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WATER-BORNE COATINGS BASED ON EPOXY RESIN FOR CORROSION PROTECTION OF STEEL

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ABSTRACT

The preparation of water thinnable resin based on the reaction of bisphenol-A-type of epoxy with trimellitic anhydride, and its use in the preparation of a paint are described. The chemical resistance properties of the paint and resin system have also been studied.

Key words: Water-borne coating paint, epoxy resin, corrosion protection

INTRODUCTION

The water-borne coatings which form one type of nonpolluting coatings, have several advantages over conventional coatings uisng organic solvent as thinner material. In the present epoch where great importance is attached to environmental protection, the development of water-thinnable paint system is highly relevant to the society in preserving a healthier environment.

In this paper, the preparation of water thinnable resin based on the reaction of bisphenol-A-type of epoxy with trimellitic anhydride and its use in the preparation of a paint have been described. The properties of the prepared paint system have also been studied.

EXPERIMENTAL

Preparation of water-thinnable epoxy resin

The water-thinnable epoxy resin has been prepared by introducing carboxyl group into the epoxy resin and neutralising the resultant carboxyl containing epoxy resin with ammonia/amines [1-3]. This was carried out as follows: Bisphenol-A based epoxy resin (epoxide equivalent 500) was reacted with trimellitic anhydride in methylisobutyl ketone medium at a temperature of 120°-125° C for about 2 hrs in a round bottomed flask fitted with a condenser. After the reaction was over, butylcellosolve was added to the reaction product. Then methyl isobutyl ketone was removed from the reaction mixture by vacuum distillation. At this point, the acid value of the reaction product was around 15-20. It was then neutralised with monoethanol amine and then diluted with water-butanol mixture.

Preparation of water-thinnable paint

The paint based on the water-thinnable resin was prepared by employing titanium dioxide (Rutile) and bentonite as pigments. The pigments were mixed well with water thinnable resin in a ball mill for 40 hrs. Pigment volume concentration employed in the paint was around 30%. Sodium hexametaphosphate was employed as the dispersant for pigments [4] to eliminate flocculation of pigments. Dibutyl phthalate was included as plasticiser to avoid brittleness of the paint film. Similarly traces of sodium benzoate prevents the flash rusting of the mild steel substrate. A typical paint formulation arrived at contained:

Titanium dioxide (Rutile grade)	30-35%
Bentonite	5-6%
Sodium hexametaphosphate	0.001%
Epoxy ester	15-20%
Butylcellosolve	7-8%
Water	30-35%
Dibutyl phthalate	1-2%
Monoethanolamine	0.5-1%
Butanol	1-2%
Sodium benzoate	0.1-0.2%

Preparation of painted panels

Mild steel panels of various sizes were sand blasted to remove the mill scale and rust. Then they were degreased with trichloroethylene and the paint was applied by brush over these panels and dried around 200°-250° C for about 30 minutes in an oven. The thickness of the coating obtained by brush application was 25-30 microns.

Study of mechanical properties of the coating

The mechanical properties of the coating such as adhesion, flexibility, impact resistance and abrasion resistance were studied.

i) Adhesion (by tape test)
The painted panel was placed on a firm base and the coating was scratched by sharp knife till the base metal was visible in such a way that the space between two consecutive cuts was 1 mm apart, 100 such squares were made. The thickness of the paint coatings measured was 1.5 mil. An adhesive cellotape was placed over the tape for 2 hours. Afterwards, the tape was removed by seizing the free end of the tape and pulling it off. The removal of coating from the surface was visually observed with magnifying glass.

ii) Conical mandrel test
This method covers the determination of adhesion of coatings when applied to flat sheet metal of uniform surface texture. In this test, the paint was coated on thin (30-32 gauge) cold rolled carbon steel strip of the dimensions of 10 cm width a maximum length of 19 cm. The test specimen was kept upright on its lengthwise position between the mandrel and draw bar (with the finish side towards the draw bar). It was then tightly clamped in position in such a way that end of the coated specimens adjacent to the narrow end of the conical mandrel was almost touching the side ot the draw bar lever frame. The lever was moved through about 180 degrees at uniform velocity to bend the specimen approximately in about 15 seconds. The bend surface of the specimen was examined immediately for cracking.

iii) Impact resistance
In this test, a tub of 900 gm weight was allowed to fall from a known height.

iv) Taber abrasion
The abrading wheel of silicon carbide was allowed to abrade a painted

specimen placed over a disc rotating at a speed of 60 rpm. The loss in weight of paint per 1000 gm load per 1000 revolutions was determined.

Study of chemical resistance properties of the coating

i) Immersion tests

Painted M.S. specimens were immersed in distilled water and 3% sodium chloride solution for 30 days.

ii) Salt spray (fog) test

The painted M.S. specimens of size 7.5 cm x 5 cm in duplicate, were exposed in the Canning salt spray (fog) chamber where 3% sodium chloride solution was atomised by the compressed air to create a fog. The specimens were exposed for 200 hours.

RESULTS

The observations are given in Table I.

Table I: Mechanical and chemical resistance properties

No. Property	Results
1. Adhesion test (tape method)	Passes
2. Flexibility conical mandrel	Passes 1/8" thickness
3. Taber abrasion	83 mgms/1000 gm wt/1000 revolutions
4. Impact resistance	Withstands a fall from a height of 10 cm
5. Scratch resistance	Passes 500 gm load
6. Immersion in distilled water for 30 days	No change
7. Immersion in 3% NaCl solution for 30 days	No rust at scratch and coating was not affected.
8. Salt-spray (fog) test for 200 hrs.	No change

DISCUSSION

In the preparation of water-thinable resin, formation of an ester during the reaction was confirmed by the infrared spectra of the reaction product. The absorption band at 1200 cm^{-1} which is characteristic of epoxy group disappears and a band at 1100 cm^{-1} emerges which is characteristic of ester group.

CONCLUSION

The water-borne stoving paint thus prepared possesses a fairly good mechanical and corrosion resistance properties. In order to improve its mechanical and corrosion resistant properties further, different types of epoxy resins and inhibitive pigments may be employed.

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