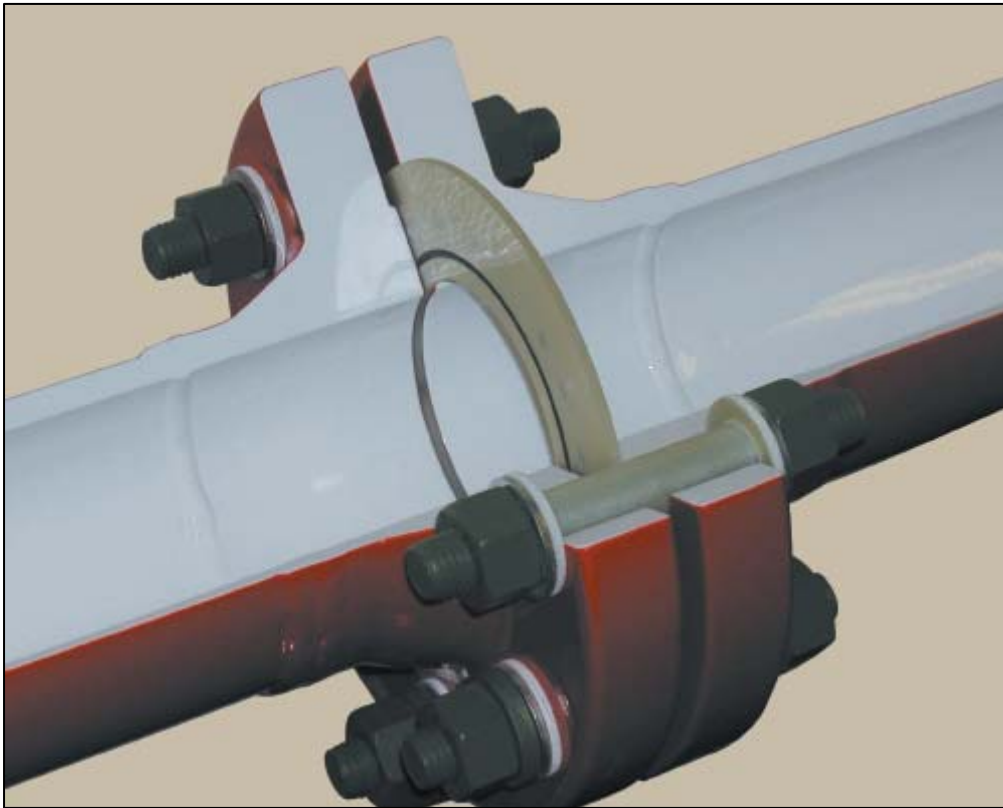




Complex Composites Solve Problems

By: Alan Johnson



Standard fiberglass-based gaskets are not strong enough for large pipelines; therefore, this gasket combines the strength of stainless steel with the electrical insulating properties of an epoxy resin fiberglass composite. Image courtesy Pikotek Inc.

Complex composites provide multiple properties required by applications in power generation, construction, aerospace, packaging, and other industries by combining two or more different materials. These composites also cut costs by placing expensive high strength materials only where needed in a structure, part, or package. Complex composite materials are custom designed to meet the requirements of particular applications, and are combinations of

- Two or more different substrates;
- Two or more different resin systems; or
- A conventional composite material and a non-composite material.

Piping applications

Consider a piping application that calls for a stiff material. Metals, with their high flexural strength and modulus, would fill the bill. However, when electrically conductive metal components touch each other, they are susceptible to cathodic corrosion when the parts are in contact with water or chemicals.

Therefore, the application also requires an insulating material that separates the metal surfaces. One option would be to coat the metal parts with a ceramic, which would provide the necessary insulation and enhance the rigidity of the components. However, the process of machining the part would seriously damage the ceramic coating. Moreover, a ceramic coating would be fairly brittle, making it vulnerable to cracking and other types of damage in the field.

A better alternative is a complex composite consisting of metal covered by a thin insulating layer of fiberglass-reinforced thermoset. Like a ceramic coating, the thermoset layer protects the metal from cathodic corrosion. Unlike ceramics, thermosets are less brittle and less expensive. Sold on thermosets, some makers of steel products have tried to provide insulation by simply gluing thin thermoset sheets to steel surfaces. In most cases, this is a temporary solution that will eventually fail to prevent corrosion. As a result, many manufacturers opt to mold thermoset material onto steel surfaces. This joining of the two materials into a complex composite effectively prevents contaminants from working their way between the material layers and corroding the steel.

In addition, such complex composites can slash costs by reducing or eliminating expensive fabrication and assembly steps. In cases such as the one above, the finished cost of the complex composite is significantly less than the cost of applying standalone thermoset sheets for insulation. Such sheet application typically involves several steps, including fabricating the steel component; fabricating two sheets of thermoset material (one for each face of the steel part); and gluing the sheets to the steel. By contrast, molding thermoset materials to steel requires only a single fabrication step, eliminating the need for costly assembly procedures, high-tech glues, and surface preparation.

Copper composites

Copper is another metal that has been a component of complex composites. In the medical equipment industry, conductive copper wires had been packaged in large bundles to generate magnetic fields. These bundles were supposed to be housed in large machines, but manufacturers found it extremely difficult to secure them firmly in place while the machines were being assembled.

Therefore, they replaced the bundles of copper wire with a complex composite made by applying copper directly to a thermoset material. In this form, the copper can be machined into the shapes necessary to generate the required magnetic fields.

Besides solving a manufacturing problem, the copper thermoset complex composite costs less than the copper wire it replaced. Furthermore, by eliminating the need to hold the wire bundles in place, the composite reduced machine assembly time from months to days, and significantly reduced assembly costs.

Optimizing properties

In other cases, complex composites slash material costs by allowing manufacturers to improve properties only in specific areas. For example, many applications in the construction industry require strong panels, but the stiffness of such panels depends much more on the properties of the material on the outer surface than it does on the properties of the core material. Therefore, instead of a stiff panel made entirely of a strong and expensive fiberglass-based thermoset, manufacturers can opt for a stiff but cost-effective complex composite panel consisting of a fiberglass-based outer material, and a cheaper paper based or cotton-based core.

Complex composites can save weight as well as money. Weight savings are particularly important in the aerospace industry, in which high-strength panels designed for aircraft must be as light as possible. Although panels made entirely of strong fiberglass-based thermosets might be too heavy for an aircraft design, complex composite panels consisting of a fiberglass outer material and lighter foam or honeycomb core materials can often meet the strength and weight requirements.

Other complex composites add flexibility to packaging products, which must be flexible enough to allow folding as well as strong enough to resist tearing. Thermoplastics can provide the necessary flexibility, but they tear too easily. Thermosets can provide the needed strength, but these rigid materials cannot be folded.

The solution: a complex composite consisting of a thermoset inner material and flexible thermoplastic film on the outer surface. The thermoset layer is cut in certain places, but the thermoplastic film is left intact. As a result, the composite is strong but can also be folded in the places where the thermoset was cut.

Doing the impossible

How do you know when you need a complex composite? When the requirements of your application are technically difficult or impossible to meet with a conventional material. Take the packaging application mentioned above, which required a material that was both stiff and flexible. While no single conventional material can provide both stiffness and flexibility, some material suppliers can produce complex composites with both stiff and flexible members.

Complex composites may also be needed to satisfy requirements that are economically difficult or impossible to meet with a conventional material. For example, consider the case in which a fiberglass-based thermoset material strong enough for a given application costs \$7 per pound, but budget considerations limit the manufacturer to a material that costs no more than \$5.00 per pound. In this case, a material supplier can mix a less rigid and less expensive material with the fiberglass-based thermoset to produce a complex composite that is significantly less expensive than the fiberglass product, but still meets the strength requirements.

A conventional paper-based material would be economically acceptable in this case, but it does not have the required strength. A material supplier can add enough fiberglass to the paper-based material to create a complex composite strong enough for the application, but still within the price range.

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