Differences between resins

There are three main types of resins used for composite materials; polyester, vinyl ester and epoxy resins. Polyester resins are standard resin for composite construction. Because of their chemical structure Vinyl Esters and Epoxies offer higher mechanical strength, adhesion and heat resistance over polyester resins. Polyester resins are generally the cheapest followed by vinyl esters and epoxy resins.

Polyester Resins

Polyester resins are the most widely used resin systems, particularly in the marine industry. The majority of dinghies, yachts and workboats built in composites make use of polyester resins. The addition of styrene in amounts of up to 50% helps to make the resin easier to handle by reducing its viscosity.

Polyester resins will eventually gel or set (polymerise) if left on their own for long periods of time. This rate of polymerisation is too slow for practical purposes so catalysts are used to achieve the polymerisation of the resin within a practical time period. Catalysts are added to the resin system shortly before use. Typically, polyester resins use Methyl Ethyl Ketone Peroxide (MEKP) as a catalyst in a 4:1 or 5:1 ratio.

Ortho vs Iso Polyester Resins

Orthophthalic (Ortho) resins are based upon orthophthalic acid and are a good basic, general-purpose, inexpensive resin. They have styrene content between 35% and 45%, and are used in applications that do not require elevated service temperatures, high corrosion resistance, or high mechanical properties. Isophthalic (Iso) resins are better suited for corrosion environments, elevated service temperatures, and have greater mechanical properties. Iso resins have between 42% and 50% styrene because the higher molecular weight more solvent is required to create a workable viscosity. Iso Resins typically cost more than Ortho resins.

Vinyl Ester Resins

A thermoset that resin is an alternative to polyesters and epoxies. Its characteristics, strengths, and bulk cost are intermediate between polyester and epoxy.

- Vinyl esters are more tolerant of stretching than polyesters. This makes them more able to absorb impact without damage. They are also less likely to show stress cracking.
- Vinyl ester has fewer open sites in its molecular chain. This makes it much more resistant to water penetration ('hydrolysis') which can cause blistering.
- Vinyl esters shrink less on curing, which means that 'pre-release' of a laminate from a mold is less significant.
- Vinyl esters bond to core materials much more effectively than polyesters and delamination is less of an issue.
- Vinyl esters are less sensitive to ambient conditions (temperature and humidity) than are polyesters.

- Vinyl esters are more expensive than polyesters though the relative strengths need to be factored in - you can use less vinyl ester to achieve a given strength.

- Both polyester and vinyl ester resins are susceptible to 'chalking' - UV breakdown at the surface - unless an additive is incorporated in the mix.

Where prolonged exposure to water is likely (such as a boat hull or water tank), then by using polyester for the bulk construction with a surface barrier of vinyl ester, water penetration can be reduced considerably without a significant increase in cost.

Epoxy Resin

Epoxies are more expensive than polyesters, and cure times are longer, but their extended range of properties can make them the ideal choice for critical applications.

Epoxies generally out-perform the other resin types in terms of mechanical properties and resistance to environmental degradation. As a laminating resin, their increased adhesive properties and resistance to water degradation make them ideal for use in applications such as boat building.

The absence of ester groups means that the epoxy resin has particularly good water resistance. The epoxy molecule also contains two ring groups at its centre which are able to absorb both mechanical and thermal stresses better than linear groups and therefore give the epoxy resin very good stiffness, toughness and heat resistant properties.

Epoxies differ from polyester resins in that they are cured by a 'hardener' rather than a catalyst. The hardener, often an amine, is used to cure the epoxy by an 'addition reaction' where both materials take place in the chemical reaction.

Since the amine molecules 'co-react' with the epoxy molecules in a fixed ratio, **it is essential that the correct mix ratio is obtained between resin and hardener** to ensure that a complete reaction takes place. Unreacted resin or hardener will remain within the matrix which will affect the final properties after cure.