

Silane in Fiberglass

1. Glass fiber surface treatment Objective and Significance

Surface treatment is a processing which use the treating agent to cover the surface of reinforcement. These treating agents include treating compound, some of silane coupling agent and auxiliaries. It helps forming a well bond surface between reinforcement and substrate and also can improve various properties of compound materials.

Significance of treatment: We know that function of compound materials are not only related with content and property of resin and fiber, but also greatly depend on the bond of resin and fiber. Surface treatment includes interface processing which is coating a called “surface treatment agent” on the surface of glass fiber. This agent could solidly combined fiber and resin so as to increase the function of glass.

2. Silane coupling agent and their reaction theories.

Silane coupling agent is this kind of materials which are usually have two different groups on themselves ends. One end’s groups have the chemical action or physics action with the surface of reinforcement, while the other end’s groups can react with base materials, so that well bond the reinforcement with substrate to get the good bonding between interfaces and improve many respects of functions and effectively resist water.

Organic-functional silane is a kind of surface treating agent with many different and effective kinds and it’s normal chemical structure is R_nSiX_{4-n} .

There are four steps to treat fiber glass with Organic functional Silane coupling agent:

1. First, there are three unreliable X groups in atom Si to hydrolyze
2. Second, the silane coupling agent condensate Oligomers
3. Third, those oligomers formed hydrogen bond with the “-OH” group of the glass fiber surface
4. Last, In the process of drying and curing, silane creates covalent bonds with glass fiber surface.

3. Glass fiber surface processing method and factors.

1. The treatment method of silane coupling agents for the surface of fiberglass:

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(1) Post-treatment (2) Pre-treatment (3) Grafting

Most of silanes are used in treating compound of fiberglass. We will mainly introduced pre-treatment.

Pre-treatment

Changing the formula of treating compound appropriately, it is not only meet the requirements of fiber forming, spinning and other process, but also not hinder the infiltrating and adhesion between the resin matrix and fiberglass. And also not hinder resin base material wetting and sticking on glass fiber. In the process of fiber forming, we add the silane coupling agent into the treating compound which make the surface treating agent coated on the surface of fiberglass, and we call this process is pre-treatment, which is weaving fiber cloth with fiber which is covered by reinforced treating compound.

2. The dosage of silane coupling agent and factors of treatment.

a. The dosage of silane coupling agent

Playing the role in silane coupling agent is the micro-quantity of monolayer of silane coupling agent. And the appropriately dosage of each kind of silane is result from the experiment.

Attention: the dosage of silane coupling agent can calculate:

Computing method: $V2/V1 = M$

V1: The minimum coating area of 1g silane coupling agent

V2: The surface area of 100g reinforced materials

M: The required quantity of silane coupling agent to coat a monolayer in 100g treated materials.

For example: treated material specific surface is $7m^2/g$. Check table, the minimum covering specific surface of the silane coupling agent USi-2301 is $330m^2/g$, the treated materials is 100g, so the dosage of silane coupling agent we need is:
 $100 \times 7 / 330 = 2.1(g)$

Generally, the real dosage of silane coupling agent in treating materials should higher than above-mentioned calculate dosage.

b. Factors of treatment:

1) The dosage of silane coupling agent

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- 2) The temperature and time of drying
- 3) The pH value of treatment compound

3. Typical composition of enhanced glass fiber:

Silane coupling agent	0.2-2.0%
Film former	2.0-20.0%
Lubricant	0.1-0.3%
Surface active agent	0.0-0.5%
Antistatic agent	0.0-0.3%
Added de-ionized water to 100%	

4. The main silane coupling agent in fiberglass industry.

- 1. USi-1302: γ -Aminopropyltriethoxysilane
- 2. USi-2301: γ -Glycidoxypropyltrimethoxysilane
- 3. USi-3301: γ -methacryloxypropyltrimethoxysilane

5. Requirements on silane coupling in fiberglass industry

- a. Silane coupling must be dispersed in water, because the wetting agent of fiberglass adopts water as the carrier;
- b. Purity of silane coupling should be higher, such as USi-3301 requires the purity is higher than 99%; if the content is low and foreign substance is too much, the strength of the compound materials will change greatly;
- c. The hydrolysis rate is required to be within 30 min, affecting the production efficiency of wetting agent.
- d. It can improve the strength and electric properties, etc. of fiberglass reinforced resin.

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