Printability of Ink for On-Demand Inkjet Printing on Different Paper

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Abstract. In order to evaluate the printing effect of self-made on-demand ink-jet printing ink and to study its influencing factors, its printing suitability and the influence of different substrate on its performance were studied in this paper. The drying process of ink on different paper was tested by contact angle tester. The color reproduction performance of self-made ink and common ink-jet ink was compared by measuring the printing samples of ink on different substrates with spectrodensitometer. The experimental results showed that the absorption rate of ink on offset paper was the fastest compared with that of coated paper and photo paper, and the drying time of self-made ink on substrate was shorter than that of ordinary ink-jet ink, which was basically volatilized and permeated in 2–3 s on offset paper. In terms of color reproduction performance, two kinds of three primary color inks could reproduce the better color of the image on the coated paper. The color strength of the self-made three primary color inks on the offset paper and the coated paper was higher than that of the ordinary ink-jet ink and the color hue error was smaller, so the color reproduction performances on the paper were better.

Keywords: Inkjet · Ink · Paper · Printability

1 Introduction

There were some problems in traditional printing and publishing, such as uncertain printing capacity, high storage pressure and high production cost. With the continuous development of digital printing technology, graphic processing technology and network technology, great changes had taken place in the way of printing and publishing [1]. On-demand printing and publishing refers to printing and publishing according to the needs of users, which has the advantages of on-demand, timeliness and personalization. It is the future development direction of printing and publishing [2].

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On-demand printing and publishing is based on digital printing technology, which achieves low printing volume and on-demand printing. On-demand printing and publishing can solve the repeated waste of warehousing, raw materials, and information resources. It can also improve business efficiency, and optimize industrial structure [3]. Inkjet printing technology has the advantages of on-demand, personalization, energy saving and environmental protection. It is a printing plate-free, pressureless, and contactless printing technology. The information to be copied can be printed by inputting the information to the inkjet equipment directly. Inkjet printing has a wide market and is the mainstream of digital printing technology [4, 5].

Digital inkjet printing is a process of information replication in the form of graphics and text, in which ink is sprayed from nozzle to substrate under the control of computer. The inkjet printing ink and paper as well as the printability between them are the key factors to determine the quality of inkjet printing [6]. On the basis of the previous work [7, 8], this paper compared the drying speed of self-made inkjet ink and ordinary inkjet ink on different paper, and the reproduction performance of color of picture and text on different paper.

2 Experimental

2.1 Equipments

The printing samples were printed by Epson stylus Pro 9910 inkjet printer. The drying processes of ink on paper were characterized by a fully automatic contact angle tester of brand KRUSS and model DSA100S. The color reproduction performance of the printed proofs was tested by X-Rite's eXact standard spectrodensitometer.

2.2 Materials

In this experiment, laboratory-made four-color inkjet printing ink would be used. Commercially used offset paper, coated paper, and photo paper, which were produced by Chenming group, were also used in the experiment, and their grammages were 90 g/m^2, 157 g/m^2, and 180 g/m^2 respectively. In the experiment, the four-color ink-jet printing ink produced by Jinan Apollo Ink Co., LTD. would be used too.

2.3 Sample Preparation and Performance Tests

Ink absorption test of paper The laboratory-made inkjet inks were individually tested for ink droplet drying on offset paper, coated paper, and photo paper. The drying process of ink on paper was observed by contact Angle tester, and the drying time of ink was recorded. Repeated the above tests using commercially available ink, and recorded the results.

Color properties of ink *Color strength* Three primary color blocks were printed, on three kinds of paper, using laboratory-made inkjet ink and commercial common inkjet ink. The density of color block was measured by the three primary color filter of densitometer. The color density with the highest density in each group was the color strength.

Hue error According to Formula (1), the color hue errors of the ink were calculated according to the result of color strength test.

$$\frac{M - L}{H - L} * 100\% = \text{Hueerror} \tag{1}$$

In Formula 1, M is the density value between H and L. L refers to the lowest density value of the ink. H is the highest density value of ink.

3 Results and Discussion

3.1 Ink Absorption of Paper

Absorption process of ink on different paper In this experiment, the drying performance of laboratory-made ink on different paper was tested, and the drying process of ink droplets on different paper was photographed by contact angle tester. The drying processes of ink droplets on offset paper, coated paper and photo paper were shown in Fig. 1.

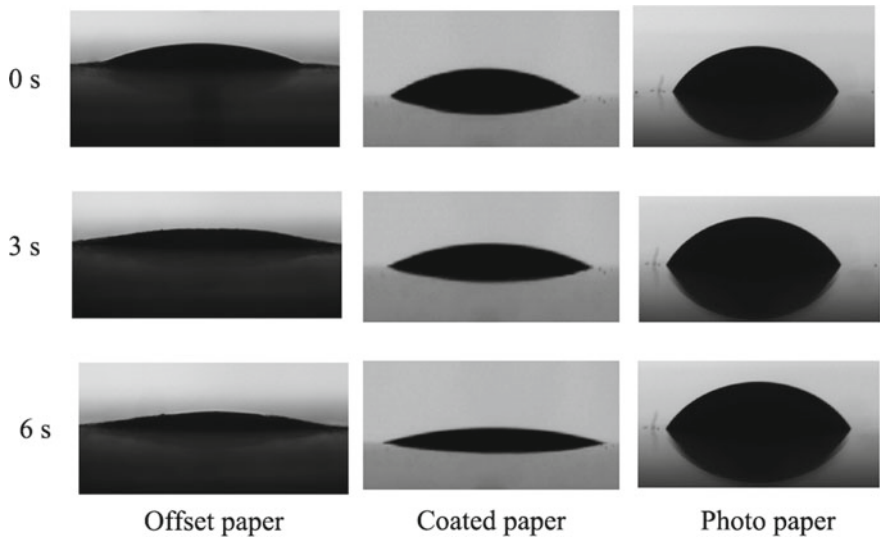

Fig. 1 The changing process of laboratory-made ink droplets on different papers

From Fig. 1, it can be seen that the ink droplets on the paper gradually became smaller within 6 s. Among them, the evaporation and penetration time of ink droplets on the surface of offset paper was shorter than that of coated paper and photo paper. It was because the surface coating of coated paper and photo paper affected the paper's ink absorption capacity and the penetration of ink droplets to the paper.

The above experiments were carried out using commercial ordinary inkjet inks. The results showed that the ink droplets dried quickly on the surface of offset paper, and

basically volatilized and penetrated within 3 s. There was a phenomenon of ink piling on the surface of coated paper and photo paper, especially for photo paper. And the ink had not completely volatilized or penetrated on the paper in 6 s.

Comparison of paper absorption properties between laboratory-made ink and commercial ink-jet ink In order to compare the drying performance of laboratory-made inks and ordinary commercially available inkjet inks, offset paper was selected as the substrate, and the drying process of ink droplets was observed separately. The results showed that the drop size of commercial inkjet ink changed slowly within 6 s, while the drop size of laboratory made ink gradually decreased, and the evaporation and penetration time were significantly shorter than that of commercial ordinary ink.

Using coated paper and photo paper as substrate, the drying process of two kinds of ink drops on the paper surface was compared. The results were consistent with the above experimental results. The drying performance of laboratory made inks was better than that of commercial inkjet inks. The laboratory-made ink could evaporate and penetrate better on the paper surface, and the diffusion area on the paper surface was smaller.

3.2 Color Reproduction Performance of Ink

Color strength test of laboratory-made ink and commercial ordinary ink The inkjet printing proofs were carried out on offset paper and coated paper by using laboratory-made and commercially available three primary color inks respectively. The printing sample density was measured by densitometer to obtain the ink color strength. The experimental results were shown in Fig. 2.

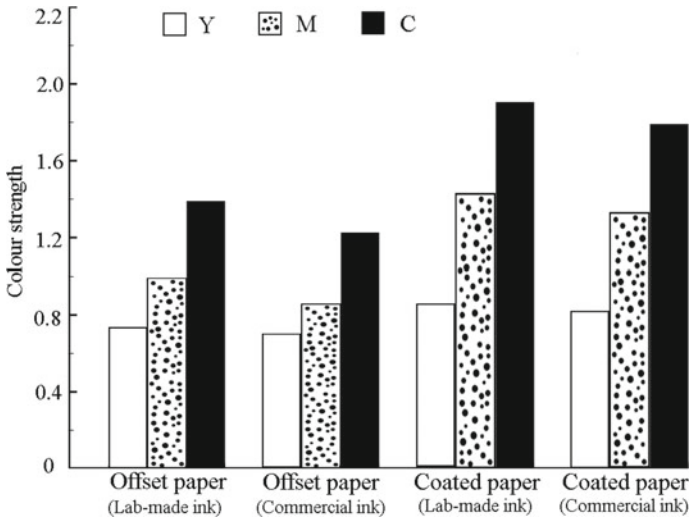

Fig. 2 Color strength of ink on offset and coated paper

It can be seen from Fig. 2 that the color strengths of the two kinds of three primary color inks on coated paper were all higher than that on offset paper. On coated paper,

the color strength of laboratory-made inks was higher. On offset paper, laboratory-made cyan and magenta inks had high color strength, of which cyan had a color intensity of 1.39 and magenta had a color strength of 1.00. The difference of color strength between two kinds of yellow inks was small.

Hue error test between laboratory-made ink and commercial ordinary ink According to the above experimental test results, the hue error of each ink was calculated by Formula (1). The calculation results were shown in Table 1.

Table 1 Hue error of different inks on different papers

Hue error ink (%)	Paper					
	Offset paper			Coated paper		
	C	M	Y	C	M	Y
Lab-made ink	26	68	15	22	60	11
Commercial ink	35	75	16	30	67	12

As can be seen from Table 1, the hue errors of laboratory-made three primary color inks on offset paper and coated paper were smaller than that of commercial three primary color inkjet inks. For cyan and magenta inks, the hue errors of the two three primary colors inks on coated paper were smaller than those on offset paper. For yellow ink, the difference in hue error of the two three-primary inks on offset paper and coated paper was small.

Combined with the test results of color strength and hue error, the color reproduction performance of three primary color inks made in laboratory was better on coated paper.

4 Conclusions

In terms of ink drying performance, laboratory-made inks had a faster drying speed than commercially available ordinary inks, among which the drying speed was the fastest on offset paper. In terms of color reproduction performance, laboratory-made inks had better performance, among which the color performance on coated paper was better. The properties of ink drying and color reproduction, are important factors to ensure the quality of ink-jet printing. This paper would have a certain reference value for the related research in the field of on-demand printing and publishing.

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