Chapter 4

Continuous Fibre Reinforced Thermoplastics

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4.1. Introduction

In continuous fibre reinforced plastics it is the fibre which determines the basic property profile: the function of the resin is to allow the fibre to develop its full potential by transferring the load from one fibre to another and, by providing a support, to prevent the fibre from buckling. From this standpoint it is clear that the best possible property profile will derive from the highest loading of the longest fibre, provided that...
each fibre is fully wetted by a resin of adequate stiffness to prevent buckling of the fibres when subjected to compressive loading. Further, we require that the resin shall maintain the ability to continue to transfer load from one fibre to its neighbours in a service environment.

Besides its function as a glue, the resin phase also acts as a carrier for the fibre at the fabrication stage: it is responsible for seeing that the fibre goes where it is directed, and stays there. The resin phase, and, in particular, how it is made mobile to shape the product and how it is made form-stable to retain that shape, also determines the economics of fabrication.

A resin system to work with high loadings of continuous fibre reinforcement may be chosen from three groups:

1. "chemi-setting" systems based on the mixing of two components which react and polymerise;
2. "thermo-setting" systems which polymerise when heated, usually forming a crosslinked product; and
3. "thermoplastic" resins derived from the rigorous chemistry of linear chain polymerisation producing a system which softens when heated in a physically reversible process.

On a snapshot impression, the product of the fibre reinforced plastics industry can be divided into two groups:

1. low loadings (<30% by volume) of short (<1 mm) fibres based on thermoplastic resins and injection moulding technology, or using chemi-setting systems with the emerging reinforced reaction injection moulding (RRIM) technology; and
2. high loadings (>50% by volume) of long (including continuous) fibre based on thermosetting resins.

The preference for thermoplastic or chemi-setting resins for work with low loadings of short fibre is a tacit recognition of the cycle time advantages in fabrication for a system which requires only heat exchange or only chemical reaction to effect the transition from a mobile to a solid state in comparison with a system which requires heat exchange in order to initiate a chemical reaction. The historical preference for thermosetting resins with high loadings of long fibres is an acknowledgement of the convenience of impregnating the fibrous matt with a stable pourable resin, where surface tension can be relied upon to effect the wetting, compared with the difficulty of impregnating a closely packed array of fibres with a viscous resin or with one which is