

FABRICATION METHODOLOGY OF A COMPOSITE COOLING FAN

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Abstract- Development of a composite coolingfan by preparing patterns, using carbon fiber and a matrix element epoxy which comes under the composite materials and some testing methods for obtaining the results of noise level, mass flow rate, and dynamic balancing are explained as reference to the future work of this project. *Air cooling* is a method of dissipating heat. It works by making the object to be cooled have a larger surface area or have an increased flow of air over its surface. In the case of the latter it is done by using a fan blowing air into or onto the object one wants to cool. for the purpose of creature comfort (particularly in the heat), ventilation, exhaust, cooling or any other gaseous transport. Mechanically, a fan can be any revolving vane or vanes used for producing currents of air. Fans produce air flows with high volume and low pressure, as opposed to a gas compressor which produces high pressures at a comparatively low volume.

I. INTRODUCTION

1.1 COOLING FAN



FIG1.1 SIMPLE MECHANICAL COOLING FAN

A *mechanical fan* is an electrically powered device used to produce an *airflow* sink that makes for greater efficiency in cooling. In all cases, the air has to be cooler than the object or surface from which it is expected to remove heat by means of second law of thermodynamics.

Centrifugal fans were successfully tested inside coal mines and factories in 1832-1834. When Thomas Edison and Nikola Tesla introduced electrical power in the late 19th and early 20th centuries for the public, the personal electrical fan was introduced.

In the 1970s, Victorian-style ceiling fans became popular. In the 20th century, fans have become utilitarian. During the 2000s, fan aesthetics have become a concern to fan buyers. The fan is part of everyday life in the Far East, Japan, and Spain (among other places) Electric fans have been largely replaced by air conditioners in offices, but they are still a common household appliance.

1.1.1Types of Fans:

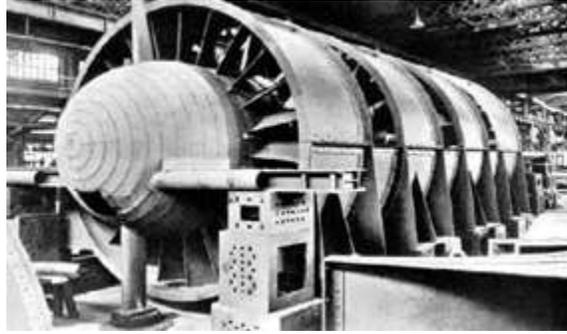


FIG1.2 MOST POWERFUL SINGLE AXIAL FLOW FAN IN THE WORLD

Mechanical revolving blade fans are made in a wide range of designs. In a home you can find fans that can be put on the floor or a table, or hung from the ceiling, or are built into a window, wall, roof, chimney, etc. They can be found in electronic systems such as computers where they cool the circuits inside, and in appliances such as hair dryers and space heaters. They are also used for cooling in air-conditioning systems, and in automotive engines, where they are driven by belts or by direct motor. Fans create a wind chill but do not lower temperatures directly

There are three main types of fans used for **moving air**:

- Axial fan
- Centrifugal fan (also called radial)
- Cross flow fan (also called tangential).

Axial Fan:

The **Axial-Flow** fans have blades that force air to move parallel to the shaft about which the blades rotate. Axial fans blow air across the axis of the fan, linearly, hence their name. This type of fan is used in a wide variety of applications, ranging from small cooling fans for electronics to the giant fans used in wind tunnels.

Axial flow fans use a propeller to create a flow of air in the direction of the axis of rotation. Because they create a large airflow, axial flow fans are optimal for wide variety of cooling and other airflow needs. An axial flow fan operates with increased efficiency, reduced noise and resistance to stall. The blade is provided with a twist that varies with distance from blade root such that the work done on air moved by the blade, whether at the blade root or tip is substantially equal.

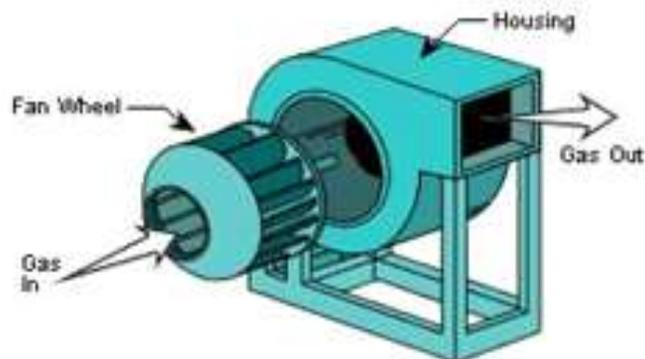


FIG 1.3 CENTRIFUGAL FAN

Centrifugal Fan

A centrifugal is a mechanical device for moving air or gases. It has a fan wheel composed of a number of fan blades, or ribs, mounted around a hub. As shown in Figure, the hub turns on a driveshaft that passes through the fan housing. The gas enters from the side of the fan wheel, turns 90 degrees and accelerates due to centrifugal force as it flows over the fan blades and exits the fan housing. Centrifugal fans can generate pressure rises in the gas stream. Accordingly, they are well-suited for industrial processes and air pollution control systems. They are also common in central heating/cooling systems.

Cross Flow Fan:

A **cross flow** fan is a centrifugal fan in which the air flows through the fan, rather than through an inlet. The rotor of a cross flow fan is covered to create a pressure differential. When used in household fans, cross flow fans have a smaller opening on one side and a larger opening on the other. The resultant pressure difference allows air to flow straight through the fan, even though the fan blades counter the flow of air on one side of the rotation. Cross flow fans give airflow along the entire width of the fan. Cross flow fans are noisier than ordinary centrifugal fans presumably because the fan blades fight the flow of air on one side of the rotation unlike normal squirrel cage fans. Cross flow fans are often used in air conditioners, automobile ventilation systems, and for cooling in medium-sized equipment such as photocopiers. The action of a fan or blower causes pressures slightly above atmospheric, which are called plenums.

II. COMPOSITE MATERIALS

Composite materials are engineered materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure.



FIG 2.1 Composite Material: Carbon Fiber

The most primitive composite materials were straw and mud combined to form bricks for building construction; the Biblical book of Exodus speaks of the Israelites being oppressed by Pharaoh, by being forced to make bricks without straw being provided. The most visible applications pave our roadways in the form of either steel and aggregate reinforced Portland cement or asphalt concrete. Those composites closest to our personal hygiene form our shower stalls and bath tubs made of fiberglass. Solid surface, imitation granite and cultured marble sinks and counter tops are widely used to enhance our living experiences.

Composites are made up of individual materials referred to as constituent materials. There are two categories of constituent materials: matrix and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination. Engineered composite materials must be formed to shape. The matrix material can be introduced to the reinforcement before or after the

reinforcement material is placed into the mold cavity or onto the mold surface. The matrix material experiences a melting event, after which the part shape is essentially set. Depending upon the nature of the matrix material, this melting event can occur in various ways such as chemical polymerization or solidification from the melted state.



FIG 2.2 Composite Material

2.1 Moulding Methods

A variety of moulding methods can be used according to the end-item design requirements. The principal factors impacting the methodology are the natures of the chosen matrix and reinforcement materials. Another important factor is the gross quantity of material to be produced. Large quantities can be used to justify high capital expenditures for rapid and automated manufacturing technology. Small production quantities are accommodated with lower capital expenditures but higher labor and tooling costs at a correspondingly slower rate. Most commercially produced composites use a polymer matrix material often called a resin solution. There are many different polymers available depending upon the starting raw ingredients. There are several broad categories, each with numerous variations. The most common are known as polyester, vinyl ester, epoxy, phenolic, polyimide, polyamide, polypropylene, PEEK, and others. The reinforcement materials are often fibers but also commonly ground minerals. The various methods described below have been developed to reduce the resin content of the final product, or the fiber content is increased. As a rule of thumb hand lay up results in a product containing 60% resin and 40% fiber, whereas vacuum infusion gives a final product with 40% resin and 60% fiber content. The strength of the product is greatly dependent on this ratio. For certain geometries and material combinations, it can be referred to as a casting. For certain continuous processes, it can be referred to as a profile. Applied with a pressure roller, a spray device or manually. This process is generally done at ambient temperature and atmospheric pressure two variations of open moulding are Hand Layup and Spray-up.

Vacuum Bag Moulding:

A **vacuum bag** is a bag made of strong rubber-coated fabric or polymer film, open at one end, and used to bond or laminate materials. In some applications the bag encloses the entire material, or in other applications a mold is used to form one face of the laminate with the bag being single sided to seal the outer face of the laminate to the mold. The open end is sealed, and air is drawn out with a vacuum pump. As a result, uniform pressure approaching one atmosphere is applied to the surfaces of the object inside the bag, holding parts together while the adhesive cures. The entire bag may be placed in a temperature-controlled oven, oil bath or water bath and gently heated to accelerate curing.

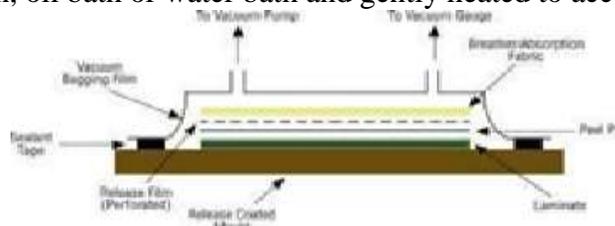


FIG 2.3 Vacuum bag process

A process using a two-sided mould set that shapes both surfaces of the panel. On the lower side is a rigid mould and on the upper side is a flexible membrane or vacuum bag. The flexible membrane can be a reusable silicone material or an extruded polymer film. Then, vacuum is applied to the mould cavity. This process can be performed at either ambient or elevated temperature with ambient atmospheric pressure acting upon the vacuum bag. Most economical way is using a venturi vacuum and air compressor or a vacuum pump. everything from vacuum infusion (see also resin infusion) to vacuum assisted resin transfer molding. This process can be performed at either ambient or elevated temperature.

Hand Lay-Up

Hand lay-up is a simple method for composite production. A mold must be used for hand lay-up parts unless the composite is to be joined directly to another structure. The molds can be simple as a flat sheet or have infinite curves and edges. For some shapes, molds must be joined in sections so they can be taken apart for part removal after curing. Before lay-up, the mould is prepared with a release agent to insure that the part will not adhere to the mold.

Reinforcement fibers can be cut and laid in the mold. It is up to the designer to organize the type, amount and direction of the fibers being used. Resin must then be catalyzed and added to the fibers. A brush, roller or squeegee can be used to impregnate the fibers with the resin. The lay-up technician is responsible for controlling the amount of resin and the quality of saturation. Other fabrication processes such as vacuum bagging, vacuum resin transfer molding and compression molding can be used with hand lay-up to improve the quality of the finished part or save time.

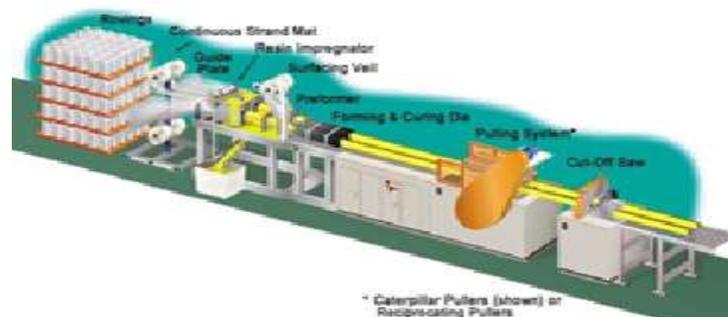


FIG 2.4 Hand lay up process

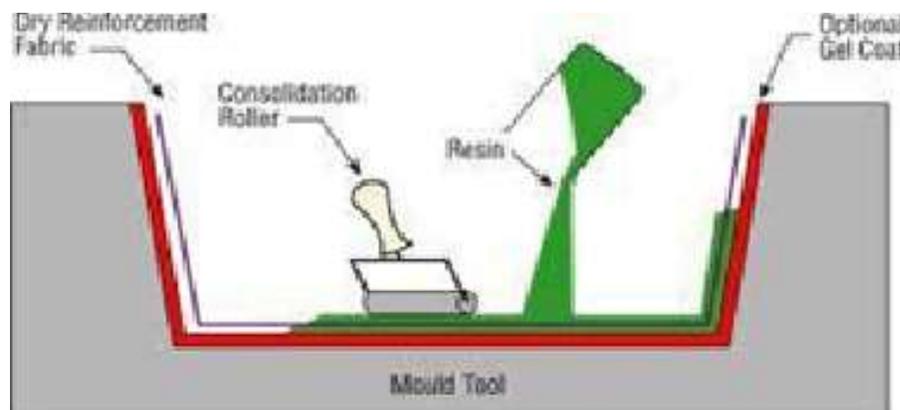


FIG 2.5 Pultrusion process

Other types of mouldings:

Braiding:

“Braid” refers to a family of fabrics continuously woven on the bias, with a system of three or more yarns intertwined such that no two yarns are twisted around one another. Braided fiber architecture

resembles a hybrid of filament winding and woven material. Like filament winding, tubular braid features seamless fiber continuity from end to end of a part. Like woven material, braided fibers are mechanically interlocked. When functioning as a composite reinforcement, braid exhibits exceptional properties because it distributes loads very efficiently.

Closed Moulding:

Closed molding comprises a family of techniques for composite fabrication that either use a two-sided mold set or take place within a vacuum bag. The processes are often largely automated and include methods such as compression molding, pultrusion, reinforced reaction injection molding, resin transfer molding, vacuum bag molding, vacuum infusion processing, centrifugal casting and continuous lamination.

Compounding and Injection Moulding:

Injection molding is used predominantly to manufacture thermoplastic parts, and it can produce very complex parts very quickly. The mold usually comprises two sections held together by a clamp strong enough to withstand the pressure of injected molten plastic, with channels for heating, cooling and venting. Resin systems can be filled or unfilled, and using glass fibers in the resin increases the mechanical strength of the part and provides dimensional control. Typical reinforcements are chopped or milled fibers in the form of pellets. Long-fiber technology (LFT), which enables molders to compound in-line with the injection processes, is also used to make a range of structural and semi-structural parts. TufRov fiber glass by PPG provides high composite strength and offers excellent processing in compounding and injection molding operations.

2.2 Granular Long-Fiber Technology:

The G-LFT process incorporates fiber glass rovings into an impregnation center with any of dozens of available base polymers. After the glass is incorporated with the resin, the compound is cooled and then pulled into a chopper that cuts it into pellets. The benefits of G-LFT include enhanced mechanical properties, improved fatigue performance and high impact resistance. This process accommodates industrial, automotive, health-care and consumer applications.

Open Molding:

With open molding, the gel coat and laminate are exposed to the atmosphere during the fabrication process. Hand lay-up, spray-up and filament winding are examples of open mold processes.

Scrim:

Scrim is a simple, strong, flexible, web-like product that is sometimes fire retardant. Its fibers are not crimped by weaving but joined at a greater variety of angles and chemically bonded through advanced technology. Scrim can be produced at far greater speeds than other glass-reinforced fabrics.

Texturizing: The texturizing process blows air into continuous fiber glass filaments, adding bulk. When a certain air pressure is reached in the process, air hitting the fiber glass causes it to break or become disoriented, resulting in a "puffed-up" appearance. Texturized yarn is often used in high-temperature applications because of its thermal tolerance, and it can fill tight die radii to provide maximum die fill.

III. TOOLING

Some types of tooling materials used in the manufacturing of composites structures include

Invar:

Invar, also known generically as **FeNi36** (**64FeNi** in the US), is a nickel steel alloy notable for its uniquely low coefficient of thermal expansion (CTE or α). It was invented in 1896 by Swiss scientist Charles Eduard Guillaume. He received the Nobel Prize in Physics in 1920 for this discovery, which

shows the importance of this alloy in scientific instruments. Invar is a registered trademark of ArcelorMittal - Stainless & Nickel Alloys, formerly known as Inco Alloys (US Trademark #63970). Like other nickel/iron compositions, Invar is a solid solution; "Invar" refers to invariable; that is, it will not react to thermal expansion. Common grades of Invar have α (20–100 °C) of about $1.2 \times 10^{-6} \text{ K}^{-1}$ (1.2 ppm/°C). However, extra-pure grades (<0.1% Co) can readily produce values as low as 0.62–0.65 ppm/°C. Some formulations display negative thermal expansion (NTE) characteristics. It is used where high dimensional stability is required, such as precision instruments, clocks, seismic creep gauges, television shadow-mask frames valves in motors, and antimagnetic watches. There are variations of the original Invar material that have slightly different coefficient of thermal expansion such as:

- Inovco, which Fe-33Ni-4.5Co and has α (20–100 °C) of 0.55 ppm/°C.
- FeNi42 (for example NILO alloy 42), has a nickel content of 42% and

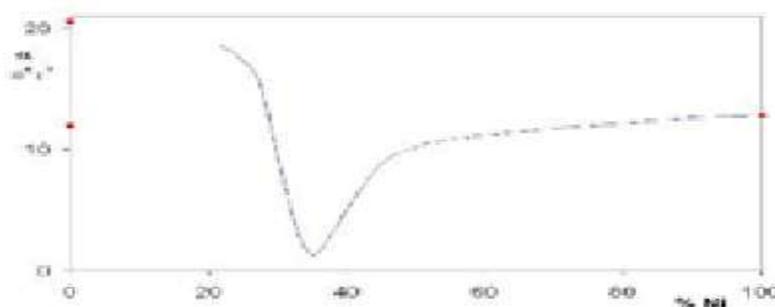


FIG 3.1 COEFFICIENT OF THERMAL EXPANSION

$\alpha \approx 5.3 \text{ ppm/}^\circ\text{C}$ which matches that of silicon and therefore is widely used as lead frame material for electronic components, integrated circuits, etc.

- FeNiCo alloys — named Kovar or Dilver P — that have the same expansion behavior as borosilicate glass, and because of that are used for optical parts in a wide range of temperatures and applications, such as satellites.

Steel:

Steel is an alloy consisting mostly of iron, with a carbon content between 0.2% and 2.14% by weight (C: 110–10Fe), depending on grade. Carbon is the most cost-effective alloying material for iron, but various other alloying elements are used such as manganese, chromium, vanadium, and tungsten. Carbon and other elements act as a hardening agent, preventing dislocations in the iron atom crystal lattice from sliding past one another. Varying the amount of alloying elements and form of their presence in the steel (solute elements, precipitated phase) controls qualities such as the hardness, ductility, and tensile strength of the resulting steel. Steel with increased carbon content can be made harder and stronger than iron, but is also more brittle. The maximum solubility of carbon in iron (as austenite) is 2.14% by weight, occurring at 1149 °C; higher concentrations of carbon or lower temperatures will produce cementite. Alloys with higher carbon content than this are known as cast iron because of their lower melting point and cast ability. Steel is also to be distinguished from wrought iron containing only a very small amount of other elements, but containing 1–3% by weight of slag in the form of particles elongated in one direction, giving the iron a characteristic grain. It is more rust-resistant than steel and welds more easily. It is common today to talk about 'the iron and steel industry' as if it was a single entity, but historically they were separate products.

Carbon fiber:

Carbon fiber or (alternatively called **carbon fiber**, **graphite fiber**, **graphite fiber** or **carbon graphite**) is a material consisting of extremely thin fibers about 0.005–0.010 mm in diameter and composed mostly of carbon atoms. The carbon atoms are bonded together in microscopic crystals that are more or less aligned parallel to the long axis of the fiber. The crystal alignment makes the fiber very strong for its size. Several thousand carbon fibers are twisted together to form a yarn, which may be used by itself or woven into a fabric. Carbon fiber has many different weave patterns and can be combined with a plastic resin and wound or molded to form composite materials such as carbon fiber reinforced plastic (also referenced as carbon fiber) to provide a high strength-to-weight ratio material. The density of carbon fiber is also considerably lower than the density of steel, making it ideal for applications requiring low weight the properties of carbon fiber such as high tensile strength, low weight, and low thermal expansion make it very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports.

Structure and properties: Carbon fibers are the closest to asbestos in a number of properties. Each carbon filament thread is a bundle of many thousand carbon filaments. A single such filament is a thin tube with a diameter of 5–8 micrometers and consists almost exclusively of carbon. The earliest generation of carbon fibers (i.e., T300, and AS4) had diameters of 7-8 micrometers. Later fibers (i.e., IM6) have diameters that are approximately 5 micrometers

The atomic structure of carbon fiber is similar to that of graphite, consisting of sheets of carbon atoms (grapheme sheets) arranged in a regular hexagonal pattern. The difference lies in the way these sheets interlock. Graphite is a crystalline material in which the sheets are stacked parallel to one another in regular fashion. Depending upon the precursor to make the fiber, carbon fiber may be turbostratic or graphitic, or have a hybrid structure with both graphitic and turbostratic parts present. In turbostratic carbon fiber the sheets of carbon atoms are haphazardly folded, or crumpled, together. Carbon fibers derived from Polyacrylonitrile (PAN) are turbostratic, whereas carbon fibers derived from mesophase pitch are graphitic after heat treatment at temperatures exceeding 2200 C. Turbostratic carbon fibers tend to have high tensile strength, whereas heat-treated mesophase-pitch-derived carbon fibers have high Young's modulus and high thermal conductivity.

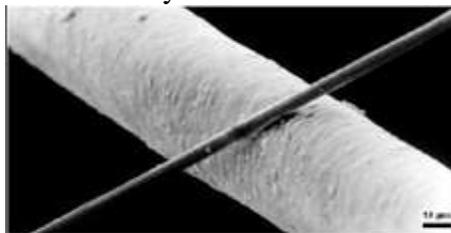


FIG 3.2 Carbon filament

3.1. Resins:

Typically, most common composite materials, including fiberglass, carbon fiber, and Kevlar, include at least two parts, the substrate and the resin.



Fiberglass:

This material made from extremely fine fibers of glass. It is used as a reinforcing agent for many polymer products; the resulting composite material, properly known as fiber-reinforced polymer (FRP) or glass-reinforced plastic (GRP), is called "fiberglass" in popular usage. Glassmakers throughout history have experimented with glass fibers, but mass manufacture of fiberglass was only made possible with the invention of finer machine tooling. In 1893, Edward Drummond Libby exhibited a dress at the World's Columbian Exposition incorporating glass fibers with the diameter and texture of silk fibers. This was first worn by the popular stage actress of the time Georgia Cayvan under the trade name Fiberglass, which has become a generalized trademark. A somewhat similar, but more expensive technology used for applications requiring very high strength and low weight is the use of carbon fiber.

Formation:

Glass fiber is formed when thin strands of silica-based or other formulation glass is extruded into many fibers with small diameters suitable for textile processing. Glass, even as a fiber, has little crystalline structure (see amorphous solid). The properties of the structure of glass in its softened stage are very much like its properties when spun into fiber. One definition of glass is "an inorganic substance in a condition which is continuous with, and analogous to the liquid state of that substance, but which, as a result of a reversible change in viscosity during cooling, has attained so high a degree of viscosity as to be, for all practical purposes, rigid.

The technique of heating and drawing glass into fine fibers has been known for millennia; however, the use of these fibers for textile applications is more recent. Until this time all fiberglass had been manufactured as staple. When the two companies joined to produce and promote fiberglass, they introduced continuous filament glass fibers. Owens-Corning is still the major fiberglass producer in the market today. The first commercial production of fiberglass was in 1936. In 1938, Owens-Illinois Glass Company and Corning Glass Works joined to form the Owens-Corning Fiberglas Corporation. Two types of fiberglass most commonly used are S-glass and E-glass. E-glass has good insulation properties and it will maintain its properties up to 1500 degree F (815 deg C). S-glass has a high tensile strength and is stiffer than E-glass.

Properties:

Glass fibers are useful because of their high ratio of surface area to weight. However, the increased surface area makes them much more susceptible to chemical attack. By trapping air within them, blocks of glass fiber make good thermal insulation, with a thermal conductivity of the order of 0.05 W/(mK). Glass strengths are usually tested and reported for "virgin" fibers: those which have just been manufactured. The freshest, thinnest fibers are the strongest because the thinner fibers are more ductile. The more the surface is scratched, the less the resulting tenacity. Because glass has an amorphous structure, its properties are the same along the fiber and across the fiber. Humidity is an important factor in the tensile strength. Moisture is easily adsorbed, and can worsen microscopic cracks and surface defects, and lessen tenacity. In contrast to carbon fiber, glass can undergo more elongation before it breaks. The viscosity of the molten glass is very important for manufacturing success. During drawing (pulling of the glass to reduce fiber circumference), the viscosity should be relatively low. If it is too high, the fiber will break during drawing. However, if it is too low, the glass will form droplets rather than drawing out into fiber.

IV. GLASS-REINFORCED PLASTIC

Glass-reinforced plastic (GRP) is a composite material or fiber-reinforced plastic made of a plastic reinforced by fine fibers made of glass. Like carbon fiber reinforced plastic, the composite material is commonly referred to by the name of its reinforcing fibers (fiberglass). The plastic is

thermosetting, most often polyester or vinyl ester, but other plastics, like epoxy (GRE), are also used.

Epoxy In chemistry, epoxy or polyepoxide is a thermosetting epoxide polymer that cures (polymerizes and crosslink's) when mixed with a catalyzing agent or hardener. Most common epoxy resins are produced from a reaction between epichlorohydrin and bisphenol-A. The first commercial attempts to prepare resins from epichlorohydrin were made in 1927 in the United States. Credit for the first synthesis of bisphenol-A-based epoxy resins is shared by Dr. Pierre Castan of Switzerland and Dr. S.O. Greenlee of the United States in 1936. Dr. Castan's work was licensed by Ciba, Ltd. of Switzerland, which went on to become one of the three major epoxy resin producers worldwide. Dr. Greenlee's work was for the firm of Devoe-Reynolds of the United States. Devoe-Reynolds, which was active in the early days of the epoxy resin industry, was sold to Shell Chemical (now Hexion, formerly Resolution Polymers and others)



FIG1. 4.1 Epoxy

As with many other composite materials (such as reinforced concrete), the two materials act together, each overcoming the deficits of the other. Whereas the plastic resins are strong in compressive loading and relatively weak in tensile strength, the glass fibers are very strong in tension but have no strength against compression. By combining the two materials, GRP becomes a material that resists both compressive and tensile forces well.

4.1 Categories of Fiber-Reinforced Composite Materials

Fiber-reinforced composite materials can be divided into two main categories normally referred to as short fiber-reinforced materials and continuous fiber-reinforced materials. Continuous reinforced materials will often constitute a layered or laminated structure. The woven and continuous fiber styles are typically available in a variety of forms, being pre-impregnated with the given matrix (resin), dry, uni-directional tapes of various widths, plain weave, and harness satins, braided, and stitched.

The short and long fibers are typically employed in compression molding and sheet molding operations. These come in the form of flakes, chips, and random mate (which can also be made from a continuous fiber laid in random fashion until the desired thickness of the ply / laminate is achieved).

4.2. FABRICATION

The step by step fabrication procedure of a composite cooling fan made up of carbon fiber is considered. This methodology is adopted at Naval Science Technological Laboratories, Visakhapatnam. This model is chosen as it acts as replica to our composite cooling fan. Let's see the step by step procedure involved in this process.

4.2.1. Step by Step procedure:

Preparing patterns for shrouds and blades individually Sample fabrication using carbon fiber(random oriented & 0/90) and chemicals Fabrication of the inner shroud and outer shroud by hand lay up method of fabrication Fabrication of blades of a cooling fan Assembling inner shroud, outer shroud and blades. Final component with surface finish Dynamic balancing Acoustic analysis

4.2.2. Pattern Preparation for Shrouds and Blades Individually:

Types of Pattern

Patterns are of various types, each satisfying certain casting requirements.

1. Single piece pattern
2. Split or two piece pattern
3. Match plate pattern

Single Piece Pattern:

The one piece or single pattern is the most inexpensive of all types of patterns. This type of pattern is used only in cases where the job is very simple and does not create any withdrawal problems. It is also used for application in very small-scale production or in prototype development. This type of pattern is expected to be entirely in the drag and one of the surface is expected to be flat which is used as the parting plane. A gating system is made in the mold by cutting sand with the help of sand tools. If no such flat surface exists, the molding becomes complicated. A typical one-piece pattern is shown in Figure.

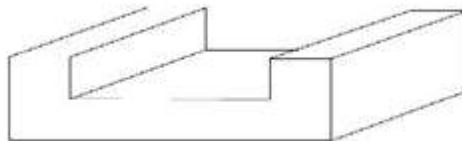


FIG 4.2 A Typical Single Piece Pattern

Split or Two Piece Pattern:

Split or two piece pattern is most widely used type of pattern for intricate castings. It is split along the parting surface, the position of which is determined by the shape of the casting. One half of the pattern is molded in drag and the other half in cope. The two halves of the pattern must be aligned properly by making use of the dowel pins, which are fitted, to the cope half of the pattern. These dowel pins match with the precisely made holes in the drag half of the pattern. A typical split pattern of a cast iron wheel

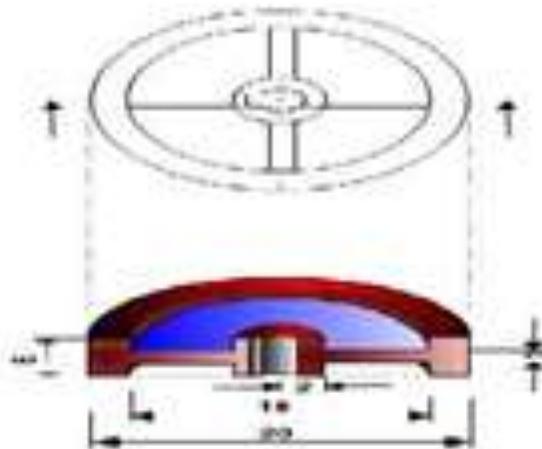


FIG 4.3 The Details of a Cast Iron Wheel

Preparation of Inner and Outer Shrouds:

Proper required wood material is taken. Required outer dimensions are made on the wooden material. The logs of woods are shaped into required patterns by turning operation on lathe machine. The logs are placed in between the chucks on the machine and centered. The cutting tool is placed in the tool post and centered. The templates of the required shapes are taken and using these, the required curvatures of the inner surfaces of the patterns of the shrouds are made. After getting the required shapes of the patterns, surface finishing is done using emery paper by continuing the turning operation. Thus the patterns for both the shrouds are attained.



FIG 4.4 INNER SHROUD



FIG 4.4 OUTER SHROUD

Pattern Preparation for the Blades:



FIG 4.5 Blade Fiber Pattern

Using the wooden material, the blade of required aerofoil shape and half meter length is made. To this wooden blade, the required chemicals (i.e.) polish, p.v, the mixture of catalyst, accelerator, resin and pigment is applied on its surface and let it dried for some time. After completely dried, layers are applied on the surface one after the other by using the carbon fiber and the mixture of catalyst, accelerator, resin and pigment. Then let it dried for some hours. After it was completely dried, the mould on the surface is slowly removed and thus upper part of the pattern is made. Same procedure is followed for lower part of the pattern. Thus the fiber patterns for the fabrication of the blade are made.



FIG 4.6 Blade Fiber Pattern

4.2.3. Sample Fabrication:

Using sample pieces of carbon fiber and mixture of catalyst, accelerator, resin and pigment, sample fabrication is done to know the tensile strength. Here two orientations of carbon fibers are used; one is random orientation and 0-90 orientation. The mixture is applied on the surface of the sample

pattern and made it to dry. The layers are arranged one above the other using the mixture. The arrangement is compressed by putting some weight on it and let it dried for some time. After drying both the sample layers are taken for testing the tensile strength. Here it is known to us that random orientation is more preferable than that of 0-90 orientation Thus, the randomly oriented carbon fiber is used for fabrication.



FIG 4.7 Sample Fabrication With Random Oriented



FIG 4.8 Sample Fabrication With 0-90 Oriented Fiber

4.2.4. Fabrication of the Inner Shroud and Outer Shroud:

□□By hand lay up fabrication method, fabrication of inner and outer shroud is done.

4.2.5. Assembling the parts

The individual parts are now assembled in this step. Individual parts are rubbed with emery paper for surface finishing. The inner circumferential areas of the both the shrouds are divided into six equal divisions. The aero foil shaped grooves are made on the surface of inner shroud to fix the blades. Now epoxy araldite mixed with fevitate are applied in the grooves and the blades are fixed on the inner shroud and let it dried for some time. After getting dried, the outer shroud is placed on the other side of the blades and fixed by using small nails.

After this if at all any gap is present between blades and the shrouds, they are filled with epoxy araldite

4.2.6. Final Component:

After getting dried it is checked so that the alignments of assembled parts are tightly fixed. Thus the final component is thoroughly rubbed with emery paper and single fine layer of required color is applied. Thus the cooling fan of the required model is fabricated.



V. CONCLUSION

The need for forced-air cooling is a fact of life in many power-supply applications, and designers depend on that airflow to maximize power density in their products. Many cooling fans are available to create that airflow, and these devices are judged on a variety of performance criteria, including their ability to move air for a given Size fan, audible noise output and power consumption.

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