Processing of Glass Fibres in Textile Industries

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Abstract

The idea of making yarns and fabrics from glass is hundreds of years old. The earliest Egyptian glass vessels ,used as containers for oils , unguents and perfumes , were built from glass fibres spun laboriously by hand round lightly glazed cores of clay . During the Renaissance, artisans were drawing out a "spun glass "of fine glass strands or rods for decorative purposes on goblets and vases. There followed many efforts to produce glass filaments for textile purposes. Fine glass strands were drawn by hand for decorative purposes on textiles as early as 1713 by the French physicist, Rene –Antoine Ferchault de Reaumer, and in 1822 by the British inventors, Alexander and David Gordon .In 1842, production was reported of glass filaments and glass fabric made by Louis Schwabe, a Manchester silk weaver and supplier to Queen Victoria and the French Court. He produced glass filaments by extruding molten glass through small orifices, which may have been the first use of spinnerets for the modern technique of spinning manmade fibres. In 1893, Edward Drummond Libbey exhibited a glass dress, lampshades, and other articles of woven glass at the Worlds Columbian Exposition in Chicago. The fabric was made of bundles of glass fibres woven together with silk threads .The experiment was spectacular but of no practical value, since the fabric was too stiff to be creased, folded, or draped. Some progress was made during the early 1900 s when several patents were issued in Germany and in England on various processes for drawing glass fibres. These fibres were relatively coarse, and the cost was high. It was used in place of asbestos as insulation material during World War I. At last in 1931 trials were taken in US to produce glass fibres that were finer, more pliable, and lower in cost. At that time, the Owens-Illinois Glass Co and the Corning Glass Works started to develop a method of drawing out glass from the molten state through very fine orifices into pliable filament form. For several years, work progressed in development of filament and staple yarns. By 1938, sufficient progress was made to indicate a promising future for glass fibre for practical textile purposes .The two companies merged to form the Owens-Corning Fiberglas Corp. Their textile product was registered under the trademark Fiberglas.

I. Introduction

Glasses used for the manufacture of fibres are either soda-lime- silicates or boro-silicates (eg E or C glass) . Other materials can be added to the silica network to modify the properties of the resulting glass. Glasses of many different compositions are made by the glass industry ,the type produced being selected to suit the end uses for which it is required .Silica sand (silica) and limestone (calcium carbonate) may be regarded as basic ingredients , to which are added varying amounts of other materials such as soda ash (sodium carbonate) , potash (potassium carbonate) , aluminium hydroxide or alumina (aluminium oxide), magnesia(magnesium oxide) or boric oxide .The glasses commonly used in making textile fibres are E glasses &C glasses**.** The above raw materials are melted in a furnace at temperature of about 1649 deg c. The compounds combine toform a clear glass marble of about 1.6 cm in diameter. The marbles are called cullets. Imperfect cullets are sorted out to prevent imperfections in the filaments. The perfect marbles are fed into a small furnace, where they are melted at temperatures of about 1371 deg c. and the molten glass falls by gravity pull through a platinum spinneret which has approximately 100 orifices. As the molten glass leaves the spinneret, it solidifies. For filament yarns the fibres are pulled together, lubricated for ease in handling, and wound on tubes in strand form, for use in fabric manufacture. Each marble of 0.0284 kg can produce about 62 kilometres of filament. E class glass fibre is known for its high heat resistance and high electric resistant characteristics whereas S class glass fibre is known for its high strength.

II. Methods of production

There are two major methods of producing glass fibre yarns.

a. Continuous -Filament process - This process produce continuous filaments of indefinite length having exceptional brilliance . Molten glass flows downward through temperature –resistant metal –alloy bushings (spinnerets) that have two hundred or more small openings. The strand of multiple filaments is carried to a high-speed winder .As the 50 or more filaments are drawn from the orifices, they are brought together into a strand. A lubricating size /binder is applied to facilitate subsequent processing like twisting and winding and to reduce abrasion and breakage during yarn formation. After winding ,the filaments are twisted and plied to form yarns by methods similar to those used for making other continuous –filament yarns and the size/binder is removed by volatizing in an oven .These yarns are available in standard basic counts e.g . of 5.5 ,11,22,33 and 66 Tex . The multifilament yarns are used for a wide variety of purposes, from draperies to cord. Different types of textured glass fibre yarns have been produced. An air –bulking process, similar to the technique used to make Taslan, disarranges and loops the filaments giving the yarn a rough texture. It looks and almost feels like wool or mohair. A process of expanding individual strands or groups of glass fibres permits the weaving of the yarn into openwork casements, producing a fabric that looks like wool or linen. In flat weaves it looks like linen.

b. Staple –Fibre Process -There are three methods of producing glass staple fibre

1. Centrifugal Process.

In this process , molten glass is passed through holes in the base of metal spinner rotating at high speed .Fibres are then bonded into a web .Such glass fibres are used in heat and sound insulation . This technique is not suitable for producing textile grade glass fibres.

2. Jet Process.

In this process, molten glass is flown out through small holes of spinnerets (temperature resistant platinum bushings). Compressed air from jet is passed through the thin stream of molten glass resulting fine fibres varying in lengths from 8 to 15 inches. The fibres fall through a spray of lubricant and a drying flame onto a revolving drum on which they form a thin web. This web of staple fibre is gathered from drum into a sliver, which is then made into yarn by methods similar to those used to make cotton or wool yarns. This is then processed on conventional textile machines for weaving into glass fibre staple fabrics .This yarn is also used for industrial purposes where insulation is needed.

3. Rod Drawing Process.

It is the modern version of old technique of drawing strands from glass rods. In this process, ends of the rods are melted drops of glass fall away drawing off glass filaments after them onto a speedily revolving cylinder where they are wound parallel to each other. Sideways movement of cylinder causes a web of sliver to be formed. Alternatively, the staple may be thrown off the cylinder continuously onto a stationary sieve where it forms a sliver for processing into spun yarn. Binder may be sprayed on staple fibres. Staple fibres are conveyed through an oven with controls that determine the thickness of the web. In the oven, the fibre mass is compressed to a desired thickness and binder is cured for permanently binding of the fibres.

The leading manufacturers for glass staple fibre, monofilament and multifilament are

a. Owens –Corning Fiberglas Corp -Trade mark is Beta &Fiberglas.
b. Reichhold Corp – Trade mark is Chemcut&Chemglas.
c. NicofibresInc – Trade mark is Fiberglass.
d. PPG Industries, Inc – Trade mark is Fiberglass.

Various diameters of glass fibre yarn are made from staple. These yarns are used for industrial purposes, such as conveyor belts and electrical –braid insulation.

III. Properties

Glass is an inorganic, incombustible, high tenacity man-made textile fibre .Glass fibre is second only to para-aramid (Kevlar/Twaron)as the strongest of all textiles. Even some types are stronger than equivalent diameters of stainless steel. Glass fibre is not brittle like glass in mass, and possesses high tensile strength. Fabrics made of glass fibre are non-inflammable, are non-conductors of heat and electricity, are poor conductors of sound and chemical inactive .Glass fibres are smooth –surfaced and commonly of circular cross-section .They are transparent.

Table1: Comparison of properties of glass fibre with other fibres

Parameters	Unit	Glass	m-aramid	Nylon -66	Polyester	Cotton
Tensile strength	cN/dtex	8.5	4.4-4.9	3.9-6.6	4.1-5.7	2.6-4.9
Elongation	%	2-4	35-45	25-60	20-50	6-10
Young"modulus	cN/dtex	270	57-71	8-26	22-62	60-80
Moisture content	%	-	5.0-5.5	3.5-5.0	0.4-0.5	7.0
Specific gravity	-	2.5	1.38	1.14	1.38	1.50-1.54

Glass fibres are resistant to acids of normal strength under ordinary conditions. Glass fibre is damaged only by hydrofluoric and hot phosphoric acids. It is resistant to most alkalis. It is not attacked by organic solvents. It is unaffected by bleaches since glass fibre does not discolour. Glass fibre not attacked by Mildew, insects and micro-organism. It is highly resistant to heat. Abrasion resistance is poor. It is virtually inelastic. It is incombustible. The lack of elasticity has no effect on the flexibility and wrinkle resistance. Sunlight has no effect on glass fibre fabrics. This makes them useful for outdoor purposes, such as awnings, as well as for such decorative fabrics as curtains and draperies. The fine glass fibres have excellent flexibility and pliability and can be woven into fabrics of excellent draping quality, particularly when given proper finish .Consequently, they are excellent for curtains and draperies .Glass fibre fabrics can be easily sewed by hand or by machine with good-quality mercerized cotton thread, using a sharp needle, a long stitch, and low tension. Glass fibre is dimensionally stable. It will not shrink because it is unaffected by water. In general, ironing of glass fibre fabrics is unnecessary. Ironing may be carried out, however, using a cotton setting.

IV. Dyeing & Finishing

Glass fibres absorb only negligible amount of water, which is why their affinity to dye is close to zero. It is not possible to dye glass by using the conventional dyeing methods. Many specialized processes have been developed. Most successful technique is the pigmentation of molten glass eg adding finely –dispersed pigments to the melt before spinning as used in the production of many other types of dope dyed synthetic fibres. In view of the high temperature at which glass fibre is spun (around 1200 degc), it is necessary to use inorganic pigments. A basic finishing operation for all glass fibre fabrics is to subject the cloth to high temperatures. This releases the stresses that may be present in the yarns as a result of twisting and weaving .This provides the fabrics with such desirable qualities as wrinkle resistance, greater durability, and good hand. They may then be treated in a number of ways. Color may be applied with the aid of a binder to hold the dye to the surface of the cloth. The fabric may be coated with a protective agent to improve its abrasion resistance. For marquisettes, the finish is regulated to produce a crisp yet flexible fabric. A patented process called Coronizing is also applied .This process combines a heat –setting treatment with the application of finishing resins. The heat setting relaxes the fibres, permanently crimps the yarns, and sets the weave, giving the fabric a soft hand, good drape, and wrinkle proof qualities. The finishing resins provide abrasion resistance, launder ability and water repellency. Better colour retention and the use of pastel shades are possible with the aid of this process. Other finishes given are an antistatic finish, corrosion resistant finish for industrial purposes, –and a strengthening treatment for heavy duty fabrics, such as awnings and tarpaulins. The strengthening treatment involves a technique in which the fabric is given a resinophobic coating that inhibits resinous materials from adhering to the glass yarns. Then the fabric is coated with a resin. However, since the resin will no longer adhere to the glass yarns, it coagulates in the interstices of the fabric. This increases the tear and bursting strength of the glass fabric.

V. Conclusion

The fabrics are used for wearing apparels, but are usually used for making draperies. Continuous filament yarns are used for such fabrics as curtains and draperies. Fibre glass sewing threads are manufactured from continuous glass filament. It has got superior strength retention, remain stable and flexible upto 1400 deg F and do not kink and break like other high temperature threads .It has got excellent sewability to run on all industrial sewing machines. It provides durable and good quality seams. Polytetrafluoroethylene coated fiberglass thread is highly resistant to chemicals due to non-reactive properties of PTFE with most solvents, acids and alkalis. Glass fibres are widely used for electrical, thermal and acoustical insulation purposes. They are less bulky and more efficient in many respects than other insulators. Glass –fibre reinforced plastics are used in building boat hulls, in car bodies, aircraft, radio and television cabinets etc. Glass fibre and fabrics are used for filtering gases and liquids in many industrial operations. Glass yarns used as reinforcement in radial ply tyres. Glass fibre is used as reinforcement in industrial belting, including conveyor belts for handling hot materials and driving belts. Despite various drawbacks in the use of glass fibres for general textile applications, the fibres have established important end-uses. They are made into fireproof fabrics for curtains and draperies in cinemas, theatres and other public buildings .Tablecloths made from glass fibre, for example, are not damaged by cigarettes left burning on them. Glass fibres are used for apparel fabrics in special applications such as car racing suits and suits for astronauts. Last but not the least Glass staple fibre has started being blended with other textile fibres and making yarn and fabric. Initiative being taken by China, Indonesia, Japan and Thailand. Similar trials must be taken in various researches Institute in India.

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