Lightweight Plastics Invade Industrial World

Reinforced polysters, one of the many plastics to hit the headlines since World War 11, are seen at their most spectacular in sports car bodies. But, says the author, these materials have also been working a quiet revolution in the industrial world. Here's an account of the origin and fabricating methods of these materials, some of the things that are made from them; and their prospects for industrial and consumer use.

by Bradford Henderson

Reinforced polyster plastics have hit the advertising headlines in a big way within recent years. Because of their use in the new sports cars — Chevrolet's Corvet and Kaiser's Darrin — the public has heard much of their potentialities, and has been intrigued at the possibility of bounceable fenders and everlasting car bodies.

It is not generally known, however, that polysters have been working a quiet revolution in the less glamorous industrial world. Their use in places of metal is actually making inroads in the steel industry. Although they were practically unused before the war, polyesters are being consumed at a 27,000,000 pound clip today, and experts expect that figure to rise to 200 million pounds in the foreseeable future.

Car bodies may be the most spectacular, but are far from being the sole consumer product being made from these remarkable plastics. They have practically revolutionized the manufacture of small boats and canoes, where their combination of strength and lightness makes them an ideal material. Large storage tanks for water and corroaive substances are being fabricated from polyesters. They make an ideal skylight material, and are being used for partitions in many modern buildings in Canada. In the US they are used as panelling for trailer truck bodies and as light weight replacement for steel pipe and these uses are being mooted in Canada also.

Steely Strength

Poyester plastics are making themselves felt because of their dual characteristics of great strength and light weight. Reinforced with glass fibres (as most of them are) polyesters' strength approaches that of steel, but their weight is similar to wood. Additional virtues are flexibility and toughness which gives bounce and eliminates shattering.

Here's an outline of the history and the nature of these new plastic materials. Some of the most durable compounds ever produced by synthetic means are the result of reaction between an acid and a basic (alkaline) substance. Materials produced in such a way are called esters in the chemists' lexicon. Two examples produced by reacting acid and base are nylon and Dacron. Linseed oil is also an ester, well known for the tough paints and floor coverings it makes. It is manufactured, of course, in nature's wonderful laboratory, at a price considerably lower than even the cheapest man-made plastics.

The search for plastic materials with the qualities of polyesters has been going on for many years in laboratories all over the world. The track has lead repeatedly to ester-type products. Actual development of the polyesters began at the turn of the century, but it was not till the mid-40's that the correct acids and bases were developed which made it possible to produce polyesters at a reasonable price.

The chemical materials from which the polyesters are made are derived from coal tar and petroleum. In a sense the polyesters are children of the great new petro-chemical industry which has transformed so much of our everyday manufacturing into chemistry. It was not until the petrochemical industry fuond its feet (during World War II) that it was possible to make the polyesters — and many other plastics — at a price the public could afford.

Glass Does the Trick

Even though the polyesters have remarkable properties by themselves they never really came into their own until somone developed a method of 'reinforcing' them with glass. This is accomplished by laying in layers of glass cloth or fibre-glass roving at the same time as the plastic is poured into the mould. Slight pressure may be applied to compress the glass and plastic together to increase the bonding strength.

Glass is not the only reinforcing material. Sometimes sisal fibre is used, especially when exterme lightness is desirable. Glass, is however, preferred because its fibres are actually stronger than steel. In the spinning of glass threads this brittle and fragile material picks up a tensile strength that amazes even the physicists who work with it. Fibres being produced on an experimental basis today have a tensile strength of one million lbs. per square inch.

Combination of a tough, corrosion-resistant plastic like polyester with glass fibres which runs through it in every direction like fine steel threads, makes one of the strongest structural compounds known. And it never rusts, takes a polish like the finest wood, and is practically fireproof.

First application of reinforced polyesters to make the headlines was their use by the U.S. army in the hulls of assault landing boats — a development kept a secret until after the war. These boats could be driven onto a rocky shore at 35 miles an hour without damage to the hulls. Landing boats with steel hulls ill-treated in this way were a dead loss, and were usually left on the beach as expendable.

Radar too used reinforced polyesters, which have almost perfect transmission for radio waves and were therefore suitable for making plastic domes covering the directional antennas for radar installations and on planes. Tail fins and many other aircraft parts are now being made from this strong, light material.

Polyesters, like many other industrial developments, had their 'bugs.' After the war many individuals and companies rushed into polyester prorication and manufacture without any real product research and testing. Strangely enough the product usually gave excellent service. But when the producer started adding up his figures he found he was losing money. Inadequate equipment and tools for finishing reinforced plastic materials often necessitated prodigious quantities of hand labor to make them marketable.

Polyesters acquired a reputation for being a trap — which looked fine for a large part of the fabrication process and then failed pricewise on some vital component. In 1945 consumption of polyesters was 6 million lbs. but this slumped to 1 million pounds when peace came. Many manufacturers were afraid to touch them until fabricating procedures were worked out with more scientific detail.

Today's consumption, however, is 27 million pounds, and the graph is pointing almost straight up.

Equipment Costs Little

One great advantage of polyesters is that they can be fabricated into useful products without expensive or large scale equipment. Take for example an aircraft seat now being made by Smith and Stone Ltd. of Georgetown, Ont. Dies for manufacturing this seat by injection moulding of plastics would cost over $30,000. But for the same product in polyester plastic a handyman can make the dies in his basement. Furthermore, reinforced polyester is far superior to any other plastic which could be used economically for the same type of seat.

Dies for conventional plastics must be made to withstand pressures of thousands of pounds per square inch, but for reinforced polyesters need be designed for only slight pressures, or none at all. For polyester, dies can be made from wood or plaster of Paris; whereas conventional plastics demand dies of specially hardened steel.

Though the cheapness of dies for polyester fabrication has attracted fly-by-night manufacturers, and ha sresulted in many products being put on the market without adequate testing, it has released plastics from the size-limits which hitherto held back development. A die for a car body or a bathtub, laboriously drilled out of high alloy steel, represents a very large investment. Made out of wood or plaster, the investment is small.

An example of the type of manufacture which is making success out of polyester fabrication is the Humphrey-Cosburn Co., Ltd., which operates in a converted barn in the suburbs of Toronto. Both Humphrey & Cosburn are young engineering graduates. After leaving college, they spent a considerable period of apprenticeship with large companies and secured a good grounding in the economics and processes involved in rubber and plastics manufacture.

Fabricating Methods

Their fabricating methods for reinforced polyester products can be classified into three types, matched metal moulding, balloon moulding and forming over a pattern.

Matched metal moulding is the most expensive of the three, but for some applications gives the best product. In this method two moulds are made, the first corresponding with the shape of the object to be manufactured, the second somewhat larger so that the first fits into it and leaves room for the plastic. Glass fibres are placed over mould number one, the fibres are soaked with liquid polyester, and number two mould is clamped in position. The moulds are then heated (usually by electricity) and this cures the resin. After a short cure the moulds are unclamped and the product (a chair for example) is removed. This technique gives a good finish and permits working to exact dimensions.

In the balloon moulding method a wooden or plaster die is made to conform to the general outlines of the object to be manufactured. Next fibreglass and polyester resin are laid in, and a balloon is inflated inside the mould. Simultaneous heating cures the resin and the balloon forces the plastic and gas into the required shape.

Forming over a pattern is the simplest of all methods for reinforced polyester production. Bathtubs are made in this fashion from fiberglass and polyester. A shape identical to the inside of a bathub is made from wood or plaster of Paris. Fibreglass strands and polyester resin are laid over the shape in alternate layers and then put in the sun to harden. After several days the bathub is lifted from the form and after trimming and finishing is ready for the market. Boats are made in a similar fashion.

There Are Drawbacks Too

One of the interesting applications of fibereglass polyester forms of this type is as covering for machinery to be used in Northern Canada where air transportation is necessary. Ingersoll-rand of Sherbrooke, Quebec makes cover for its air compressors out of fibreglass reinforced polyesters. Tho' polyester is somewhat more expensive than steel sheet, it has the advantage of lightness, and it does not dent and "ding up" after service in the field.

Even though reinforced polyester have assumed an important place in the industrial world, they are not the perfect plastic material. One factor that discourages their more general use is cost — particularly in Canada The Naugatuck Chemical Co. of Elmira, Ont., and the Chemical Oil and Resin Co. of Toronto manufacture raw polyester resins in Canada, but the components are imported from either the USA or abroad. These raw materials are plentiful but are subject to duty and freight charges.

Another disadvantage is that automatic machinery has not yet been developed to handle reinforced polyesters efficiently, and labor costs are usualy high. It is this factor which holds back large scale production of reinforced polyester car bodies. Rumor has it that General Motors is finding its Chevrolet Corvet to be an expensive number. For sports car drivers and other enthusiasts this doesn't matter, too much but it's no good for the average buyer.

New Stamping Method

Ironically enough, polyester resins are in one development working against themselves. Large metal stamping dies are being made from polyesters reinforced with fibreglass. The same combination of characteristics which makes polyester sheets so strong works with these large dies. Made from some of the newer polyester ("epoxy-type") resins they are as strong as steel dies, but can be formed by one man with a sanding machine. This process promises to make stamping metal sheet so cheap that reinforced polyester sheets will never be able to compete pricewise. Chrysler is reported to be using these new dis in the USA and Canadian metal working concerns are experimenting with them.

Lightweight articles with great structural strength and resistance to corrosion seem to offer the most profitable industrial field for polyesters at present. They are moving more slowly into the consumer field where mass production is a vital factor. But their characteristics are so useful that industry will probably find it worthwhile to overcome mass production difficulties, and make polyesters part of everyday living.