ISSN : 0974 - 7486 Volume 9 Issue 2

Materials Science

An Indian Journal

Trade Science Inc.

Full Paper

MSAIJ, 9(2), 2013 [63-66]

Development and application of steel plate inkjet coating

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Received: 13th June, 2012 ; Accepted: 4th October, 2012

ABSTRACT

The aim of this study was the preparation of new steel plate inkjet paint using non-toxic ethanol and isopropyl alcohol as solvent, alcohol-soluble acrylic resin as film forming substance, micron-sized titanium dioxide as filler. This coating is characterized by low VOA, good storage stability, quicker drying and film toughness strength. Covering power can be achieved 106g/m^2; it has been tested with excellent performance in an iron and steel company.

KEYWORDS

Steel plate;
Alcohol solvent;
Acrylic resin;
Inkjet coating.

INTRODUCTION

At present most of the plate ink-jet coating adopt import in China, because of a lot of steel enterprise are supplied by Europe suppliers. The nationalization of coating will help to reduce the production cost. It is well known that the traditional hydrocarbons and aromatic solvent-based coating volatile a mass of volatile toxic pollutantsÿnot only the pollution of the environment but also human health and the ecological balance have a serious negative effect. It was predicted that the environmental protection to pay the more attention, the development of environmental friendly coating has become the new trend now. Therefore introduction of the alcohol solvent greatly reduces the VOA emissions. Due to the characteristics of low boiling point, it is also short of time of the film forming into conjunctiva. The jet of the handwriting required following characteristics: clear, excellent characteristics of resistance to wipe and font luster. Alcohol soluble acrylic resin as the film forming substance, it has excellent weathering resistance and high mechanical feature[1].

To investigate the phenomena that thermoplastic acrylic resin don't happen further crosslinking in the film-forming process, its relative molecular weight is larger, which is provided great gloss retention and color retention, water resistance and chemical resistance, quick drying and facilitating construction. The coating was supplied apparent clear color after spraying coatings, which has the very great resolution. J A Antonelli ever reported the development of acrylic polymer coatings. Because of its property of the shading clear was confirmed, it has been used in widely including automotive industry[2].

Notably, it is very important to choice solvent used to dissolve coating during the preparation. Ethanol alcohol and isopropyl alcohol as solvent, not only it can protect the environment but also improve coating performance, the quicker drying time than water-based coating. J Kamikuri has reported water-based acrylic coating[3], although the VOA volatile greatly reduced, it exhibited long drying time and influenced the produc-

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tivity of the steel finishing. To overcome this issue, for a comparison, Chen once put vinyl alcohol adding into ethanol as solvent, so that avoid shortcoming of the construction time[4]. In order to reduce volatile of the harmful solvents, R T Khanna has studied high solid coating containing 50% film forming substance[5], even he viscosity of the coating, so that it will increase the difficulty of the construction in the spraying process. High solid coating is difficult to be stored. The advantage of titanium white as filler was confirmed the higher refractive index, the stronger tinting strength, the higher covering power, the greater dispersion property, the higher whiteness, non-toxic comparing other kind fillers.

EXPERIMENT

Reagents and materials

Acrylic resin comes from Shenyang Tricyclic Comp. Titanium dioxide (26 um) comes from Jinzhou titanium white Comp. Several additives are commercial products. Ethanol alcohol and isopropyl alcohol are of analytically pure.

Instrument

A high speed mixer, Paint 4 cups and DNJ-7 Rotating viscometer were adopt in processes of making and testing.

Operations

Acrylic resin and dispersant pre-dissolved with the alcoholic solvents, and high speed disperse 30 min, make out to titanium white paste, then adding to resin and other additives high-speed grinding mixed 30 min.

RESULTS AND DISCUSSION

Uniform experimental design

Considering all the influence of the constituents on the stability of the coating, to gain more insight into the interaction of all constituents, the uniform design mathematics method is used to optimize the relationship of composition and the stability of the paint. Optimization formula could be gained in fewer tests, according to the four factors 5 levels test arrangements.

The proportion is shown in TABLE 1 in producing coating, the content of titanium dioxide was fixed as 13.0%. The finished coating is put into 10ml centrifugal tube in 3000 r/min spin 10 min, measured with the volume of not layered, as an indexes of paint stability.

TABLE 1 : Uniform experimental design and the results

No	Resin %, x_1	White carbon black %, x_2	Dispersant %, x_3	Thickener %, x_4	No stratification volume /ml
1	17.0	0.50	0.40	0.80	9.65
2	17.5	0.70	0.30	0.70	9.55
3	18.0	0.50	0.45	0.60	9.60
4	18.5	0.60	0.35	0.50	9.75
5	19.0	0.80	0.50	0.90	9.80

Note: x_1, x_2, x_3, and x_4 means resin, white carbon black, dispersant, thickener; y means stability results.

In order to simplify the calculation the 4 factors were standardized as following:

$X_1=2(x_1-18)/(19-17)$; $X_2=3(x_2-0.65)/(0.8-0.5)$; $X_3=2(x_3-0.4)/(0.5-0.3)$; $X_4=4(x_4-0.7)/(0.9-0.5)$

TABLE 2 : Standard component ratio

No	X_1	X_2	X_3	X_4	y
1	-1	-1	0	1	9.65
2	-0. 5	0. 5	-1	0	9.55
3	0	-1. 5	0. 5	-1	9.60
4	0. 5	-0. 5	-0. 5	-2	9.75
5	1	1. 5	1	2	9.80

$$y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4$$

$$a_i = (X_{ij})(y_j)(i = 1,2,3,4; j = 1,2,3,4,5)$$

By the parameter estimation, the expression of a four- element equation was solved.

As can be seen from the uniform design to solve the regression equation:

$$y = 72.98x_1 + 3.594x_2 + 5.406x_3 + 3.991x_4 - 1375.31$$

From the regression equation, it is confirmed that for stability the resin, white carbon black, dispersant, thickener are the proportional relationship. The uniform design shows that four elements are in play the role of coating stability, the main factor is resin. The resin as high viscosity acrylic resin, resin and titanium dioxide absorb form each other space crosslinking system, the greater stability of the coating was confirmed. Thickener in coating system form strong network system formed thixotropic, to further improves the stability of the coating. White carbon black itself is a kind of good anti-settling and wear-resisting agent, with silicon alkyl

alcohol on the surface, these Silicon alkyl alcohol can form hydrogen bonding with near silicon dioxide particles, the influence of hydrogen bonding form thixotropic structure. it's considered the difficulty to reunion settlement, because of dispersant adsorb on white solid particle surface, therefore it also play a role of stability.

TABLE 3 : Orthogonal experiment design and results

NO	Titanium dioxide%	Thickener %	White carbon Black%	Resin %	No stratification height /ml
1	11	0. 5	0. 5	17	9. 10
2	11	0. 8	0. 8	18	9. 30
3	11	1. 0	1. 0	19	9. 40
4	12	0. 5	0. 8	19	9. 60
5	12	0. 8	1. 0	17	9. 40
6	12	1. 0	0. 5	18	9. 60
7	13	0. 5	1. 0	18	9. 70
8	13	0. 8	0. 5	19	9. 80
9	13	1. 0	0. 8	17	9. 70
K_1	9. 27	9. 50	9. 50	9.40	
K_2	9.47	9. 47	9. 53	9.53	
K_3	9.73	9. 57	9. 50	9.53	
K	0.46	0. 10	0. 03	0. 13	

The orthogonal design optimization experiment

In this study, to investigate this uniform design reveals influence tendency of components for coating, orthogonal experiment design was be used to verify the result. According to the orthogonal test reveals the best stability of the composition proportion with considering the comprehensive properties[6].

Making paint samples and analysis its stability experiments were similar to uniform design process.

In the four components the order of the stability of the coating is titanium dioxide, resin, thickener, White carbon black. It can be concluded that titanium dioxide can improve the stability, because of its nano size particle is easily possessed strong surface adsorption effect which can absorb resin and solvent, to improve the stability of the coating has a great effect. Interestingly, the amount of filler should not be too much. Understandably, the adhesion is decreased with increasing filler.

The test of each index about coating

The various coating performances were test based specific experimental operation, experimental conditions refer to Chinese standard (GB).

TABLE 4 : Alcohol-soluble acrylic resin performance test

Test item	Standard value	Test value	Test method
The film appearance and color	luster and smooth on surface, white	qualified	GB/T 1729-79
covering power,g/m^2	≥110	106	GB/T 1726-1979
wipe resistance performance	not show the material	qualified	GB/T 23989-2009
Viscosity (paint -4),s	≥30	36	GB/T 9269-2009
surface dry,min	≤30	5	GB/T 9269-2009
entity dry,h	≤2	0.5	GB/T 9269-2009

The results of alcohol-soluble acrylic resin performance shows that steel plate inkjet coating performance fully comply with the GB, on the other hand, which shows better performance in some aspects. Our sample was applied in the Anshan I&S Com. get a good results.

CONCLUSION

The aim of this study was prepare a paint alcohol as solvent of acrylic resin to pray mark on steel plate. The conclusion for optimization results of the coating and composition ratio in considering stability, covering power and site spraying performance: Titanium white, 13%; Resin, 18%; Thickener, 0.8%; Dispersant, 0.8%; White carbon black, 0.8%; Alcohol solvent, 67.5%.

The influent for the coating properties were investigated, the main factors are resin and titanium white. This paint in site application got an excellent result.

REFERENCES

[1] Yuming Niu; Selection of industrial coating based on environmental impact characteristics. ProQuest Digital Dissertation, UMI Number 3126285, **(2004)**.

[2] Joseph A.Antonelli, Isidor Hazan; Coating composition of an acrylic polymer, a dispersed acrylic polymer and an alkylated melamine cross linking agent [P]. United States Patent, 4, 591, 533, May 27, **(1986)**.

[3] Joshimasa Kamikuri. Water-based paint composition painting method and paint flint [P]. United States Patent, 5, 767, 188, June 16, **(1998)**.

[4] Yung-ming; Chen.Ethylene vinyl alcohol composition and coating [P]. United States Patent, 6, 759, 054, July 6, **(2004)**.

[5] Ram-Tirth Khanna, Robert L Turner; High solids coating composition of a low molecular weight acrylic polymer and an alkylated melamine cross-linking agent [P]. United States Patent, 4, 276, 212, June 30, **(1981)**.

[6] Haiying Teng, Guoqiang Zhu, Ping Huang; Analysis of the orthogonal experiment design and example [J]. Technology and method, P75-75, August 28, (**2007)**.