History of composites

Landmarks in the history of composite resins

1847 The Swedish chemist, Berzelius, one of the founders of modern chemistry, makes the first laboratory cook of a saturated polyester

1894 Vorlander studies glycol maleates in the laboratory, the earliest record of chemical work with unsaturated polyesters

1920s The pioneering Wallace Carothers studies polyesters prepared from ethylene glycol and unsaturated acids

1922 The first polyester resins are produced as lacquers

1930s (late) Researchers Bradley, Kropa and Johnson investigate the curing of (monomer-free) unsaturated polyesters and report them to be insoluble and infusible (thermo set) when cured. Carlton Ellis conducts experiments on using liquid monomers, such as styrene, to give lower viscosity mixtures which cure much faster than unsaturated polyesters on their own.

1935 Owens Corning introduces the first fine glass fibers

1941 The first commercial application for unsaturated polyesters is in the USA where they are used for castings

1942 The US Rubber Company develops the first glass fiber reinforced polyester composite. The technology is taken up by the US military in the first commercial application as radomes for housing radar equipment are made by vacuum injection and the resin is cured at high temperatures. The scarcity and high cost of glass fiber restrict applications during this period to defense and aerospace.

1946 Boat builders start to realize the potential that reinforced composites offer to their industry, and in this year the first commercial boat hull is built in the USA. The first cold curing systems are introduced

1950s (early) The first closed molding processes are patented

1951/2 Commercial production of unsaturated polyester resins begins in Europe. A curing system that leaves tack-free surfaces is developed. The first chopped strand mat is introduced. The composites industry now has glass reinforcement in a totally compatible form; products that cold cure in open moulds without any air inhibition; and, most importantly, lower cost raw materials - as polyester resins and glass reinforcements become mass produced.

1963 Carbon fiber reinforcement is first introduced

A brief history of composites

Composites are structures that are made up of diverse elements, with the principle being that the sum of the whole is greater than the sum of its component parts (i.e. 1+1=3). An understanding of composites seems to be inherent in animal behavior, evident in the nest building of birds, bats and insects, for example.

Primitive man used the basic materials that were available to him such as animal dung, clay, straw and sticks to form composite structures that were literally the first building blocks of civilization. Even the biblical Noah's Ark was allegedly made of coal-tar pitch and straw, which could perhaps be the first reported construction of a reinforced composites boat!

Moving forward several thousand years, and the second wave of the industrial revolution that swept though western Europe from the1830s onwards, saw new found industries developing their own composite technologies such as laminated wood, alloyed metals and steel reinforced concrete. The earliest polymer castings were developed by Lepage in France using albumen, blood and wood flour to produce decorative plaques. The first semi - synthetic plastics were produced when cellulose fibres were modified with nitric, acid to form cellulose nitrate - or celluloid as it was to become known.

Phenolic, trade named Bakelite by its Belgian born US inventor L.H.Baekeland, was the first wholly synthetic plastic material. As well as being used for decorative items such as umbrella stands and pipe stems, phenolic was also used to make components for the emerging electrical, telephone and radio industries. Different fillers such as wood flour, mica, asbestos and textile fabric were used to enhance the heat resistance and insulating properties of the resin.

For the first half of the 20th century, phenolic resins were dominant. However the emergence of the more versatile and user-friendly polyester resins in the 1940s opened up whole new markets for composites.

Wars tend to give a major boost to technological development. Such was the case in the early years of the Second World War, when new structural materials were needed to complement the use of the emerging radar technology. Glass fiber reinforced polyester composites fitted the bill perfectly - providing protective housings for radar antenna, which are transparent to radio waves.

When the war was over, a new set of imperatives emerged which further drove the wider use of glass fiber reinforced plastics, or GRP as it was becoming known. Firstly a major infrastructure and rebuilding program was necessary and traditional materials such as steel were in short supply. Secondly there was a growing sense of the need for change and future orientation - especially when the space race got underway in the late 1950s - generating a spirit of optimism that favoured the experimentation and adoption of new materials; and finally there was the practical benefits in that the price of glass fiber and resins began to decrease as new capacities came on stream.

Several industries quickly picked up on the very special benefits that polyester composites could offer. For example boat builders found in GRP moulding an excellent way of mass producing hulls and superstructures; truck and car builders realized it was a material that was pound-for-pound stronger than steel and did not rust or dent; and fabricators of tanks and pipes recognized GRP as a material that was lighter and more chemically resistant than traditional materials such as metals and concrete. The result was that the ten year period 1955 to 1965 was the 'big bang' for composites - an explosive decade for composite developments and applications, the likes of which may never be seen again.

From the late 60s to late 70s, the oil crisis and cyclical global recessions put the brakes on the runaway success of the composites industry. The aftermath of this period saw a more responsible approach emerge. Many businesses collapsed during this period and many raw material producers either withdrew from the market or consolidated their businesses. Those companies looking to make a quick killing were replaced by more professional and responsible suppliers and producers who were there for long term growth and not for short term gain.

Nowadays the composites industry has settled into a mature phase. Products, processes and applications are well established, and developments are evolutionary rather than revolutionary. Nevertheless new market sectors for composites continue to appear, such as wind turbine blades - an application undreamt of 20 years ago. Likewise as new industries and new technologies emerge in this new century, the demand for tough and lightweight polyester composite structures will be even stronger. So who's to say that the next 50 years won't be even more eventful than the last 50 years for the composites industry?