LESSON 1 – TYPES OF COMPOSITES AND APPLICATIONS

INTRODUCTION

Composite material systems described in this course are typically two-part systems made up of a reinforcing part and a resin part. Both the reinforcements and the resins have different qualities that should be considered before undertaking any work. The most common reinforcement is fibreglass which is inexpensive and relatively easy to use but there is increased use of newer reinforcements such as carbon fibre and Kevlar too. The most common resin is polyester, but vinyl ester and epoxy are also very popular. Understanding what each of these materials does and how it interacts with other materials is important to understand when undertaking any work with composites. This lesson introduces the common composite materials used and expands into pre-impregnated materials and 3D printing alternatives.

REINFORCEMENTS

As the title of this section suggests, reinforcement materials provide much of the strength for any parts made with them. They are thin light materials that demonstrate very good strength to weight properties and can be tailored to many versatile shapes and uses. They are made up of some form of fibre to improve the mechanical properties of the finished composite.

Fibreglass

Suggested Tasks: ▼

Throughout this course you will be provided with suggested tasks and reading to aid with your understanding. These will appear in the right hand column.

Remember: these tasks are optional. The more you complete, the more you will learn, but in order to complete the course in 20 hours you will need to manage your time well. We suggest you spend about 10 minutes on each task you attempt, and no more than 20 minutes.

Fibreglass

Fibreglass is the most popular form of reinforcing composite material as it is readily accessible, easy to use and features several desirable characteristics. It started to become popular in the 1950's in automotive and marine applications and since then has found applications in all kinds of different industries. This is largely due to its adaptability and versatility. Though it has several key features listed below, by changing the chemical composition of the glass fibres within the material different features can be enhanced leading to maximise specific characteristics.

When considering the properties, it is worth remembering that fibreglass is a glass product and as such has many of the same characteristics.

Electrical

- As fibreglass is composed of a non-conductive material its electrical conductivity characteristics are very low. This means it insulates against electrical charges very well, even when very thin coverings are used, such as in electrical cables.

- Along with this it is dielectrically permeable which means it can support the formation of magnetic fields. This is an important feature in electronics as it supports the operation of many components such as capacitors and inductors.

Physical

- Fibreglass is very durable and stable as a material and is resistant to temperature change and moisture. This resistance coupled withs its mineral composition means it is not subject to rotting or rusting and it is not affected by animals, mould, or mildew.

- It is also incredibly strong. The strength to weight ratio for fibreglass, which is a good measure of its specific strength, has an average of around 1300 kN/m kg. This can be higher or lower depending on the fibreglass composite used but means on average it is over 20 times stronger than steel.

- Its unreactive nature and the ability to form it to any dimension that is required means that it is also compatible with many other materials, such as resins or cement.

Thermal Properties

- Fibreglass has low thermal conductivity, meaning it does not transfer heat.

- It also has a low coefficient of linear expansion, which is the degree to which the material will expand when subjected to heat.

- Fibreglass is also incombustible. This means it will not burn which is due to it being made up of mineral elements. Under extreme temperatures it may melt but it will not emit harmful fumes or smoke when it does.

At its base level most fibreglass is very similar both in how it is produced, and the raw materials used. As previously mentioned though, the quantities of different materials in the composition can be adjusted to emphasise different features of the material. For instance, the fibreglass required for home insulation will have different properties emphasised than that used in producing an automobile body.

The different types will always use silicon dioxides as the base element. This is most commonly seen in quartz or sand and is used extensively in glass making. There will also be a number of metallic oxides introduced such as aluminium, boron, calcium, magnesium (with the exception of Q grade fibreglass) to enhance the base properties of the fibreglass material. From here depending on the features desired different elements and proportions of elements will be introduced to emphasise the desired characteristics. This may be the removal of fluorine for strength, or the addition of beryllium for high tensile modulus (stiffness), or the removal of fluorine along with the addition of barium for chemical resistance.

LEARN MORE

Suggested Tasks

Look around your home or workplace. Try and identify some fibreglass products.

Discuss each product with a family member or colleague. Consider why fibreglass has been used in each instance i.e., which properties of fibreglass makes it suitable.

Also, consider any cons of using fibreglass in these situations. For example, could it become damaged or degraded? How easy would it be to repair?

Types

The most common grades of glass fibre used in fibreglass production, along with their key chemical elements, key features, and common applications are listed in the table below.

Glass Fibre Types

Type	Composition	Key Features	Applications
A **(Alkali)**	Aluminium Oxide Boron Trioxide Calcium Oxide Fluorine Iron Oxide Magnesium Oxide Potassium Oxide Silicon Dioxides Sodium Oxide Titanium Dioxides	Chemically stable. Low cost. Very easy to work. Quite hard. Recyclable. Can be reworked.	Food and beverage containers. Bakeware. Cookware. Cooking utensils. Windowpanes. Process equipment.

Type	Composition	Key Features	Applications
AE **(Alkali Electric)**	Aluminium Oxide Boron Trioxide Calcium Oxide Magnesium Oxide Silicon Dioxides	Strong. Stiff. High heat resistance. Non-flammable. Electrical insulation. Impact resistant. High corrosion resistance.	Industrial coatings. Marine coatings. Coatings for pipes and tanks.
AR **(Alkali Resistant)**	Aluminium Oxide Boron Trioxide Calcium Oxide Iron Oxide Lithium Oxide Potassium Oxide Silicon Dioxides Sodium Oxide Titanium Dioxides Zirconium Dioxides	Strong. Flexible. Water resistant.	Developed as an additive to concrete to enhance its strength and flexibility.
C **(Chemical)**	Aluminium Oxide Barium Oxide Boron Trioxide Calcium Oxide Iron Oxide Magnesium Oxide Potassium Oxide Silicon Dioxides Sodium Oxide	Very high chemical resistance. Heat resistant. Moisture resistant. Stable. Durable. Strong. Corrosion resistant.	Pipe and tank coatings.