

Study of Effectors on the Tinting Strength of Water-based Digital Printing Ink

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Abstract

In order to obtain water-based digital printing ink with good coloring property, different kinds of pigments were used to prepare ink samples, by testing the tinting strength of samples to discuss the influence of the variety of pigments and the characteristic of pigments on the coloring property of ink. By changing the content of pigment, as well as the dispersity of pigment, to prepare ink samples, investigate the effect of the content of pigment and the dispersity of pigment on the coloring property of ink. The results showed that different characteristic of pigment has key influence on the tinting strength of ink. The content of pigment is also an important factor that affects the tinting strength of ink. When the content of pigment increases to a certain value, the tinting strength of ink will reach the best state. Besides, the tinting strength will become better with the improvement of dispersity of pigment.

Introduction

Water-based Digital Printing Ink, which without volatile organic solvents, is a kind of energy efficiency and environmental ink. Since the solvent is water, it has advantages of low cost, and the safe preparing environment can not only ensure the operators' health, but also reduce the consumption of energy, as well as environmental cost. The printing can reduce or even eliminate the organic residual in products, which can also ensure the health of customers [1].

Tinting strength, is also called the strength or the concentration of ink, is a parameter to value the inks' performance of assigning color to others, it determines the inks' printing properties in a certain degree. Generally, inks with high tinting strength, will use less in print process, and the print quality is better. On the other side, inks with low tinting strength will need more in printing process, and the color is light relatively. It's obviously that tinting strength influences the print quality directly. So learning and understanding the factors that affect the tinting strength of ink is meaningful to make a good control of printing process and improve the quality of printing products [2].

Experiment

Materials

Pigments: Carbon black M-L, C500, ZY-5, H8. Grind resin: HPD 96. Film-forming resin: JONCRYL 77. Solvent: deionized water. Additives: dispersants, defoamers. Standard white ink and black ink [3]. Scrape paper: 160mm*60mm, pictorial paper.

Instruments and equipments

D2004W electric mixer (Shanghai sile Instrument

corporation); Microtrac S3500-laser particle size analyzer (made in America); BUHLER grinding machine (Switzerland); X-Rite-528 densimeter(X-rite).

Experimental methods

Ink preparation: Blend pigments with resin, deionized water and other additives, to predisperse 30min in D2004W electric mixer, grind 1h in BUHLER grinding machine. Mix the based ink with film-forming resin and other ingredient, and then stir 30min in D2004W electric mixer.

Performance evaluation

Dispersity test: Particle size of ink was tested with Microtrac S3500-laser particle size analyzer, and ink's 95% particle size was used to reflect the dispersity of ink.

Tinting strength test: Mix 1g ink sample and 10g standard white ink, and with the same proportion, mix standard black ink and standard white ink thoroughly. Scrape these two inks to 80-100mm ink layer respectively. When the color density of both sample and standard sample ink layer are consistent, recording the amount of standard white ink which were used to dilute ink sample and standard respectively. Using the formulation:

$$S = \frac{D}{C} \times 100\%$$

to calculate tinting strength. S: Tinting strength,

%; C: The dosage of standard white ink used to dilute the standard black ink, g; D: The dosage of standard white ink used to dilute the sample ink, g.

Results and discussions

Influence of dispersity of pigment on the tinting strength of ink

Dispersity of ink, which reflects the size of pigment and determines the reaction of pigment to light, is an important factor to influence tinting strength, so it's necessary to do a research on it. Fix every component, change the grinding condition to prepare ink, and test every ink's particle size. Also the tinting strength was calculated. The result is shown in Figure 1:

Figure 1 indicated that the better the ink's dispersity, the better tinting strength. With the particle size of pigment increases gradually, the tinting strength becomes worse. Thus it can be seen that the dispersity of pigment has a great influence on the tinting strength of ink. This is mainly because ink's tinting strength is achieved by the complex reaction between the light and the pigment's surface. Pigment with good dispersity has

smaller particle size, and specific surface area is larger, so the reaction to light is strong. This may contribute to the tinting strength of ink, since the appearance of ink is uniform, smooth, less spots, as well as smaller chromatic aberration[4].

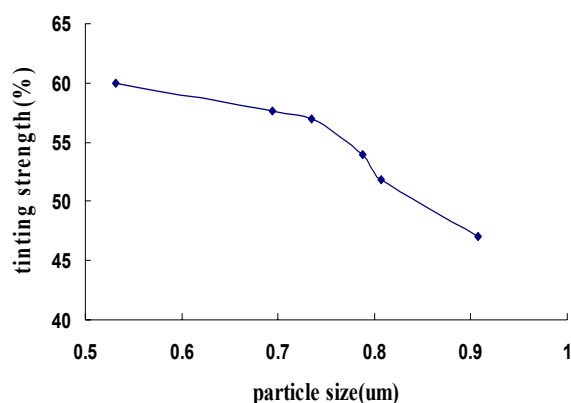


Figure 1: influence of the dispersity of ink on the tinting strength of water-based ink

Influence of the kinds of pigment on the tinting strength of ink

Different kinds of pigments, because of their different chemical structure, as well as different optical absorption, have different ability that endowed other material with its own color. Therefore, the paper made a study on the effect of kinds of pigment on inks' tinting strength. Fix the content of every component, change the kinds of pigment to prepare ink, test and calculate the inks' tinting strength, the result is shown in Figure 2:

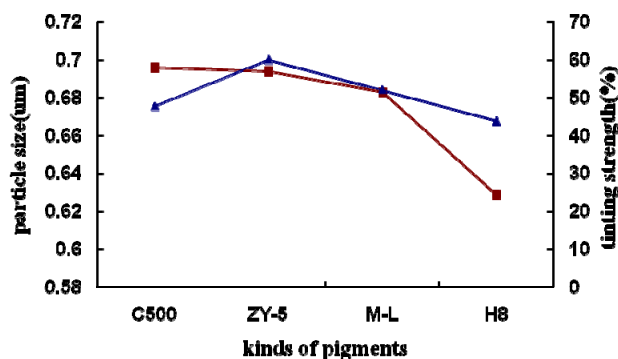


Figure 2: influence of kinds of pigments on the tinting strength of water-based ink (■:particle size, ▲:tinting strength)

Figure 2 showed that inks prepared with different pigment have different tinting strength. Inks, which prepared with ZY-5, have the best tinting strength. Though the dispersity of inks prepared with ZY-5 is a little worse, but the different chemical properties between every pigment make the tinting strength is not simply determined by pigment's dispersity. Tinting strength,

in terms of pigment, is mainly depends on the performance of optical absorption [5]. ZY-5 is a kind of pigment with high tinting strength. Besides, ZY-5 was treated with surface activation, pigment particles are relatively loose, and the adhesion force is low, this makes the pigment hardly to get together. This may make sure the tinting strength of ink in some degree.

Influence of the content of pigment on the tinting strength of ink

The content of pigment in ink is an important factor that influences the tinting strength. Generally, the more pigment, the better tinting strength, but this trend is not always the same, that is the content is not the higher the better [5]. So the paper made a research on it. By changing the content of pigment to prepare ink with high concentration of pigment, and test the tinting strength. The result is shown in Figure 3:

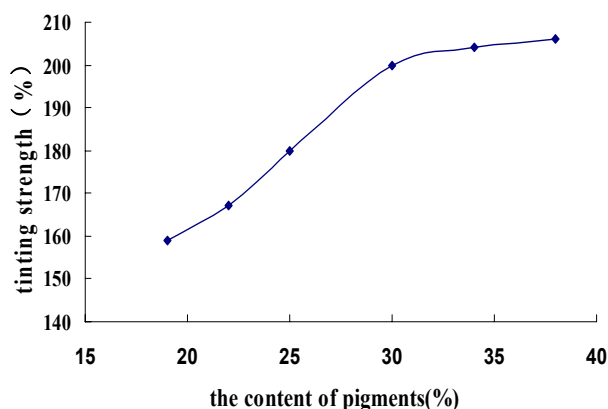


Figure 3: influence of the content of pigment on the tinting strength of water-based ink

As can be seen in Figure 3, with the increase of the content of pigment, the tinting strength increased correspondingly, but it is not the higher the better. When the content gets 30%, ink's tinting strength is the highest, with its' continue increase, the tinting strength won't grow. This is because at the beginning, inks' tinting strength was determined by the concentration of pigment, so tinting strength can be grow with the increase of pigment. But when the content gets a critical value, inks' tinting strength won't grow as usual trend, since the concentration of pigment reaches saturation. What's more, high content of pigment will lead the change of rheological properties of ink, which is bad for the ink's transfer rate during print process.

Conclusions

1) The dispersity of pigment is also an important factor that influences the tinting strength of ink. The better the dispersity, the smaller the particle size and the tinting strength is better as well.

2) The kind of pigment has an important influence on the tinting strength of ink. In this research, inks prepared with ZY-5 have the best tinting strength.

3) The content of pigment is the key factor that influences the tinting strength of ink. With the increase of the content of pigment, the tinting strength increases too, but not infinite growth. When the content of pigments is 30%, inks' tinting strength gets the best state, and it won't change greatly with the continued growth of the content of pigments.

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References

- [1] Xiulan Xin, "Research Process of Water-based Ink," Jour. China Printing and Packaging Study, 03, 3 (2011).
- [2] Qilai Kang, "The Relationship between the Concentration of ink and Printing Quality," Jour. Guangdong Print, 03 (2011).
- [3] Yunxing Liu, Printing Ink (Printing Industry Press, Beijing, 2009) pg. 1289.
- [4] Shuilin Zheng, "A Study on Surface Modification of Ultra-fine Oxide Iron Red Pigment," Jour. 12, 2 (2003).
- [5] Xiaokun Qi, "Carbon Black and Black Ink," Jour. Guangdong Print, 02(1997).

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Dandan Wang, a postgraduate comes from school of printing and packaging engineering of Beijing Institute of Graphic Communication, and her main research direction is materials physics and chemistry. Water-based ink is one of her research directions.