



Development of sizing agent for fiberglass products

With the continuous construction of fiberglass furnace and expansion of crucible furnace, the production of high quality fiberglass yarn is more and more. The digestion and outlet of glass fiber yarn has become an urgent problem. It can be expected that the competition of fiberglass products will be fiercer and fiercer in the international market.

Some fiberglass processing factories purchase fiberglass yarn from the yarn factories, weaving into a variety of fabrics or even further coating or treatment, and be made of various insulation, soundproofing partitions, waterproof building decoration, waterproof glass fiber products. High value-added product have good economic returns. From the technical and economic point, the deep processing of glass products is from drawing to deep processing to form a complete industrial chain, can occupy a larger market share in the international market and achieve better economic benefits than the export of glass fiber yarn.

1 Introduction to the deep processing of glass fiber products

A part of glass fiber deep processing products is industrial fabric, and there are hundreds of different types. Most of the industrial fabrics with reinforcing textile-type sizing agent such as NBS-140, NBS-180, NBS-185, or water-soluble polyesters SR-1, SR-2; Fixing agents and lubricants for the preparation of a special agent or modified sizing agent of paraffin-type and starch-based. In order to prevent the coating peeling off, adding the coupling agent into the sizing agent. In addition there are a variety of blankets, including chopped strand mat, continuous filament mat, a variety of surface felt, nick carpet and so on. for example:

1.1 Sound-absorbing partition material including glass fiber decorative cloth

These kinds of material are beautiful, washable, fireproof, anti-aging, non-flammable, widely used in cars, train coach decoration, housing, opera, dance halls, KTV rooms, etc.

(1) Adhere the fiberglass cloth on the mineral wool and glass wool board to prevent the mineral wool, glass wool board of wool and dust escape.

(2) Adhere the fiberglass sound-absorbing cloth, using the fiber microporous resonance to cause acoustic resistance, the thickness of the cloth should be thick, thus, it's better to use the bulked yarn.

1.2 Insulation material

(1) Be widely used in car roof, roof lining. Otherwise, glass fiber and cotton and





other fibers blended at molding temperature 300°C, press it on the curing of plastic parts, it also can be used for refrigerated trucks, boats, cold storage, industrial Furnace, chemical metallurgy aluminum foil glass cloth.

(2) The fiberglass fabric requires a certain thickness, patterned, textured decorative cloth, thickness is from 0.4 to 2mm, normally the thickness of fabric is 0.8 to 1.2mm, the fabric structure is plain, twill or satin, jacquard weave a variety of patterns.

1.3 The base fabric of air ducts

The surface treatment of industrial fabrics (if using the enhanced textile-type sizing agent, it can pass the finished treatment, and strength retention is high), coated with neoprene, silicone rubber, PU, acrylic adhesive aluminum foil, it is made into flame-retardant aluminum foil composite fabric and the base fabric of the air duct.

1.4 Electrical insulation products laminates, sleeving, copper clad board fabric 7628, 2116 cloth, etc.

1.5 Mesh cloth

Alkali-resistant wall mesh with fiberglass cloth coated alkali-resistant acrylic coating, it can withstand calcium hydroxide erosion, retaining strength is high, including the capping self-adhesive mesh belt.

1.6 Window screening

Screening are single-wire coated flat woven screens, with the yarn of high strength, wear-resistant, less fuzz, don't plug holes, good cluster, and the smooth appearance.

1.7 Glass fiber bulked yarn

Glass fiber textured yarn is a continuous glass fiber yarn by a special device, under the action of high-pressure air to be puffed (deformation) into soft fluffy glass yarn. It not only keeps the general performance of ordinary glass fiber, but also has the strength of continuous glass fiber and the fluffiness of short fiber. It is a kind of heat resistance, corrosion resistance, low thermal conductivity, low bulk density, textile, filter resistance and softness glass fiber products. It can be used as high-temperature filter material, FRP reinforced materials, asbestos can also be used as a friction material reinforcement materials, as well as a variety of wall decoration materials, packaging materials.





1.8 Membrane material

Membrane materials commonly used in membrane structure is a high strength, good flexibility of the film material; It' s made from the fabric substrate (glass fiber, polyester filament) and coating (PTFE, silicones, PVC) compound of the coated fabric. It is light, flexible, thin thickness, light weight, good light transmittance; natural light reflection, absorption and transmission capacity; It is non-flammable, flame retardant; with durable, fireproof, good airtight and other characteristics; Plastic processing (coating PVF or PVDF) of the membrane, itself is not sticky with good self-cleaning properties.

Glass fiber with high elastic modulus and high tensile strength, glass fiber is not vulnerable to UV damage, it can be applied to the permanent construction.

1.9 Geogrids

With the rapid development of road construction, the amount of geogrid is increasing, geogrid is a direct twist roving or twisted roving by warp knitting woven mesh grille, and then by dipping machine coating Coated with asphalt - acrylic adhesive or PVC plastic system, according to the practical experience, the effect of using twist roving is good for geogrids.

2 The sizing agent requirements of the fiberglass deep-processing products.

The sizing agent requirements of the fiberglass deep-processing products is divided into in two ways. Firstly, the sizing agent requirement of original yarn, which requires the sizing agent can give glass fiber with good cluster, wear resistance and high strength (the highest tensile strength can reach 0.5N / Tex or more), good performance of weaving and deep processing. Secondly, the sizing agent requirements of end products deep products (various fabrics, carpets, belts, etc.), it requires the surface of the glass fiber infiltration and deep processing of the coating and the matrix resin has good compatibility, the above two specific requirements are as follows

2.1 Fiberglass decorative materials and sound-absorbing insulation materials used in industrial fabrics

These industrial yarns require the sizing agent to have good effect on the yarn cluster protection, high yarn strength, few filaments, and no formaldehyde and other harmful substances to escape, high performance enhanced textile-type sizing agent, starch-type sizing agent, the improved paraffin-type sizing agent can also be used.

2.2 Fireproofing and dedusting industrial fabrics

Many national laws stipulates that families, restaurants and public places should





be equipped with fiberglass fire blankets, fire blanket fabric requires final treatment to remove the organic matter to prevent smoking, the general use of starch-based sizing agent in order to facilitate the removal of glass fiber surface sizing agent. Environmentally friendly dust bag is also a major industrial application of the industrial fabrics. For using bulked yarn to heat insulation, it's better to use enhanced textile-based sizing agent for industrial fabrics of dedusting, in order to facilitate the combination of coating and fiber glass.

2.3 The base fabric of air ducts

In order to improve the surface treatment effect of the air duct base fabric, the coupling agent is often in the infiltration agent coupling agent. The coupling agent of neoprene air ducts base fabric of the sizing agent is mercapto silane coupling agent, such as A-189 (United States carbon), KH-590 (China brands), Z-6062Z (US Dow Corning). Silicone rubber fiberglass base fabric with sizing agent coupling agent of methyl triacetoxysilane coupling agent, PTFE coated glass fiber base cloth with sizing agent coupling agent methyl tri-tert-butyl peroxy silane coupling agent.

2.4 Electrical insulation laminates and casing often use enhanced textile sizing agent, copper clad laminate base fabric 7628, 2116 because of the need for surface heat cleaning, so often use starch sizing agent.

2.5 Mesh fabric

In order to improve its alkali resistance, acrylic resin penetration of mesh fabric should be good, while requiring infiltration agent film should be waterproof, so generally using the enhanced textile-type sizing agent, and it's the best to use the cross-linked acrylic emulsion and ring Oxygen emulsion.

2.6 Window screening

Screening requires high strength, wear-resistant, good cluster, so requires the strong bonding of the formation of the sizing agent, good lubrication Lubricant and does not affect the glass fiber coating. Thus, the enhanced textile sizing agent is often used.

2.7 Glass fiber bulked yarn

During the puffing process of the glass fiber, and due to the impact of high-pressure air violent, fiber and airflow, fiber and fiber will have a strong friction. In order to make the fiber go through the puffing process successfully, and does not produce a large number of broken fiber, fiber glass filament, it requires soft, abrasion resistant, flexing resistant, good lubrication glass fiber. Besides the diameter of





the single wire and twist, the the protection of sizing agent is very important factor. If the protection effect is large, it will affect the puffing process; if the protection effect is small, there will be a large number of fiber breakage, low strength retention. Therefore, the infiltration of glass fiber suitable protection is critical, so the dedicated sizing agent of bulked yarn should be used.

2.8 Membrane

The Membrane material with high elastic modulus and high tensile strength glass fiber, But the fiber is easily damaged by repeated compression, in order to overcome the shortcoming, using the smaller diameter fiber to reduce the damage. The Monofilament diameter is about $4\sim 5\ \mu\text{m}$, called yarn B, the requirements of yarn on the textile process performance are particularly high, thus usually using a special starch-based sizing agent.

2.9 The glass fiber sizing agent of Geogrid

The glass fiber yarn of geogrid should be made by interweaving direct rovings which is leaked by 2000 hole board in plain weave pattern. Because of its single yarn, tension uniformity, high strength, and when it is weaving by warp knitting machine, through the yarn guide hole and weft through the pinhole, it is not easy to wear or plug the pinhole to cause the broken yarn. The strength of direct yarn is greater than $0.4\ \text{N/Tex}$, to ensure the strength of the finished geogrid (many factories have reached $0.55\ \text{N/Tex}$). The sizing agent is similar with the winding yarn sizing agent, the main film-forming agent is epoxy resin emulsion, the high-performance bisphenol A-based polyester emulsion can also be the main film-forming agent, and supplemented by efficient lubricants. This kinds of products require strong adhesion after the formation of the sizing agent, the glass fiber bundle is good, and does not produce scattered filaments and sporadic monofilament which is not sticky (or scattered wire and broken monofilament accumulation, plug the pinhole, resulting in broken yarn), while the sizing agent can not be sticky after film formation, the sticky and thick sizing agent will rub, plug the pinhole, also cause serious broken yarn. Thus, about the design project of sizing agent formulation, control the infiltration of solid content and use a variety of high-performance, excellent performance matching sizing agent to get the best results.

3 Introduction of various sizing agents for glass fiber deep processing products
Fiberglass processing products usually are made of spun textile yarn. Reinforced roving such as winding yarn, the woven roving yarn, pultrusion yarn are rarely used.





3.1 The general textile sizing agent:

3.1.1 Paraffin-type sizing agent

The traditional paraffin, vaseline, engine oil, peregol, dye-fixing agent of the sizing agent material have been used for decades, however, many factories has improved the paraffin-type sizing agent.

(1) The important symbol is the addition of a variety of resin film-forming agents in the six basic raw materials of paraffin-type sizing agent to improve the strength and wear resistance of the yarn, such as adding 681,682 water-soluble epoxy, SR-1, SR-2 water-soluble polyester, etc., and adding low degree of polymerization of polyvinyl alcohol such as PVA0488, 0588, polyvinyl acetate emulsion, water-soluble acrylic resin or water-based polyurethane resin, that are very effective methods. KH-550 is often added in the infiltration agent, which can effectively increase the yarn strength and improve the interface with the combination of the interface agent, for different resin system, the KH-570 and KH-560 is also can be used.

(2) The trend of paraffin-type sizing agent is to reduce the amount of paraffin in the formula, some manufacturers use the original 2% paraffin consumption reduced to 0.5%. Even as low as 0.3%, in order to minimize the impact of paraffin on the resin system impregnation.

(3) Using the efficient lubricants. With the development of chemical industry, a variety of efficient sizing agent constantly available, increasing the choice of raw materials. And with the increasing price of the raw material, the profit of sizing agent is decreasing, some dye-fixing factories may replace some of the dicyandiamide with cheap urea, meanwhile, the urea-formaldehyde resin was introduced into the double-amine formaldehyde polycondensate of dye-fixing agent. Although the appearance of dye-fixing agent, viscosity, adhesive force has not changed, but the urea-formaldehyde resin is brittle relatively, resulting in the reducing wear resistance of sizing agent film, and increasing of the broken filament. Many large glass fiber companies use the starch type sizing agent normally, and using the enhanced textile type sizing agents for spun yarn. With the technical development of the glass fiber industry, the market of paraffin sizing agent will become smaller or even disappear.

3.1.2 Starch type sizing agent

This paper discusses how to use starch sizing agent in pot furnace. For tank furnace, there has been a great deal of successful experience in producing textile yarns using starch sizing agents, but for pot furnace of small and medium-sized glass fiber plant, how to successfully use starch sizing agent is a technical problem. Firstly, the starch sizing agent should drawing in insulation environment, and supply oil with a belt oil machine. Secondly, for the technology and equipment, the strand storage





and degradation are different with normal paraffin sizing agent. We believe that it is possible to test a large number of glass furnaces with a large number of crucible furnaces (if the scale is too small, it is difficult to control process, and poor in investment efficiency). First, introducing a single-cycle tank with higher precision temperature control, change the oil supply of wheel forging cloth to belt oil machine, and using large yarn winder,

The starch type sizing agent glass yarn with good quality, wide application, easy to heat clean, it's widely used in the production of printed circuit board yarn. Starch-oil agent has good protective effect on glass fiber, meanwhile the bond strength between yarns is moderate, which is beneficial to puffing. So starch sizing agent is also suitable for producing bulked yarn.

The starch-type sizing agent is widely used in the production of yarns for printed circuit boards. It is of good quality, wide applicability and easy to be cleaned by heat. Starch-oil agent has good protective effect on glass fiber, meanwhile, the bond strength between yarns is moderate, which is favorable for puffing. Therefore, starch-type infiltrating agent is also particularly suitable for producing bulky yarn.

3.1.3 Enhanced textile type sizing agent

Enhanced textile-based sizing agents are resin-based, can be divided into the following categories:

(1) Epoxy

The typical sizing agent is NBS-185, is modified epoxy emulsion as the main film former, JF series is based on water-soluble epoxy-based film former. The enhanced textile-based sizing agent often used epoxy emulsion as the main film forming agent, bonding and cluster performance are good, impregnated quickly, and supplemented by efficient imidazoline cationic lubricants, the yarn is smooth and wear-resistant, now NBS-185 sizing agent are used in most plants, the effect is good.

(2) Polyester

Using linear saturated polyester to enhance the textile-based sizing agent film. Polyester-based sizing agent and unsaturated resin, soaking and compatibility is particularly good, with good performance of composite materials, while linear polyester friction coefficient is small, less yarn filament, low cost, so development prospects of the product is good.

(3) Polyvinyl acetate and polyacrylate emulsion

As the large molecular weight, good adhesion, good yarn bundles of film former, it can be used for alkali-resistant mesh cloth, filter cloth and other special occasions, and with extremely excellent performance.





(4) Polyurethane

The 140 series sizing agent belongs to this polyurethane type, the main film former is water-soluble polyurethane resin, with strong adhesive force, the molecular polarity, and it has affinity with most resin, this sizing agent has been widely used. 140 series sizing agent can be divided into 140-1, 140-2, 140-3, 140-4 according to the usage and price.

In addition, the polyurethane emulsion and epoxy, polyester emulsion, also can be used as the main agent of enhance textile sizing agent, the film is tough, wearable, flexible, suitable for high-grade woven glass fiber woven fabric. For the enhanced textile-based sizing agent, strength, wear resistance and penetration rate are the three basic technical performance, for the general resin-based film former, the molecular weight moderate, non-cross-linking type have a good penetration rate, the monofilament strength requirements in terms of good yarn bundles, monofilament uniform force, less broken ends, which requires good lubrication effect of sizing agent, this is because if the lubrication is not good, the friction of yarn on the gathering roll, lubricator, traverse is too large, resulting in the large system tension, when the system tension is greater than the surface tension of the glass droplets, it will broke. Meanwhile, the infiltration agent should be mixed evenly, fine particles (water-soluble is better), so that will form a uniform, dense membrane on the glass fiber surface, and the membrane will protect the yarn on good wear resistance and strength.

The friction coefficient is between 0.8~0.95 without the sizing agent, which is similar with polished smooth steel and brass, after adding good lubricated sizing agent, the friction coefficient will be reduced to 0.2, so it's a key technology point to select the lubricant of enhanced textile sizing agent, imidazoline, quaternary ammonium salt, long carbon chain polyoxyethylene quaternary ammonium salt and other cationic efficient lubricants are good selections, and these cationic lubricants also have anti-static effect.

The wear resistance of the yarn is also related to the environmental humidity and stress during the retreat, the greater humidity, the greater stress. the less wear-resistant of yarn, and its wear-resisting times are often several times less in the abrasion tester. Therefore, the weaving process to reduce the broken filament considered from the sizing agent, twist structure, environmental humidity and tension. Fabric structure has an impact on the strength of the fabric, the strength of the yarn after the withdrawal of 100%, woven into plain weave, the single yarn strength of 60-75%, woven into plain weave, the single yarn strength of 60-75%, and woven into the forging pattern cloth, the single yarn strength of 70-85%, the retention rate is high.





3.2 Enhanced sizing agent

Besides of using the textile sizing agent on most of the spun yarn, enhanced textile sizing agent is also widely used in the deep processing of glass products, enhanced sizing agent is divided into glass fiber reinforced thermosetting resin sizing agent and glass fiber reinforced thermoplastics sizing agent, the examples are as follows:

3.2.1 Enhanced sizing agent for soft yarns

This kind of sizing agents include entangled yarn sizing agent, pultrusion sizing agent and woven roving sizing agent, the epoxy emulsion as main film forming agent system generally. The price of epoxy resin increases a lot till now, polyester emulsion as the main agent of the sizing agent can also get better effect, the bond strength is even better than epoxy, the strand strength is large, however, the problem of the polyester emulsion is that the strand tube and the direct yarn tend to turn yellow when dried. The solution is using bisphenol six system of polyester resin formulations, and control the double bond content of the synthesis formulation, Formulate the reasonable synthetic process. For the present direct yarn and paired yarn of the new sizing agent, the intensity is more than 0.5N/Tex, the yarn is smooth and wearable, and with fast resin impregnation.

3.2.2 Sizing agent for SMC yarn

The yarn sizing agent is based on cross-linked PVAc as main film forming agent. For the cross-linked PVAc film former, the strength is excellent, tensile strength greater than 25Mpa, the key technology that is using a variety of complex cross-linking agent during the PVAc emulsion polymerization, that is to ensure the necessary cross-linking density does not affect the stability of the emulsion, the SMC yarn of this sizing agent with good cluster, high stiffness, good resin penetration.

3.2.3 Sizing agent for chopped strand mat

The key technology of chopped strand mat yarn is the permeability and transparency of the felt. In addition to the use of instant PVAc in the sizing agent, a certain proportion of polyester emulsion can be used to improve the permeability and transparency of the mat. The polyester emulsion is compatible with the matrix unsaturated polyester resin, the refractive index is very close, there is no fiber trace after the transparent tile was made. After the needed polyester emulsion of the sizing agent forming the film, in addition to ensuring rapid dissolution in styrene, it should have a certain stiffness, toughness, in order to meet the dispersion requirements of the system of yarn-cutting machine group.





3.2.4 Reinforcing sizing agent for thermoplastic

This kind of sizing agents is divided into infiltrating agent for glass fiber filament and infiltrating agent for chopped yarn, which is two kinds of sizing agent with completely different composition. Owing to using one kind of sizing agent without any distinction of the plastic variety, we developed the enhanced PP, enhanced PA, enhanced PET/PBT sizing agent, which is targeted with good interface. The results show that the performance of glass fiber products have reached a high level, especially in the surface quality of products, which with uniform color, non-obvious glass fiber traces.

The key technology of sizing agent is using the high quality film former agents, such as high performance polyurethane emulsions, epoxy emulsion (color is stable under high temperature), dedicated PVAc and acrylic emulsion.

In short, deep processing of fiberglass products is a promising product, its industry is a small investment with quick effect. At the same time, we must vigorously strengthen the research and development of glass fiber infiltration technology, so that the glass deep-processing products in terms of variety or quality to achieve a high level.

