

Study on the Influence of Coated Paper's Performance on the Printing Quality of HP Indigo Digital Printer

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Abstract

In order to improve printing quality, the relationships between paper's performance and the quality of digital printing are studied; coated papers with different grams and manufacturers are chosen, the smoothness, roughness, tightness, K&N value and gloss of the paper respectively are tested. Printing proofs by the HP indigo 1050 digital printer, solid density and dot gain of the printing proofs are tested. Mathematical processing method of statistics regression analysis is used for analyzing the relationships between paper's performance and the quality of digital printing. The results show that the influence of tightness and K&N value to the quality of digital printing is the most remarkable, while the influence of roughness is relatively remarkable.

Key words: paper's performance; digital printing; printing quality; regression analysis

Introduction

Along with the rapid development of computer and network, the modern printing has got into the digital era. Digital printing has permeated into all fields of printing and it has huge potential market demand for it has some characteristics such as fast, efficient, flexible, simple process and variable date. Electrostatic imaging is one of the main ways of digital printing, and HP Indigo digital printer is the typical representative [1].

With the rapid development and widely used of digital printing, the requirements of the digital printing quality becomes higher and higher. Therefore, the study on the control of the digital printing quality becomes very important. Paper performance is one of the factors that affect the printing quality, but as the principle of digital printing is different from the traditional printing, so does the paper performance on the influence of printing quality [2]. Therefore, it has some help to improve the digital printing quality by studying the relationship between the paper performance and the printing quality of the HP Indigo printer.

Experiments

Experimental materials

Paper: ChenMing (105g/m², 128g/m², 157g/m², 200g/m²); XueYing (105g/m², 128g/m²); Golden Sun (105g/m², 128g/m²); DongFan (157g/m²); dp 157g/m²
Ink: K&N ink; electronic ink of Hp indigo digital printer

Equipment

Testing equipment: YQ-Z-11 type high precision electric thickness meter, China; AW-320 high precision electronic balance, China; TC 108 DP/ A glossmeter, Japan; ZPD-10 B type mercury-free paper smoothness locator, China; M590-PPS surface roughness instrument, US; YM-20 type ink absorption detector,

China; WSB-□ type paper whiteness meter, China; X-Rite Spectro Eye spectrophotometer, US.

Printing equipment: Hp indigo1050 digital printer

Digital printing

According to various papers, print it by the Hp Indigo digital printer under the best process parameters. The screening line number is 175lpi, and the printing speed is 1000 tickets/h.

Paper performance testing

The papers were deposed for water balance in the laboratory environment (temperature is 24 °C and the humidity is 55%), and the paper performance were tested.

Test method of tightness: weigh the substance by the electronic balance, test the thickness of the paper by electric thickness meter and the tightness can be calculated by the ratio of substance and thickness, as shown in equation 1.

$$D = \frac{W}{T \times 1000} \quad (1)$$

PS: D-tightness of paper, g/m³; W-substance, g/m²; T-thickness of paper, mm.

Test method of smoothness and roughness: distinguish from the both sides of the paper, test the smoothness of the paper by smoothness locator, and test the roughness of the paper by PPS roughmeter.

Test method of gloss: distinguish from the both sides of the paper, and test the gloss of the paper by using glossmeter.

Test method of ink absorption: use K&N test method, ink absorption pattern are prepared by using ink absorption detector, and test it by whiteness meter, and K&N value can be calculated by equation 2.

$$K \& N = \frac{R_{\infty} - R_f}{R_{\infty}} \times 100\% + R_r \quad (2)$$

PS: R_∞: the blue light reflection factor of blank areas; R_f: the blue light reflection factor of smudgy area; R_r: the ink correction factor

Printing quality testing

Test the solid density and dot gain value of the printing proofs by spectrophotometer. This paper mainly discuss the dot gain value at 25%, 50%, and 75% dot, that is to say it will study the halftone reproduction of the proofs at high, middle and dark tone.

Results and Discussion

The main performance of various papers

Test the main performance of the 9 papers, and the results are shown in Tab.1.

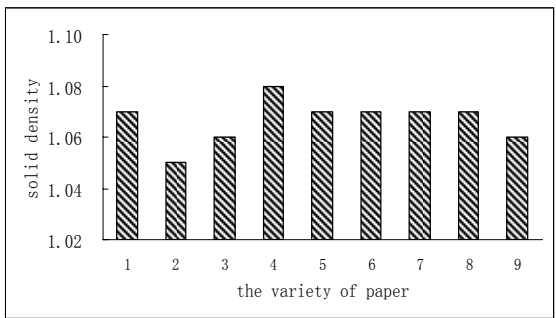
Tab.1 The main performance of various papers

Paper	substance /g/m ²	Tightness/g/cm ³	Smoothness/s/s	Roughness/s/μm	K&N value	gloss
Golden Sun	105	1.11	298.3	2.92	23.75	18.61
	128	1.16	240.8	3.12	19.77	23.71
ChenMing	105	1.14	289.0	2.93	20.35	25.17
	128	1.22	329.9	2.78	19.25	53.25
XueYing	157	1.11	195.3	3.07	21.78	24.33
	200	1.04	134.9	3.41	21.72	23.08
dp	157	1.27	412.6	2.99	13.88	50.87
DongFan	157	1.23	575.9	2.54	17.82	61.52
Huaxia Taiyang	157	1.22	466.6	3.00	18.75	58.83

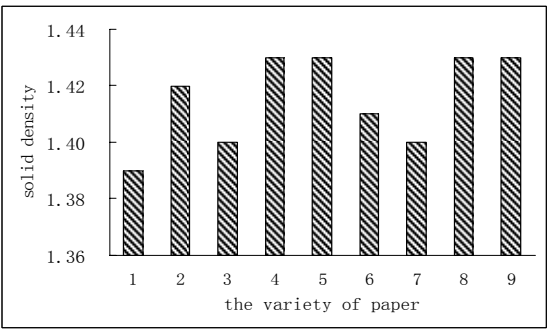
Tab.1 shows that the smoothness and gloss of the 9 papers have great difference; the roughness and K&N value have a little difference, and the tightness have no difference. There is a big difference of the paper's performance between the same brand with different substance and the same substance with different brand.

The printing quality of various papers

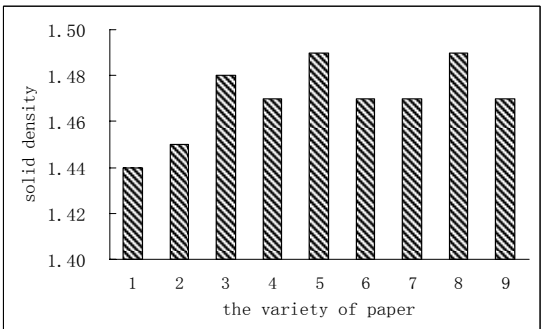
Test the solid density of the proofs that the 9 papers printed at the best process parameters, the results are shown in Fig.1. Test the dot gain value at 25%, 50% and 75% dot, and the results are shown in Fig.2. (1-Chenming Xueying 157g; 2- Chenming Xueying 105g; 3- Huaxia 157g; 4- Dongfan 157g; 5- Golden Sun 128g; 6- Golden Sun 105g; 7- dp 157g; 8- Chenming Xueying 128g; 9- Chenming Xueying 200g)



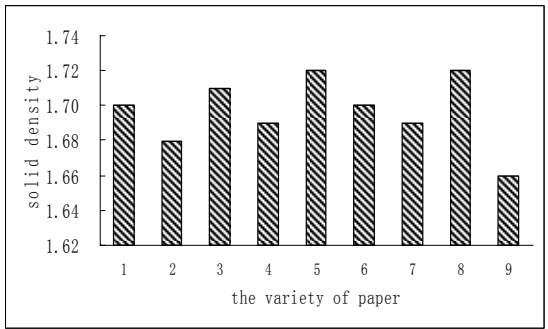
(a) Y



(b) M



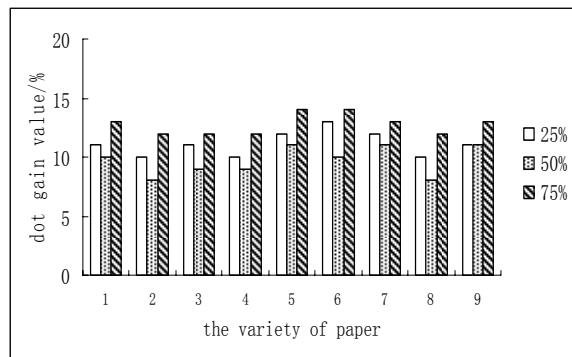
(c) C



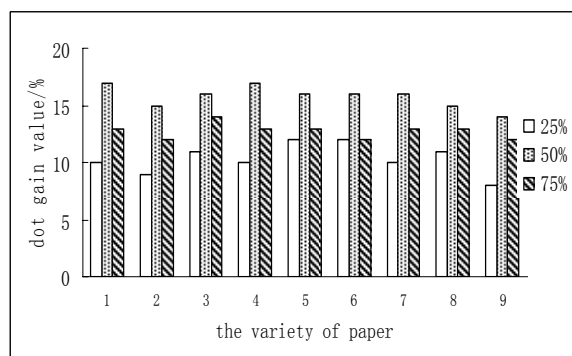
(d) BK

Fig.1 The solid density of different paper

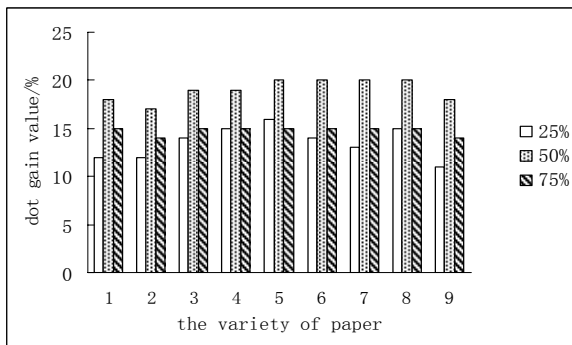
Fig.1 shows that the solid density of different paper has somewhat different. Among them, the solid density of BK、C has great difference, and the solid density of Y has very little difference. For the Hp Indigo printer, paper performance has little effect on the solid density. This is because the ink that transfer to the paper of the Hp Indigo digital printer is controlled by the electric field which formed between the developing drums and the image part on the PIP (Photographic Image Plate), and it not affected by the paper performance [3]. The influence of paper performance on the solid density depends on the thickness and spreading of the ink on the surface of paper. If the tightness of ink on the surface of paper is high, and it will absorb more light, so the solid density is high. If the ink absorption of paper is bad, the ink on the paper surface is big, so the ink can easy spread out, the thickness of ink decreases, so does the solid density.



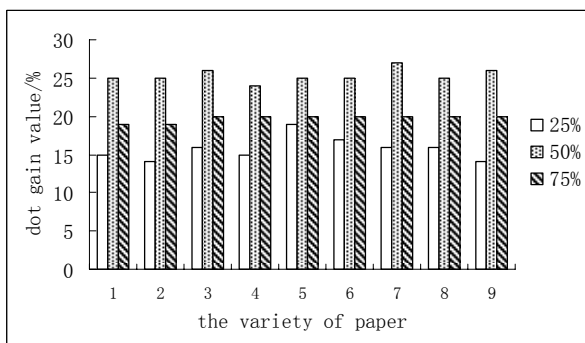
(a) Y



(b) M



(c) C



(d) BK

Fig.2 The dot gain of different paper

Of course, the solid density is not only has relationship to paper performance, but also with the relevant of the ink's permeability. When the ink's permeability is poor, regardless of the tightness of paper, the ink that enter into the paper will decrease, and the thickness of the ink that on the paper surface is little difference, so the influence of paper performance on the solid density is lesser. Rather, when the ink's permeability is good, the paper performance will have effect on solid density. BK, C ink of Hp Indigo digital printer is such ink.

Fig.2 shows that different paper has different dot gain. The dot gain of high tone has big difference, but that of dark tone has little difference. BK and C's dot gain in high tone have big difference, and that of C's has little difference. This is because dot gain is mainly has relation to the spread of ink. For Hp Indigo digital printer, it mainly depends on the thickness of ink on the paper surface and the ink absorption. The higher the tightness of paper is, the bigger the thickness of ink on the paper surface is, as well as the spread of ink and dot gain. The bigger the ink absorption is, the greater the diffusion that ink to the cross section and the internal of paper is, as well as the dot gain, the phenomenon will more obvious for the ink with better permeability [4]. In addition, in the high tone part, as the dot area is lesser, the effect of ink's spread is great. In the dark tone part, as the dot area is bigger, so the effect of ink's spread is small.

The relationship between the paper performance and printing quality

Study the relationship between the paper performance and printing quality by using statistical regression analysis, and the results are shown in Tab.2.

Tab.2 The regression analysis results of the influence of paper performance on printing quality

printing quality	Independent variable	Dependent variable	Regression coefficient	Sig value
Solid density	smoothness	Solid density	-8.80	0.338
	roughness	Solid density	0.033	0.429
	tightness	Solid density	0.726	0.028
	K&N value	Solid density	0.012	0.045
	gloss	Solid density	-7.24	0.899
Dot gain	smoothness	Dot gain value	0.003	0.666
	roughness	Dot gain value	3.782	0.254
	tightness	Dot gain value	49.130	0.037
	K&N value	Dot gain value	0.844	0.051
	gloss	Dot gain value	-0.059	0.232

By using regression analysis method, when the result $\text{sig} \leq 0.05$, it is to say the independent variable has remarkable

influence on the dependent variable [5], and the established regression relationship is effective. The influence of paper performance on the printing quality can be got, and the results are shown in Tab.3.

Tab.3 Influence of paper performance on printing quality

printing quality	Solid density	Dot gain
factors that influence significant	tightness (+) K&N value (+)	tightness (+) K&N value (+)
factors that influence significant	tightness (+) K&N value (+)	tightness (+) K&N value (+)

(PS: with “+” in brackets is positive relationship, and with “-” in brackets is negative relationship)

Tab.2 shows that the tightness and K&N value have remarkable influence on the solid density and dot gain, and the tightness of paper has the biggest effect. Both tightness and K&N value are positive relationship between solid density and dot gain. The main paper performances that influence the printing quality of Hp Indigo printer are tightness and K&N value. K&N value expresses the ink absorption, so the result of regression analysis is consistent with the previous analysis.

Conclusions

Through the above research, it can be concluded conclusions as follows:

(1) The paper performance has small influence on the solid density of Hp Indigo printer. It has great effect on the dot gain at high tone, but has very small effect at dark tone.

(2) The tightness, K&N value have effective influence on solid density and dot gain of Hp Indigo printer, and the tightness of paper has the biggest effect. Both tightness and K&N value are positive relationship between solid density and dot gain.

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Author Biography

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