



A study on the reactive diluent for the solvent-free epoxy anticorrosive coating

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ABSTRACT

Solvent-free epoxy anticorrosive coatings have the features of environmental protection, security, economy and chemical resistance. It is important to protective steel structure engineering in sea or chemical and petroleum. The affect of the different kinds and amount of reactive diluent(660A, 90, 3601, 6360) on the amount of non-volatile matter, viscosity and impact strength of coating film. From the experiment analysis, it was found that the dilution capability of different kinds reactive diluent is single functional short chain 660A > monofunctional long chain 90 > bifunctionality 3601 > Three functionality 6360; The effect of reactive diluent on the amount of non-volatile matter is 3601 ≈ 6360 > 90 > 660A; The effect of reactive diluent on the impact strength of coating film is 3601 > 90 ≈ 660A > 6360. From the amount of non-volatile matter and impact strength of coating film, it was found that 3601 as eventually reactive diluent, the most appropriate amount of 3601 is 12%.

Keywords: reactive diluent, impact strength, the amount of non-volatile matter, viscosity

INTRODUCTION

With growing environmental concern, solvent-free epoxy anticorrosive coatings is one of the key development directions of environmentally friendly anticorrosive coatings [1-3]. Solvent-free epoxy anticorrosive coatings [4,5] is a kind of containing very little or do not contain volatile organic solvent of high solid coatings, it can reduce the organic solvent volatilization to the human body and the environment pollution, it has very good safety and environmental friendly. Solvent-free epoxy anticorrosive coatings is suitable for thick coating due to high viscosity. Compare with solvent coatings, solvent-free epoxy anticorrosive coatings can reduce the construction cost and dosage in the same coating thickness. Solvent-free epoxy anticorrosive coatings has characteristics in low shrinkage, thick coating film and excellent chemical resistance etc [6], It is important to protective steel structure engineering in sea or petrochemical steel pipe and storage tank [7-9].

Solvent-free epoxy anticorrosive coatings is based on epoxy resin as main film forming material, its viscosity are too high and not conducive to the construction. In order to the lower viscosity and good applicability and construction, we need to add reactive diluent in the coating. The different kinds and amount of reactive diluent have a big impact on the performances of the coatings. Choose which kinds of reactive diluents and add how much amount of reactive diluent is the main content of this article research.

EXPERIMENTAL SECTION

Principal raw material

Epoxy resin 618, Glycidyl ether 660A, 90, Polypropylene glycol diglycidyl ether 3601, three hydroxymethyl glycidyl ether 6360, titanium dioxide, curing agent 2280

Preparation technology

Preparation of A component: Epoxy resin, reactive diluent, pigment and adjuvant was uniformly dispersed in A component; Preparation of B component: Curing agent and adjuvant was uniformly dispersed in B component.

Preparation and properties test

A and B mixed in certain proportion and formed the uniform paint film by brush, we can physical and mechanical properties test in 7 days, it includes viscosity, fineness, drying time, thickness of film, adhesive force, impact strength and the amount of non-volatile matter

RESULTS AND DISCUSSION**1. Determine the kinds of reactive diluents****1.1 The affect of the different kinds of reactive diluents on viscosity**

The main effect of reactive diluent is to reduce viscosity. we experiment with four kinds of reactive diluents: Butyl glycidyl ether 660A (Single functionality), Carbon 12-14 alkyl glycidyl ether 90 (Single functionality), polypropylene glycol diglycidyl ether 3601 (bi-functionality), Trimethylolpropane three glycidyl ether 6360 (tri-functionality), respectively. we test intrinsic viscosity and viscosity of coatings under the same amount of reactive diluent, The test results are shown in table 2.

Table2 Dilution capacity comparison of the different kinds of reactive diluent

| Reactive diluents | 660A | 90 | 3601 | 6360 |
|------------------------------|------|------|------|-------|
| Intrinsic viscosity /mPa·s | 3 | 13 | 50 | 180 |
| Viscosity of coatings /mPa·s | 4900 | 5600 | 8400 | 20160 |

With the increase of reactive diluent functionality, and its dilution ability gradually reduced. The short chains of reactive diluent(660A) has better ability of dilution than long chain (90) in the same functionality, So the dilution capability of different kinds of reactive diluents is 660A(single functional short chain) >90 (single functional long chain) >3601 (bi-functionality) >6360 (tri-functionality). We don't choose the 660A due to high vapor pressure, strong smell, high toxicity, not meet the environmental requirements.

1.2 The affect of the different kinds of reactive diluents on physical and mechanical properties

In the same system of fillers and curing agent, we experiment with epoxy resin 618 and reactive diluent 660A, 90, 3601, 6360. The preparation and detection of coating films, which the test results are shown in table 3.

The results show that the coating film with flat and smooth can be obtained when 660A, 90, 3601 as reactive diluent. The coating film have fastest drying time and pinhole appearance when 6360 as reactive diluent. This is due to 6360 with more active functional groups and faster curing rate, bubbles cannot ejected completely in drying time and produced pinhole appearance When the coating is coated on the sand blasting steel substrate surface.

Table3.1 Physical and mechanical performance test data

| Reactive diluents Test project | 660A | 90 | DY3601 | 6360 |
|-----------------------------------|--------|--------|--------|---------|
| Film appearance | smooth | smooth | smooth | pinhole |
| Drying time/min | 190 | 210 | 200 | 120 |
| The amount of non-volatile matter | 94.47 | 96.98 | 97.46 | 97.40 |
| Impact strength/cm | 45 | 45 | 50 | 40 |
| Adhesive force/ level | 0 | 0 | 0 | 0 |

The different types of reactive diluents effect on the amount of non-volatile matter (from big to small): 3601(97.5%)≈6360(97.5%)>90(97%)>660A(94%). From the molecular structure analysis that the molecular structure of 660A is simple, the vapor pressure and volatile rate of 660 has a relatively larger and the content of non-volatile matter is the lowest; Chain length of 90 is longer, the content of non-volatile matter is lower; the molecular structure of 3601 and 6360 is relatively complex, which volatile rate lowest and the content of non-volatile matter is the highest.

The different types of reactive diluents effect on the impact strength of coating film (from strong to weak): 3601(50cm) > 90(45cm)≈660A(45cm) > 6360(40cm)。we analysis suggests that the longer the chain, the better molecular chain flexibility and impact strength. Therefore, the long chain reactive diluent 3601 can improve the flexibility and impact strength. 6360 as tri-functionality reactive diluent, the functionality and crosslinking density is higher and brittleness of coating film is bigger, therefore its impact resistance is the worst then.

After comprehensive consideration of the different types of reactive diluents effect on the properties of paint film, we make sure final select 3601 as reactive diluent.

2. Research of the amount of reactive diluent

2.1 The affect of the amount of reactive diluent on the amount of non-volatile matter.

On the basis of previous reactive diluent kinds to determine, the affect of the amount of reactive diluent 3601(0% , 5% , 10% , 12% , 15% , 20% , 25%)on the amount of non-volatile matter of coating film in Fig. 1.

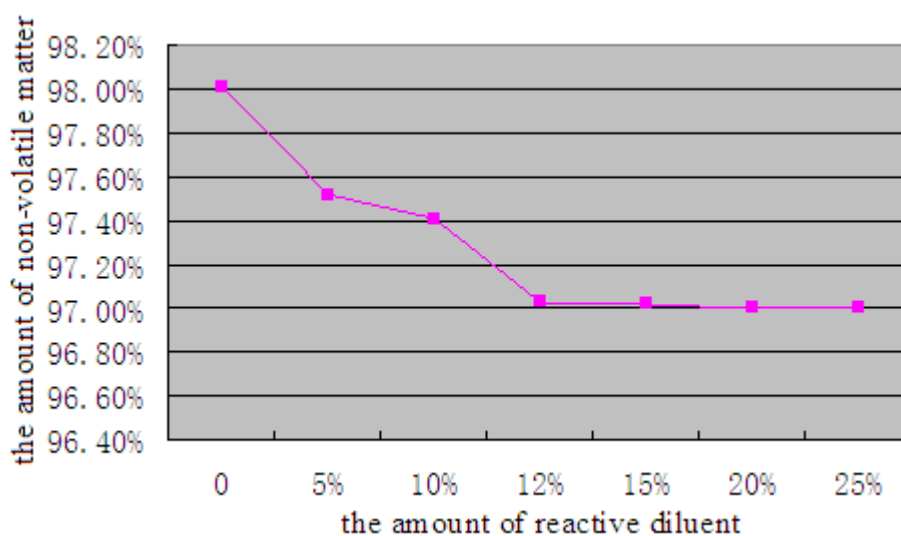


Fig. 1 The affect of the amount of reactive diluent on the amount of non-volatile matter.

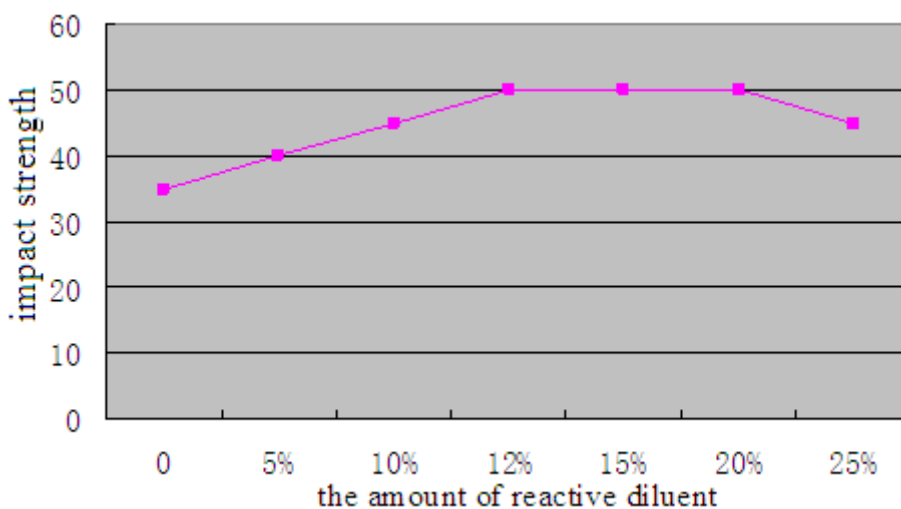


Fig. 2 The affect of the amount of reactive diluent on the impact strength of coating film

From Fig. 1 shown that the amount of non-volatile matter is 98.01% when not adding reactive diluent. The amount of non-volatile matter is dropped to 97.52% when adding 5%. With the increase of dosage of active diluents, coating of non-volatile matter content gradually reduce. The amount of non-volatile matter is 97.03% when 3601 is adding 12%. The amount of non-volatile matter is tends to be stable when continue to increase the dosage of active diluents.

2.2 The affect of the different amount of reactive diluent on impact strength of coating film

On the basis of previous reactive diluent kinds to determine, the impact strength of the coating film was measurement. the affect of the amount of reactive diluent 3601(0%, 5%, 10%, 12%, 15%, 20%, 25%) on the impact strength of coating film in Fig. 2.

The impact strength of coating film is 35cm when not adding reactive diluent. With the increase of the dosage of active diluents 3601, the impact strength of paint film increased as well. The impact strength reach maximum 50cm when the dosage of 3601 is 12% ~ 20%, the impact strength reduced to 45 cm with constantly increasing the amount of 3601

2.3 Determine the dosage of the reactive diluent

Through the experimental study shown that the viscosity and brittleness of coating is big when not adding reactive diluent. Impact strength and adhesive force will decline when the amount of reactive diluent more than a certain degree. Therefore, the suitable dosage of reactive diluents is beneficial to reduce viscosity and toughening effect. Overall consideration, we determine the most appropriate amount of 3601 is 12%.

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