CHAPTER 1

TYPES OF POLYMERS AND THEIR USES

Synthetic resins, in which plastics are also included, vary widely in their chemical composition and in their physical properties. The number of synthetic resins which can be made is vast; relatively few, however, have achieved commercial importance. Some of the polymers that have achieved commercial importance and their uses are tabulated in Table 1 and some of their important physical properties are listed in Appendix 2.

Well over 90% of all synthetic resins made today comprise no more than 20 different types, although there are certain variations to be found within each type. Synthetic resins are familiar to most people as plastics, but they have other uses, such as in the manufacture of surface coatings, glues, synthetic textile fibres, etc. The rapid growth of the synthetic resin industry has to a large extent, been made possible by the fact that ample supplies of necessary raw materials have become available from petroleum.

The synthetic resins may be divided into two classes, known respectively as 'thermosetting' and 'thermoplastic' resins, each class differing in its behaviour on being heated. The former do not soften; the latter soften but regain their rigidity on cooling. Both types are composed of large molecules, known as macromolecules, but the difference in thermal behaviour is due to differences in internal structure.

The larger molecules of the thermoplastics have a long-chain structure, with little branching. They do not link with each other chemically, although they may intertwine and form a cohesive mass with properties ranging from those of hard solids to those of soft pliable materials, in certain cases resembling rubber. On being heated, the chain molecules can move more freely relative to each other, so that, without melting, the material softens and can flow under pressure and be moulded to any shape. On cooling, the moulded articles regain rigidity. Some resins require the addition of liquid plasticizers to improve the flow of the plastic material in the mould. In such cases the moulded articles are usually softer and more flexible than the products made from the unplasticized resins.

The macromolecules of the thermosetting resins are often strongly-branched chains and are chemically joined by crosslinks, thus forming a complex network. On heating, there is less possibility of free movement, so that the material remains rigid.

Production of these resins also falls into two groups since there are, generally, two main types of chemical reaction by which they are made. These are polycondensation reactions and polymerization reactions.
### TABLE 1

<table>
<thead>
<tr>
<th>Polycondensation types</th>
<th>Phenolic formaldehyde</th>
<th>Urea formaldehyde</th>
<th>Melamine formaldehyde</th>
<th>Polyesters</th>
<th>Exopoxides</th>
<th>Nylon</th>
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<tbody>
<tr>
<td></td>
<td>(a) Unfilled</td>
<td>(a) Cellulose filled</td>
<td>(a) Unfilled</td>
<td>(a) Resin</td>
<td>Chemically resistant paints, adhesives, tools, PVC stabilizers, electrical insulation, chemical- and wear-resistant jointless flooring, road coatings, cements, laminates, powder coatings, stopping compounds, repair kits, printed circuits, filament wound pipes, tanks and pressure vessels.</td>
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<tr>
<td></td>
<td>(b) Woodflour/cotton flock filled</td>
<td></td>
<td>(b) Alpha-cellulose</td>
<td>(b) Dough moulding compound</td>
<td>(c) Sheet moulding compound</td>
<td>(a) Type 6</td>
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<td></td>
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<td>(c) Outlets in the electrical, building, motor engineering and furniture industries that compete on a cost basis with die castings and sheet metal fabrications owing to ease of moulding complicated shapes and short moulding cycles.</td>
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- (a) Adhesives, laminates, pulp mouldings, particle board.
- (b) Bottle tops, electrical parts, fuse boxes, meter cases, heat-resistant close-tolerance mouldings, toilet seats, restricted in colours obtainable, coloured ashtrays.
- As for, cellulose filled melamine formaldehyde but suitable for dinner ware. U/F resins are used for similar applications to those shown under unfilled phenol formaldehyde, white electric plugs.
- (a) Usually occurs in laminate form as surfacing for tables etc.
- (b) Noted for durability, hardness and good electrical properties, suitable for appliance housings, dinnerware, closures, writing equipment, clock housings, knobs, handles, lighting fixtures, appliances, instruction panels.
- Components often replace metal, offering non-corrosion, durability, good electrical performance and high strength.
- (c) Outlets in the electrical, building, motor engineering and furniture industries that compete on a cost basis with die castings and sheet metal fabrications owing to ease of moulding complicated shapes and short moulding cycles.
- (a) Moulded mechanical parts, gear wheels, bushings, sliding parts for storm windows, automobile and refrigerator door closures, mixer valves, switch housings, grommets, cable clamps, pipes, tubing, filaments, aerosol bottles, stockings, clothing,