ink soaping color fastness and rubbing fastness were discussed. The results showed that: different types of fixing agent had the great impact on the soaping color fastness and rubbing fastness. The content of fixing agent had a certain effect on the ink soaping color fastness and rubbing fastness. It had a different baking temperature and time with different fixing agent, and the baking time and baking temperature directly affected the ink soaping color fastness and rubbing fastness.

Introduction

Digital inkjet printing technology is a high-tech printing technology that has a kind of clean, no environment pollution in the nearly 20 years development. Moreover,it is able to adapt to the market needs of high quality, personalization, small batch, possessing the advantages of traditional printing can't achieve. Inkjet printing technology, therefore, has attracted more and more people's favour and has a very broad market prospects for development.

Ink is the main material and holds the pivotal status in the production of digital inkjet printing. It has two kinds of dyes and pigment, but the dye ink has some disadvantages such as environment pollution and craft complex, seriously hindering the development of digital ink-jet printing technology. However, the pigment ink relys on its versatility, simple technology, environmental protection, as well as good light fastness, becomeing the research focus of scientific research workers. Pigment ink has a certain limitation in coloring, yet, due to pigment inks depends on small pigment particles displaying color on the fiber surface through the adhesive. So the poor problem of wet rubbing and soaping color fastness exists in printing product. In this paper, the fixing agent was added in the homemade pigment ink, to discuss the kinds of fixing agent and its curing conditions (temperature, time) influence on color fastness. It has a great significance to improve the color fastness of the printed fabric.

Experiment

Materials

Pigment: phthalocyanine blue; Resin: AZR; Binder: water-based polyurethane(self-crosslinking); Solvent: deionized water; Additives: dispersing agent, surface active agent, defoamer; Fabric: pure cotton fabric; Accompanying fabric: DW multifibre; Standard rubbing cloth: complied with GB/T 3920-2008Adjacent fabric; Soap: complied with GB/T 3921-2008.Fixing agent: FK-500，FQ

Experimental equipments

JJ-1 Style Mechanical Agitator (Guhua corporation in Guangzhou), GJ-2S Style Velocity Mixing Disperser (Haitongda corporation in Qingdao), CJ-946 Electronic Hot Plate (Hualun electronic instrument corporation in Xiang gang), HJ-6A Style Digital Readout Constant Temperature Magnetic Stirrer; X-Rite Densimeter. Y517B Fastness to Rub & Brush Tester (Ningbo Textile Instrument Factory)

Methods of experiments

Preparation of Ink

According to the design of formula, putting pigments, deionized water ,resins and additives together for fully mixing with high-speed mixer ,and scatter on the sand mill grinding for a certain time, then get the color paste. With high-speed mixer to stir the mixture which constists of color paste，adhesive，additives, deionized water, and get the pigment ink. The ink samples were prepared by mixing the pigment ink with fixing agent and stirring fully by the agitator.

Preparation of testing samples

The self-made inks were coated in pure cotton fabric by wire bar. Making two samples in different conditions and baking the samples with electronic hot plate.

Color fastness test and evaluation methods

The test method of dry/wet rubbing fastness depends on "the GBT 3920-2008 textile color fastness to rubbing fastness experiment"and the evaluation method refers to "the FZT 01023—1993 lining fabric color level instrument rating method". The test method of soaping depends on "GBT 3921-2008 textile color fastness to soaping fastness experiment", and the the evaluation method refers to "the FZT 01024—1993 samples instrument rating method of color change "and the "the FZT 01023—1993 lining fabric color level instrument rating method"
Note: if the color fastness have intermediate series, such as level 3

or 4, is written with a magnitude of 3.5.

Results and Analysis

The influence of fixing agent type and content on color fastness

Adhesive is the key ingredient in inkjet printing ink, directly affect the fastness of printed fabrics. To some extent, the addition of fixing agent can improve the color fastness of printing ink.Therefore, in order to research the types and content of fixing agent influence on color fastness, ink samples respectively were prepared by choosing two different kinds of fixing agent. Setting baking temperature as 150 □, the curing time as 2 min for heating the printed fabric ,and its influence on color fastness as shown in figure 1 and figure 2. Figure 1 shows the influence of FQ content on the color fastness, and Figure 2 shows the influence of FQ content on the color fastness.

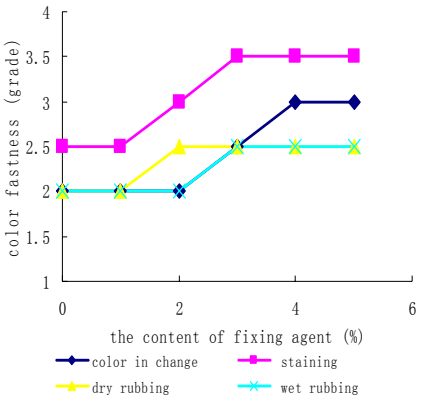

Figure1. *The influence of FQ on color fastness*

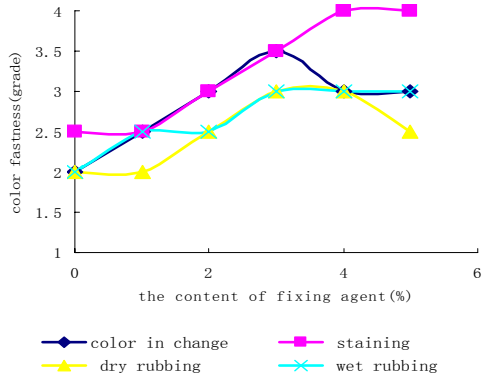

Figure2. *The influence of FK-500 on color fastness*

As showed in the figure 1 and figure 2, the addition of two kinds of fixing agent significantly contribute to the increase of color fastness . When adding different types of fixing agent with the same content, the solid color effect of fixing agent FK - 500 is better than the fixing agent FQ. This may be due to their different fixation mechanism, fixing agent FK - 500 is a kind of multifunctional n propyl organism crosslinking agent. It mainly has a crosslinked reaction with the polyurethane polymer carboxylic, formes a mesh structure in fabric, and closes the hydrophilic groups at the same time, forming a solid film which increases water resistance [1]. What's more, crosslinking agent itself plays a supplementary role on the solid degree of film, becoming a "bridge" between the pigment and fibre, which fixes the pigments and limits the transfer of pigment, thus ,the fastness of the printed fabric is improved. FQ is a fixing agent with reactive groups, its reactive groups has a crosslinking reaction with the carboxyl of cellulose, and form a layer of protective film on the fabric, so that the pigment is coated on the fiber, which is not easy to fall off and the effect of fixation improved[2].

When adding the same fixing agent with different content , the color fastness improved gradually with the increase in fixing agent content. When the content of fixing agent FQ accounts for 4%, the dry and wet rubbing fastness of printed fabric reaches 2.5 grade, the soaping fastness as 3 grade, color fastness can be improved 0.5 to 1 level; When the content of FK - 500 accounts for 3%, the dry and wet friction of printed fabric can be up to 3 grade, soaping fastness also reaches the highest, up to 3.5 grade, and 0.5 to 1.5 level can be improved. It is because when the content of fixing agent is small, crosslinking reaction with polyurethane and fiber is not sufficient. There are still a number of hydrophilic groups, making the solid degree of membrane weaken, so that the pigment is not easy to be coated on the fiber. So soaping and rubbing fastness is poorer. When increases the content , the reaction with fiber and polyurethane is more sufficient, enhancing the solid degree of membrane, thus, soaping and rubbing fastness improved. Continuing to increase the content of fixing agent, the change of color fastness is not obvious.So on the basis of cost savings, FQ content is 4%, the content of FK - 500 is 3%.

The influence of curing temperature with different fixing agent on color fastness

Crosslinking temperature related to the kinds of fixing agent. As fixing agent is different , temperature has a great differences on the crosslinking reaction. Thereby it directly affects the effect of fixing color. Fixed the content of fixing agent as 3%, the curing time for 2 min, and change the baking temperature of fixing agent ,then the effect of color fixation as shown in figure 3 and figure 4. Figure 3 shows the influence of baking temperature of FQ on color fastness, and figure 4 showes the influence of baking temperature of FK-500 on color fastness.

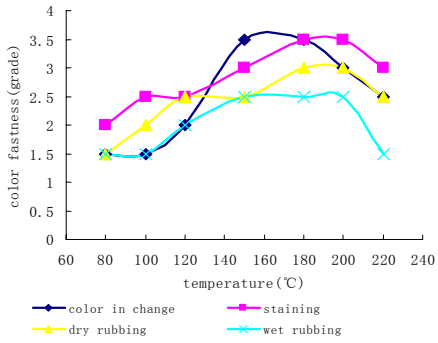

Figure3. *The influence of temperature on color fastness*

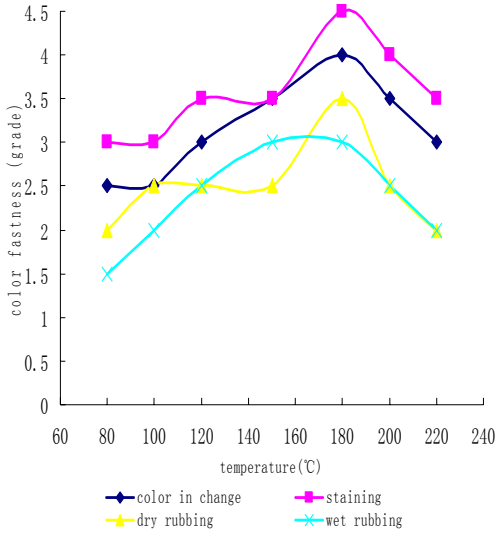

***Figure4**. The influence of temperature on color fastness*

As is showed in figure 3 and figure 4, with the increasing of baking temperature, the soaping fastness and rubbing fastness improved gradually. Both FQ and FK-500 reach the highest color fastness at 180 □. What's more, the fixation effect of FK - 500 is better than FQ in soaping fastness and wet rubbing fastness, but differences little in dry rubbing fastness. Continuing to increase the temperature, the soaping fastness and rubbing fastness reduced gradually. This shows the two fixing agent don't have a good reactivity at low temperature, with the increase of temperature, reactivity enhanced. When the temperature reaches 180 □, the contaction of fixing agent with adhesive and cellulose particles accelerated,and the crosslinking reaction degree of FK-500 with polyurethane molecules achieves the best, forming the highly diversified reticular structure, and closeing the hydrophilic groups. The crosslinking degree of FQ with cellulose reaches maximum, forming a solid film, which greatly improves the soaping and rubbing fastness of printed fabrics.Continuing to raise the temperature, the higher temperature will destroy the molecular structure[3], effecting the crosslinking of fixing agent with adhesive and fiber intermolecular, so that reduces the toughness of the crosslinked films, printing fabric color fastness decreased.

The influence of curing time with different fixing agent on color fastness

Baking time is one of the important factors that affects fixing agent crosslinking. For fixing agent, when the crosslinking of fixing agent with adhesives and fiber, water evaporation and the interparticle contaction and deformation need a certain amount of time, this time is minimum film forming time. Due to the structure is different with different fixing agent, the request of curing time at the best temperature is also different, which directly affects the color fixation effect of fixing agent. Therefore， under the condition that fixing agent content is 3% and baking temperature is 180 □, change the baking time and discuss the different curing time of fixing agent's influence on color fastness.

Figure 5 showes the effect of curing time of FQ on color fastness, Figure 6 showes the effect of curing time of FK-500 on color fastness.

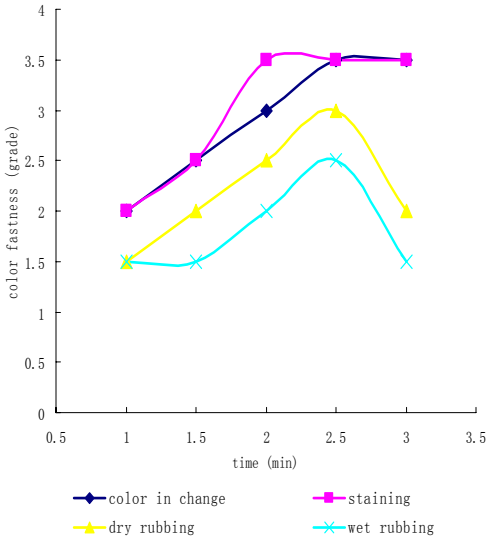

***Figure5.** The influence of baking time on color fastness*

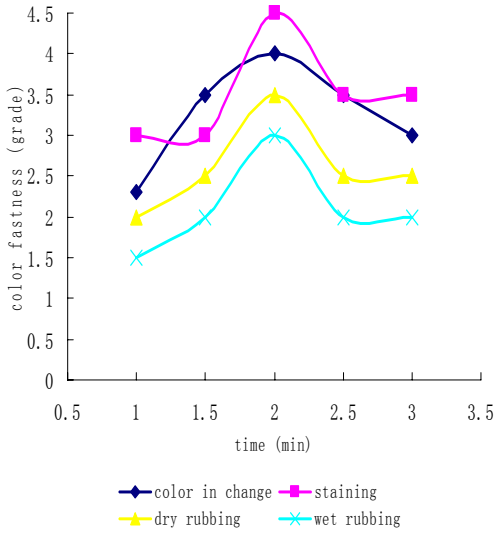

***Figure6.** The influence of baking time on color fastness*

As is shown in the figure 5 and figure 6, with the rising of baking time, the soaping fastness and rubbing fastness improved gradually, and color fixation effect enhanced. In the figure 5, when the baking time is 2.5min, the soaping fastness of fixing agent FQ achieves 3.5 grade, dry rubbing fastness up to 3 grade, and wet rubbing fastness reaches 2.5grade. In figure 6, when the baking time is 2min, the soaping fastness of fixing agent FK-500 achieves 4 grade, dry rubbing fastness up to 3.5 grade, and wet rubbing fastness reaches 3 grade. It is higher than FQ in all kinds of color fastness 0.5 grade, and the effect of color fixation is superior to FQ. Continuing to increase the curing time, the soaping fastness and rubbing fastness of printed fabric is reduced.

This may be caused by a lack of curing time, the fabric on the

evaporation incomplete, fixing agent between itself and the adhesive latex particles cannot touch each other and crosslink a film, moreover, still exist a large number of hydrophilic group, which leads to a lower soaping fastness and rubbing fastness. When extended to a certain time, the fixing agent has been responding well with adhesive and its fiber reactive groups, achieveing a certain degree of crosslinking on the fabrics , improving the strength and water resistance of film, thus each color fastness of printed fabrics enhanced. However, when time is too long, it maybe make the crosslinking of fixing agent[4], adhesive and fiber large, leading to membrane tenacity and water resistance reduced, printing fabric color fastness decreased.

Conclusion

1) The addition of fixing agent contribute to improve color fastness, but different fixing agent has a different effect on color fastness, the color fixation effect of FK-500 is superior to FQ in this experiment.

2) Different fixing agent has different fixing craft, when the content of fixing agent FK - 500 is 3%, the baking temperature is 180 □ and baking for 2 min, dry friction reaches 3.5 grade, wet rubbing achieves 3 grade, and soaping fastness can up to 4 grade, color fastness is best at this time. FQ has a great color fastness when its content is 4%, baking temperature 180 □ and baking for 2.5min.

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Author Biography

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