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Research on the Technology of Titanium Containing Inorganic Particle Doped Insulation Paint

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Abstract

This paper provides a modified titanium dioxide nanotube with a specific structure made by a specific method. The modified titanium dioxide nanotube exists in a nanotube structure with a smaller size and specific surface area, and the surface hydrophobicity treatment of the modified titanium dioxide nanotube is also given, allowing the modified titanium dioxide nanotube to participate in the cross-linking network of organic resins such as unsaturated polyester resin, On the one hand, it can ensure the uniform dispersion of modified titanium dioxide nanotubes in the insulation paint, fully utilize their chemical stability, and also improve the crosslinking degree of resin curing. On the other hand, it enables the modified titanium dioxide nanotubes in this paper to be applied to the insulation paint with a large doping amount, thereby improving the mechanical and electrical properties of the insulation paint.

Keywords

Polyester; Titanium Dioxide; Nanotubes.

1. Introduction

With the continuous development of motor technology, the power of the motor continues to increase, and the power consumption of the motor also increases[1-3]. Therefore, the requirements for insulation paint in existing technologies are becoming increasingly high, requiring excellent electrical performance and chemical stability, moisture resistance, heat resistance, and oil resistance; Good compatibility between conductors and other materials; Fast curing, good drying performance, strong adhesion, thermal elasticity, and ability to withstand the centrifugal force of motor rotation after curing; Low viscosity, good fluidity, high solid content, easy to penetrate and fill the impregnated material[4-7].

However, the vast majority of insulation paints nowadays have poor performance due to the use of polymer materials. In order to improve the performance of insulation paints, most researchers use the method of doping inorganic oxide materials[8-13]. However, these insulation paints generally require high doping to achieve high performance, and high doping will affect the mechanical properties of insulation paints. At the same time, there are also problems such as poor compatibility between doped particles and insulation paints. For example, unsaturated polyester resin, due to its simple production process, easy availability of raw materials, chemical corrosion resistance, excellent mechanical and electrical properties, room temperature curing ability, and good process performance, is widely used in insulating coatings as the largest variety of thermosetting resins. However, it also has the aforementioned problems. In order to improve performance, high doping inorganic filling materials are added, On the one hand, it is difficult to achieve good performance due to uneven dispersion, and on the other hand, the incompatibility between doped materials and organic surface interfaces further limits their effectiveness. Currently, the commonly used doping materials, nano titanium dioxide materials, have received widespread attention due to their excellent chemical

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stability and mechanical properties. Smaller titanium dioxide nanotubes have better dispersibility and are expected to address the negative effects of high doping mentioned above.

2. Sample Preparation and Analysis:

The raw materials for insulation paint in the paper include titanium dioxide nanotubes, polyols, anhydride, modified carbon nanotubes, cross-linked monomers, and initiators. Among the raw materials for the paper, 8-12 parts are isophthalic anhydride, 20-25 parts are maleic anhydride, 20-26 parts are 1,2-propanediol, 1-10 parts are surface hydrophobic treated titanium dioxide nanotubes, 0.5-2 parts are benzoyl peroxide, and 20-28 parts are styrene. The raw materials for the paper also include 0.01-0.5 parts are catalysts and 0.01-0.1 parts are polymerization inhibitors. The mass ratio of the mixture of titanium dioxide nanotubes, ethyl orthosilicate, vinyl triethoxysilane, and ammonia water for surface hydrophobic treatment in the paper is 1:0.9-1.2:1.2; The feed mass ratio of one of the paper's ethyl orthosilicate and vinyl triethoxysilane relative to the other is within 3 times.

The acid anhydride in the paper is composed of isophthalic anhydride and maleic anhydride, and the polyol in the paper is 1,2-propanediol. The total feed amount of isophthalic anhydride and maleic anhydride in the paper is 0.9-1.1:1:1 compared to the feed molar ratio of 1,2-propanediol in the paper; And/or, the crosslinking monomer in the paper is styrene; And/or, the initiator of the paper is benzoyl peroxide. Weigh each raw material according to the formula, and then add polyols, acid anhydrides, and surface hydrophobic treated titanium dioxide nanotubes to the reaction vessel. Under the protection of protective gas, heat up and stir to 155-165 ℃, and react until the acid value is less than 50mg KOH/g. Heat up to 170-180 ℃, and react until the acid value is 30-40mg KOH/g. Heat up to 195-205 ℃, and end the reaction until the acid value is 5-20 mg KOH/g; Then cool to 20-35 ℃, add remaining raw materials, mix and react to prepare paper insulation paint; Alternatively, weigh each raw material according to the formula, then add the polyol and anhydride to the reaction vessel.

Under the protection of protective gas, stir at high temperature to 155-165 ℃, and react until the acid value is less than 50mg KOH/g. Raise the temperature to 170-180 ℃, and react until the acid value is 30-40mg KOH/g. Raise the temperature to 195-205 ℃, and end the reaction until the acid value is 5-20 mg KOH/g; Then cool to 20-35 ℃, add the remaining raw materials, mix and react to prepare the paper insulation paint. Among them, titanium dioxide nanotubes account for 1-10% of the total mass of insulation paint materials in the paper.

1) Preparation of titanium dioxide nanotubes: Add anatase phase titanium dioxide powder (with a particle size of about 50 nanometers) and a 10M concentration NaOH solution in a high-pressure reactor at a mass ratio of 1:5, seal, and react under hydrothermal conditions at 140 ℃ for 72 hours; After the reactor cools down, remove the white solid from the high-pressure reactor and wash it with 0.1M hydrochloric acid (HCl) solution, then rinse with a large amount of deionized water until the pH value of the effluent solution is neutral. Finally, dry the titanium dioxide nanotube product at 80 ℃.

2) Surface hydrophobicity treatment of titanium dioxide nanotubes: Add 10% -20% mass fraction of titanium dioxide nanotubes or other titanium containing particles obtained from the previous reaction to a mixed solution of silane coupling agent and anhydrous ethanol (volume ratio 1:10), and sonicate for 10 minutes for dispersion treatment; Subsequently, treat in an oil bath at 400 ℃ for 4 hours; After the oil bath is completed, the flocs obtained from the reaction are repeatedly washed with anhydrous ethanol and deionized water, filtered, and naturally dried at room temperature.

3) Preparation of insulating paint: Weigh each raw material according to the formula, and then add polyols, anhydride, and surface hydrophobic treated titanium dioxide nanotubes to the

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reaction vessel. Under the protection of protective gas, heat up and stir to 155-165 ℃, react to an acid value of<50mg KOH/g, heat up to 170-180 ℃, react to an acid value of 30-40mg KOH/g, heat up to 195-205 ℃, and end the reaction to an acid value of 5-20 mg KOH/g; Then cool to 20-35 ℃, add remaining raw materials, mix and react to prepare paper insulation paint; Alternatively, weigh each raw material according to the formula, then add the polyol and anhydride to the reaction vessel. Under the protection of protective gas, stir at high temperature to 155-165 ℃, and react until the acid value is less than 50mg KOH/g. Raise the temperature to 170-180 ℃, and react until the acid value is 30-40mg KOH/g. Raise the temperature to 195-205 ℃, and end the reaction until the acid value is 5-20 mg KOH/g; Then cool to 20-35 ℃, add the remaining raw materials, mix and react to prepare the paper insulation paint. Among them, titanium dioxide nanotubes account for 1-10% of the total mass of insulation paint materials in the paper.

Table 1. Performance Comparison

	Example 1	Example 2	Example 3	Example 4	Pair ratio 1	Pair ratio 2
Viscosity (mPa. s, 25 ℃)	324	346	341	342	323	356
Bond strength (wire harness method) (N)	352	332	345	321	320	311
Resistivity (Ω. m)	6×10^{14}	6×10^{14}	7×10^{14}	5.0×10^{14}	5×10^{14}	6×10^{14}

3. Summary

With the continuous development of characterization methods, more and more nanotechnology used to modify water-based resins, but currently the application methods and scope are still more extensive relatively conservative, it is imperative to develop new processes and varieties. In the future, the work can be carried out from the following aspects: 1) Improving nanocomposites the preparation process of materials, refining the addition amount of various substances and their differences, the effect of addition amount on its performance; 2) Increase nano TiO_2 modification machine research on principles and improve research standards for mechanism systems; 3) Developing new types of the market for nanomaterials is constantly expanding, and the variety of applications will become more refined seeking higher, multifunctional, and diverse products to meet market requirements; 4) Ring the continuous increase in pressure and high cost are constraints on the promotion of water-based coatings important factors: optimizing the production process of nano TiO_2 and reducing production costs this will become the focus of research

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