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The effect of fluorescent whitening agent on the coated ink-jet printing paper

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Abstract: Fluorescent whitening agent is relatively small dosage in the coating, but it has great influence on the properties of the coating and ink-jet printing qualities. With the increase of fluorescent whitening agent dosage, the PH of the coating rose but the viscosity was hardly to change. The brightness of coated ink-jet printing paper and color density of the printing image firstly presented the trend of increasing then decreasing. What's more, when the brightness of the coated paper achieved to the maximum, color density and contact angle properties were the largest. Chromatic aberration property of the image reduced from 1.87 to 1.75, when the addition of fluorescent whitening agent rose from 0.1% to 0.5%. While the dosage was rose to 0.9%, chromatic aberration increased to 2.15. The gloss of coated paper decreased with the dosage of fluorescent whitening agent increasing. In sum, fluorescent whitening agent can enhance the brightness of the coated paper as well as the printing properties. The results show that the best brightness and printing qualities of coated ink-jet printing paper are obtained, when the fluorescent whitening agent is 0.5%(relative to pigment).

Introduction

Coated ink-jet papers are well-known for their superior optical and printability properties in color printing [1]. The coating is usually a high solids aqueous suspension of mineral pigments (precipitate calcium carbonate, clay, nano-silica), binders (natural or synthetic) and chemicals having some functional properties (viscosity modifiers, foam control agents, water retention aids, dispersing agents). It is often prepared in a continuous or batch manner in a coating kitchen [2]. One central step of the coating is the pigment dispersion. Indeed, a poor dispersion of pigments in coating colors may lead to coater runnability problems. This is manifested by coat defects at the paper surface, excessive coater blade wear, and an overuse of pigments [3].

The base paper is composed of pulp fibers and fillers. Coating reduces the roughness of it and improves the optical and printing properties. In order to understand how an optimal coating application and coating structure can be achieved, an appropriate assessment of the coating layer characteristics is necessary [4-6].

In this paper, a kind of fluorescent whitening agent VBL was chosen for brightener in the coating. VBL is widely used to improve the brightness of paper. It can improve the brightness and the theory is that its absorption 300 ~ 400 nm UV and changing them into 400 ~ 500 nm visible blue light. Thereby it enhances the paper brightness [7-8]. The properties of the coated ink-jet printing paper may be also caused by the dosage of VBL, and it was studied.

Experimental

Materials

Precipitate calcium carbonate (PCC) and clay were supplied by one mill in Shandong province. PVA was highly hydroxylated with high degree of hydrolysis of 99%, and its molecular weight was 1700. The dye-fixing agent was PDADMAC(PD) synthesized in laboratory. CMC of low molecular was used as water retention agent. There are many types of fluorescent whitening agents, and a kind of two sulfonic acid types VBL was chosen as the coating additive. VBL was a commercial product and suitable for alkaline conditions.

Instruments

High-speed dispersion machine GFJ-0.4: made in Shanghai, China. Viscosity meter Brookfield DV-Ⅱ+ : made in American. Optical performance tester (MICRO TB-1C) was made by Technidyne Company, American. Contact angle meter JC2000A and CIELAB color made in china. UV lamp: 3W, 340nm UV light.

Experiments

GCC was dispersed using high-speed disperser scattered at the speed of 2500r/min for 15 minutes. Then add clay at certain percentage. The mixture went on scattering at the same speed for 30 minutes. PVA was boiled at 90^{o}Cand the solid content was 10%. The solid VBL was solved in the distilled water at 50~60^{o}C and the concentration was 5%.

The formulation information of coating is showed in table 1. GCC and clay were the pigments in the experiment, and the dosage of other additives was relative to pigment.

Table 1 the formulation of coating

Coating simple	1	2	3	4	5
GCC	60	60	60	60	60
Clay	40	40	40	40	40
PVA	30	30	30	30	30
CMC	0.5	0.5	0.5	0.5	0.5
PD	1.0	1.0	1.0	1.0	1.0
VBL	0.1	0.3	0.5	0.7	0.9

Table 2 the properties of the coating

	1	2	3	4	5
Solid content (%)	23.2	22.9	23.0	23.0	23.1
Coating weight(g/ m^2)	9.28	9.26	9.26	9.25	9.24

As shown in table 2, the solid content of coating changed little. It guaranteed the stable coating process, and the coating weight was only from 9.24 g/m^2 to 9.28 g/m^2.

The coating was coated on the base paper by a small control coater. The coated paper was dried at 102±3^{o}C. Test simples were conditioned at constant temperature and humidity room for 24 hours, and then were tested according to TAPPI and ISO procedures. The test of color aging was that ink-jet printing image was put in the UV lamp for 24h. The color densities of image before lamp and after lamp were used to measure the index.

Results and Discussion

Effect of VBL dosage on the properties of coating

Table 3 the properties of the coating

	1	2	3	4	5
PH value	7.5	7.8	8.1	8.3	8.5
Viscosity (mps)	1740	1760	1770	1750	1760

As shown in table 3, with the dosage of VBL increasing, the PH value of coating increased. The PH value was 8.5 when the amount of VBL was 0.9% to pigment. The proper PH value of VBL was 7~9. Therefore, the PH value of coating was proper, when the VBL dosage from 0.1% to 0.9%. VBL was a kind of two sulfonic acid types. When it is in the solution, it forms hydroxyl ions which can improve the alkaline of the solution. The table also showed that the viscosity of the coating was almost not changed. In the coating, although VBL had high molecular weight, it existed as ions which would not improve the viscosity.

Effect of VBL dosage on the properties of the coated ink-jet paper

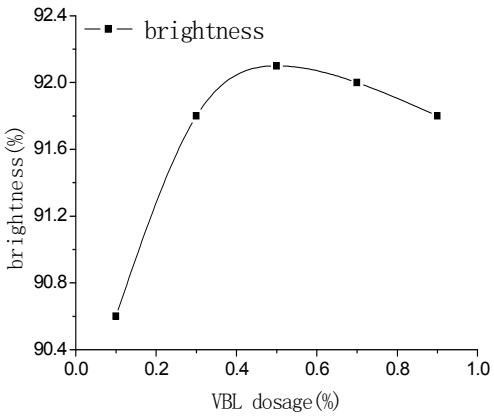

Fig.2 the brightness of the coated paper

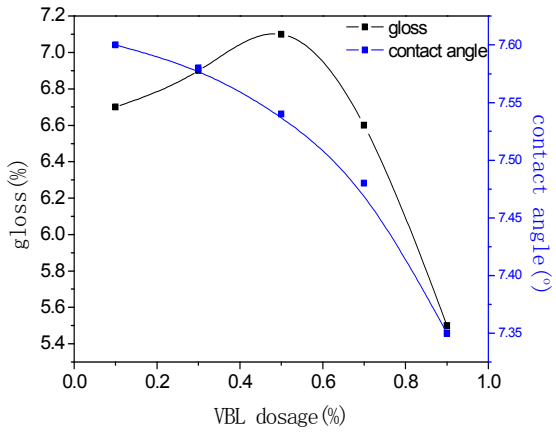

Fig.3 the gloss and contact angle of the coated ink-jet paper

As showed in fig.2, adding VBL in the coating improved the brightness of the coated paper obviously, when the dosage of VBL was less than 0.5%. But the addition rose from 0.5% to 0.9%, the brightness decreased. As is known, VBL has optimal dosage. When the dosage is more than the optimal, VBL can not absorb and reflect more ultraviolet light (UV-light), and not play the effect. Much of the VBL in the coating inhibited the absorption of lights at 200~400nm. While the dosage is less, the VBL amount in the coating will be too little, the absorption and reflection are not enough.

From the fig.3, the VBL affected the gloss and contact angle of the coated paper. When the dosage of VBL was 0.9%, the gloss of coated paper was only 5.4° and the contact angle was also low. The reason is that the ions of VBL in the solution were easily combined with water molecules, so it decreased the gloss and contact angle. However, as the dosage was less than 0.5%, VBL and PVA had an interaction improving the contact angle.

Effect of VBL dosage on the properties of the ink-jet printing image

As seen from fig.4, the color density increased firstly and then decreased with the increasing dosage of VBL, while the chromatic aberration of image presented the contrary trend. The two indexes reached maximum value (1.45) and minimum value (1.75), respectively. At the same time, when the dosage was 0.5%, the brightness of coated paper had the highest value. Thus VBL not only

improved the brightness but also enhanced the quality of ink-jet printing image. The reason was high brightness of the coated paper showed good color reproduction, making the image bright and realistic printing image.

As shown in fig.5, after the UV lamp lighted, the color density of ink-jet printing image became less. But at the point of 0.5%, the change of color density was the smallest. VBL improved the ability of ink fixation and resistance ultraviolet decomposing. The brightness and the ability of resistance ultraviolet decomposing were both improved. At the same time, the printing image showed fuller color. In sum, the VBL in the coating enhanced the time of color aging.

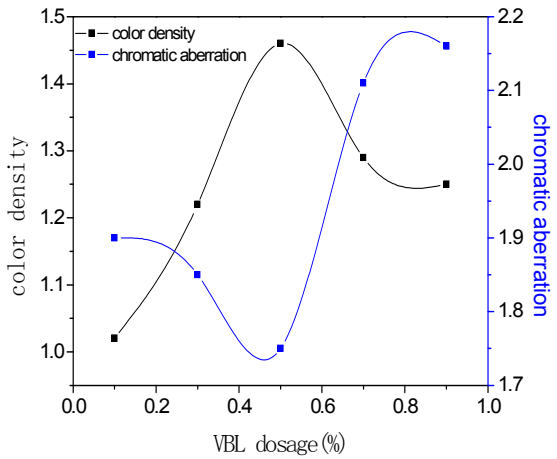

Fig.4 the properties of the ink-jet printing image

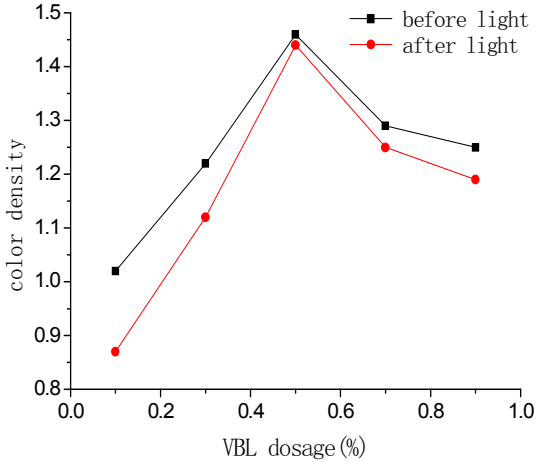

Fig.5 the color aging of ink-jet printing image

Conclusions

1. The dosage of VBL in the coating improved the PH value and the brightness of the coated paper. It has little effect on the viscosity. When the dosage of VBL was 0.5%, the brightness obtained maximum and the image performance was best.

2. The addition of VBL in the coating not only improved the properties of image, such as color density and chromatic aberration, but also enhanced the color aging of ink-jet image.

3. The properties of the best coated ink-jet printing paper are as follows: brighness was 92.75, gloss was 6.7, color density was 1.45, and chromatic aberration was 1.75.

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