Illuminate NEBRASKA
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MATERIALS

COMPOSITES

CONCEPT Composites are materials made by combining two or more different types of materials, such as fibers or particles, with a matrix material to create a new material with improved properties. The resulting composite material can have superior strength, stiffness and durability compared to the individual materials it is made of. Manufacturers use composites in a wide range of applications, including aerospace, automotive, construction and sporting goods, because of their unique properties.

TERMINOLOGY

MATRIX MATERIAL - A resin that surrounds and binds the reinforcement fibers or particles together to form a solid composite material. Common matrix materials include thermoset resins (epoxy, polyester and phenolic) and thermoplastic resins (polyethylene and nylon).

REINFORCEMENT MATERIAL - The component that provides the strength and stiffness to the composite material. Common reinforcement materials include carbon fiber, fiberglass, aramid fiber and natural fibers like bamboo and flax.

FORM FACTORS - Composites can be manufactured in a variety of forms, including sheets, tapes, rods and tubes. These forms can be tailored to specific applications to create complex shapes and structures.

BACKGROUND

Composites have been used as a manufacturing material since ancient times, with natural fibers like straw, animal hair and mud being used to create building materials. The modern era of composite materials began in the 20th century, with the development of synthetic fibers and resins during World War II. In the 1950s and 1960s, composites were first used in aerospace applications, including the construction of the Boeing 707 and the NASA Mercury and Gemini spacecraft. Since then, composites have become increasingly popular in a wide range of industries, as their unique properties and versatility have made them an attractive alternative to traditional materials.

DATA

Make sure it measures up

RULE OF MIXTURES - The rule of mixtures is used to predict the properties of a composite material based on the properties of its constituent materials. The formula calculates the composite material's stiffness, strength and density based on the volume fraction and properties of the reinforcement and matrix materials.

HALPIN-TSAI EQUATIONS - The Halpin-Tsai equations are a more advanced version of the rule of mixtures, taking into account the orientation and shape of the reinforcement fibers or particles. The equations can be used to predict the elastic modulus and strength of the composite material.

REAL WORLD CONNECTIONS

Wind turbines are becoming increasingly important as a source of renewable energy, and many of the turbine blades are made of composite materials. A wind turbine blade is made from a combination of glass and carbon fibers embedded in epoxy resin to create their blades. These composite blades offer several advantages over traditional metal blades, including higher strength-to-weight ratios, better fatigue resistance, and improved aerodynamic efficiency. They also have lower manufacturing costs and can be produced in a wide range of sizes and shapes, making them ideal for use in large wind turbines.

APPLICATION

The Boeing 787 Dreamliner aircraft is made up of about 50% composite materials, including carbon fiber-reinforced polymer (CFRP) and glass fiber-reinforced polymer (GFRP). The use of composites in the Dreamliner has several advantages over traditional aluminum construction, including lower weight, increased fuel efficiency, and improved durability. Additionally, the composite materials allow for more efficient manufacturing processes, such as automated fiber placement, which can help reduce production costs.

The 787 Dreamliner is an example of how composites can be used in a relevant and impactful way, pushing the boundaries of aerospace engineering and providing a more sustainable and efficient means of air travel.