Influence of Coalescent on the Gloss of Plastic Water-Based Flexographic Ink

Xue Gao, Zhiyong Sun, Yun Ouyang, Xiaofang Wang, Xiaoli Liu, Li Yang and Xiaojuan Feng

Abstract This article analyzed and studied the effects of different types of coalescing agent on gloss of plastic water-based flexographic ink. As one of the most important characters for plastic water-based flexographic ink, gloss determines the quality of the flexo-printing products. It is significant for plastic water-based flexographic ink to improve the film quality and reduce the dosage of coalescing agent. We mainly studied on the influence of mass fraction of alcohol coalescing agent (A1), esters coalescing agent (A2) and esters coalescing agent (A3) in plastic water-based flexographic ink. The results indicated that the best dosages of the three kinds of coalescing agents are 1.4, 1.0 and 1.0%. The gloss is increasing 5.2, 14.6 and 10.3% respectively. The esters coalescing agent (A2) have notable effect on the gloss of the ink.

Keywords Plastic water-based flexographic ink · Coalescent · Gloss

1 Introduction

As a new type of green printing and packaging material, plastic water-based flexographic ink has vast prospect applied to alcohol, food, beverage, medicine, children's toys and other printing products with strict health condition requirement [1, 2]. Gloss is a very important properties of plastic water-based flexographic ink, affects the appearance of the product. Gloss is refers to the ability of reflection of light from the ink layer in a certain angle. Lack of gloss is the main problem of plastic water-based flexographic ink, which hinders the application for printing and packaging fields seriously at present [3–5]. Therefore, it is urgent to find a kind of suitable coalescing agent to solve this problem.

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There are three kinds of coalescent, including hydrophobic hydrocarbon coalescent, half-hydrophilic coalescent and hydrophilic coalescent [6]. The hydrophobic hydrocarbon coalescing agent will cause a decline in the adhesion. The third kind of coalescing agents are used to improve the freeze-thaw stability of ink as antifreeze.

In this chapter, we focus on the impact on plastic water-based flexographic ink with amounts of second kind of coalescing agents, such as alcohol coalescent (A1), esters coalescent (A2) and esters coalescent (A3). Prepared the ink with different amount of coalescent, the properties of overprinted biaxially-oriented polypropylene plastic film (BOPP) with those inks, i.e. and gloss, are compared.

2 Experiments

2.1 Materials

Base ink	Base ink (C3) (Beijing xin nuo an Co., Ltd.);
Resin	Acrylic resin R1 (BASF);
Additives	alcohol coalescent (A1), esters coalescent (A2), esters coalescnt (A3), defoamer 810 (Deutsche Degussa), deionized water.
Printing substrate	BOPP film.

2.2 Equipments

Laboratory dispersers	SWFS-4000 (Shanghai Sower Mechanical and Electrical Equipment Co., Ltd.);
Printability Tester	IGT F1 Basic;
Gloss Meter	TC-108DP/A (Tokyo Denshoku Co., Ltd.);
Surface Roughometer	M590-PPS (Messmer Instruments Ltd.).

2.3 Preparation Method of Water-Based Ink

Weighing a certain quality of acrylic resin R1 in a beaker and adding C3 slowly while mixing for 20 min, and then dropping in 810 (0.7%) stirring for another 20 min. Finally, adding the coalescent in the plastic water-based flexographic ink with a certain mass fraction and high-speed of 1500 revolutions per minute stirring for 1 h, then water-based ink is obtained.

3 Test Methods

3.1 Proofing Method

Use flexographic proofing device. Wherein, the printing pressure is 100 N, printing speed is 0.3 m/s, and the anilox line screen number is 480 dpi.

3.2 Gloss Test

Gloss mainly depends on the angle of the lighting and observation, taking the angles of measurement is 20°, 45°, 60° or 85°. In our experiment, the angle of detect the ink film gloss is 60°, recorded data after test, take average of five points.

3.3 Surface Roughness Test

Surface roughness refers to the ink layer surface with small spacing and small peak valley of roughness. The distance between the two peaks or two troughs (wave distance) is very small (under 0.1 μm), it belongs to the micro geometry shape error. The smaller the surface roughness, the smoother of the ink layer surface is. Put ink layer between the test head and the rubber bearing and recorded data after testing, take average of five points.

4 Results and Discussion

4.1 Effects of Alcohol Coalescent (A1) on Gloss

Fixed ink ratio of components, with the mass fraction of alcohol coalescent (A1) (0, 1.0, 1.2, 1.4, 1.6, 1.8%). Figure 1 demonstrates the surface roughness and gloss of water-based ink.

As shown in Fig. 1a, the gloss increases gradually and reaching its maximum percentage of 69%, which enhanced 10.3% to the original ink, and continued to decline. At the same time, surface roughness gets minimum value (0.6 μm) with the same proportion (Fig. 1b). The amounts of A1 give rise to a rising for gloss. Basic data onto experiment is shown as Table 1.

A tiny bump on the surface of ink layer will give the degree of light scatter increases, which causes the gloss decline. Alcohol agent (A1) is small molecular substances can reduce the surface tension of plastic water-based flexographic ink. Thought a small amount of Alcohol agent (A1) couldn't reduce the ink tension

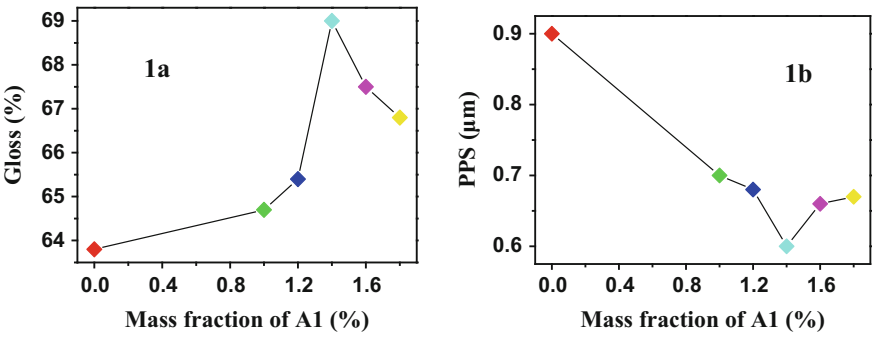

Fig. 1 Effects of the mass fraction of A1 on gloss and surface roughness of ink

Table 1 The effect of different mass fraction of A1 on ink

Coalescent	Amount/%	0	1	1.2	1.4	1.6	1.8
A1	V4/s	41.68	49.79	49.23	4735	46.06	45.59
	Size/μm	25	30	30	30	30	35
	pH	7.73	7.74	7.75	7.74	7.74	7.74
	Dryness/mm	111	85.5	109	113.5	120	122
	Solid content/%	49	49	49	49	49	49
	PPS/μm	0.9	0.7	0.68	0.6	0.66	0.67
	Gloss/%	63.8	64.7	65.4	69	67.5	66.8

obviously brings about the poor flowing property and gloss. What's more, an excess of A1 could cause a decrease of ink adhesion and reduce the layer thickness, then reduces the gloss [7]. So we found the best dosage of A1 in plastic water-based flexographic ink is 1.4%.

4.2 Effects of Ethers Coalescent (A2) and Esters Coalescent (A3) on Gloss

Fixed ink ratio of components, with the mass fraction of ethers coalescing agent (A2) at 0.5, 1.0, 1.5, 2.0 and 2.5%. Figure 2 demonstrates the surface roughness and gloss of water-based ink.

Figure 2a indicates that the gloss achieves maximum (78.4%) with the proportion of A2 is 1.0%, which enhanced 14.8% to the original ink. And gloss fall back slightly with the increase of A2. Surface roughness has sharp dropped to 0.6 μm with the A2 at the same proportion. The effect of A2 on surface roughness and gloss just the opposite, which indicated in Fig. 2b. Basic data onto experiment is shown as Table 2.

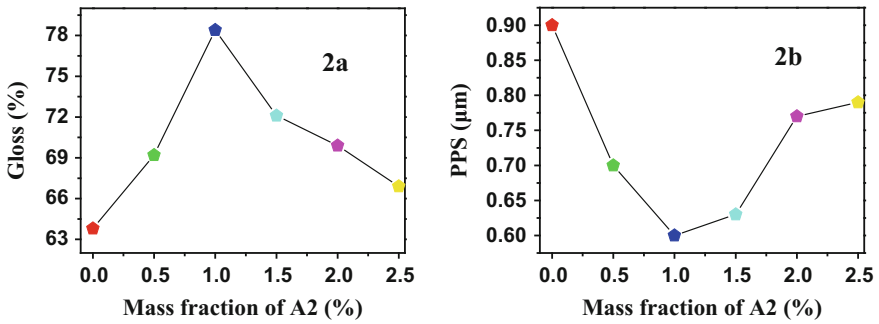

Fig. 2 Effects of the mass fraction of A2 on gloss and surface roughness of ink

Table 2 Effect of different mass fraction of A2 on ink

Coalescent	Amount/%	0	0.5	1	1.5	2	2.5
A2	V4/s	41.68	44.99	46.9	47.36	54.7	58.46
	Size/μm	25	35	35	35	40	35
	pH	7.73	7.84	7.84	7.84	7.84	7.83
	Dryness/mm	111	101	104	110	115	123
	Solid content/%	49	49	49	49	49	49
	PPS/μm	0.9	0.7	0.6	0.63	0.77	0.79
	Gloss/%	63.8	69.2	78.4	72.1	69.9	66.9

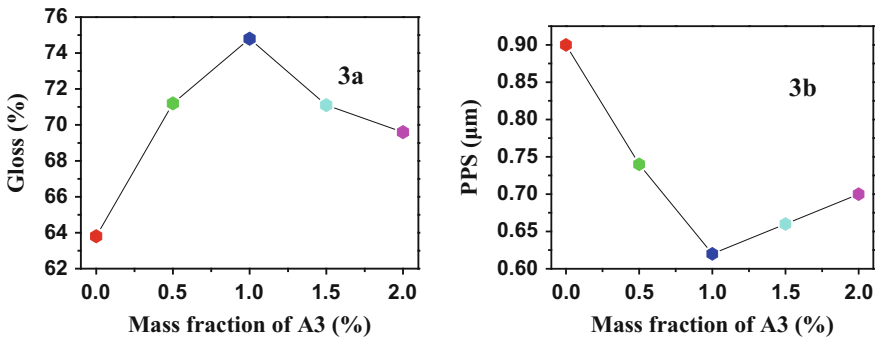

Fig. 3 Effects of the mass fraction of A3 on gloss and surface roughness of ink

The mass fraction of esters coalescing agent (A3) in water-based ink is at 0.5, 1.0, 1.5 and 2.0%. Figure 3 demonstrates the surface roughness and gloss of water-based ink. As shown in Fig. 3a, the gloss scratches maximum (74.8%) when the proportion of A3 is 1.0%, an increase of 10.3% compared to the original ink. Surface roughness has sharp drop with the addition of A3 (0.62 μm), which indicated in Fig. 3b. Basic data onto experiment is shown as Table 3.

Table 3 The effect of different mass fraction of A3 on ink

Coalescent	Amount/%	0	0.5	1	1.5	2
A3	V4/s	41.68	43.82	45.76	47.38	50.14
	Size/μm	25	40	45	40	40
	pH	7.73	7.85	7.85	7.85	7.85
	Dryness/mm	111	126	124	122	124
	Solid content/%	49	49	49	49	49
	PPS/μm	0.9	0.74	0.62	0.66	0.7
	Gloss/%	63.8	71.2	74.8	71.1	69.6

From the data above, we could consider that there are no obviously difference between ethers coalescing agent (A2) and esters coalescing agent (A3) in acrylic resin system. Compare A2 and A3, the impact on water-based ink of A3 is relatively stable, but the gloss is higher when A2 in a suitable content.

As film coalescent can reduce the MFFT of resin effectively so that can help to form a smooth film [8], A2 and A3 can reduce the MFFT of acrylic resin effectively so that can help to form a smooth film. Besides, as glycol ether, the polarity of A2 and A3 is stronger that can reduce the surface tension notably then improve the gloss and reduce surface roughness. But an excess of film coalescing agents can bring adverse effect on dispersion of water-based ink. So we should pay a great attention to amount of coalescent when we use it in actual production.

5 Conclusions

Mass fraction of coalescent has great influenced on gloss of plastic water-based flexographic ink. The results indicated that the best dosages of the three kinds of coalescing agents are 1.4, 1.0 and 1.0. The gloss is increasing 5.2, 14.6 and 10.3% respectively. The esters coalescing agent (A2) have notable effect on the gloss of the ink.

As alcohol coalescent (A1) is small molecular substances can cause a decrease of ink adhesion and with an excess of A1 (>1.4%) reduce the layer thickness, then influence surface roughness and gloss seriously. Due to an excess of film coalescing agents contain the VOC, we should pay attention to the mass fraction of ether coalescent (A2) and ester coalescent (A3) when we use them in actual production. We found the best level in water-based ink is 1.0%, and the influence of A2 to gloss is better than A3 for plastic water-based flexographic ink at the same condition.

As the best content of coalescing agents for gloss are different, we should according to the different printing products to choose the best one for plastic water-based flexographic ink.

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