



CO-MINGLING M/C

CHAPTER 1

INTRODUCTION

Effect of Processing Parameters on Commingling Behaviour and Properties of Hybrid Yarns**1.1 PREAMBLE**

Advance technology creates a need for combinations of properties that in general no individual material can provide. Today various composites become the material of choice in many such applications. Composite can be defined as a product of combinations of various dissimilar materials to perform a task that neither of the constituent material can perform individually. A reinforced textile composite is made of certain matrix materials and the textile component in the form of fibre, yarn or fabric. These textile reinforcing elements have to be arranged in proper structural form called 'textile preforms'. The consolidation of the preform with various polymeric matrix materials results into textile composites.

Traditionally, these composites were produced with randomly oriented short fiber mats impregnated with any of the thermosetting resins. Subsequently, Sheet Moulding Compounds (SMC) and Bulk Moulding Compounds (BMC), consisting of short fibres in dough of matrix, were developed for applications in automotive body panels etc. The short fibers composites are poor in mechanical characteristics. Thereafter the aerospace industry has developed textile composites using long fibres in the form of unidirectional prepreg system. These composites are becoming popular in providing strong and lightweight structures for the aerospace, automotive and other engineering applications. The reinforcing fibre elements generally preferred for high performance composites are glass, carbon and aramids etc. Some natural fibers are also being used in bio-composites. Thermosetting resins such as polyester, epoxy vinylester have traditionally been used as a matrix material. The use of thermoplastic fibres such as polyester (PET), polypropylene (PP), along with the high performance fibres viz. glass, carbon, ceramic in a

commingled hybrid yarn form, shows high potential for thermoplastic composites for various technical applications.

The hybrid yarns can be produced by different manufacturing processes such as co-wrapping, core spinning, commingling etc. These processes can provide uniform distribution of matrix and reinforcement filament with minimum damage to the reinforcing filament. The hybrid yarns produced by these processes are known as cover yarns, wrapped yarns, commingled yarns etc. depending on the yarn manufacturing technique used. In case of thermoplastic hybrid yarns when heat is applied, the thermoplastic component melts and impregnates the reinforcing component and forms amorphous reinforcing binder. After subsequent cooling, the system is transformed into rigid composite material. In commingled state the multifilament yarns are scattered amongst one another at the filament level. The thermoplastic filaments are wrapped over mingled bundle to improve the commingling quality. The performance of hybrid yarn depends on the type of materials and process parameters of yarn manufacture in general and commingling behaviour in particular. The research work is carried out pertaining to commingling and hollow spindle wrapping techniques to study the mingling characteristics of hybrid yarns.

1.2 RESEARCH AIM

A survey of various studies undertaken indicates that the existing yarn manufacturing processes are used for making commodity textiles. There is a need to modify these processes to produce hybrid yarns for technical applications. The existing machine set up can be modified accordingly. The hybrid yarn improves the mechanical properties of composites but the comparative evaluations should be made with reference to various yarn manufacturing techniques. The aim of the research is to study the effect of processing parameters on commingling behaviour and properties of various hybrid yarns.

1.3 BASIC PROBLEM

- The major problem with thermoplastic resin is its high viscosity. It is very difficult to inject the highly viscose thermoplastic melt uniformly into the textile preforms during manufacturing of composites.
- Core/sheath structures of cover yarn should give better homogeneity to improve properties of composite.
- Existing machines in general are not suitable to produce commingled yarn, due to lack of positive and precise control.
- During the winding of commingled yarns, the filaments get separated when tension is applied because of variations in their stiffness resulting into non-uniform distribution of fibres in the final composite.

1.4 BASIC CONSIDERATION

Certain points have been considered during research.

- Hybrid yarns should be manufactured using different technologies, giving the possibility of a homogenous blend of glass and thermoplastic filaments
- Glass fibres should be coated with pre-adhesive substances to the polymer matrix.
- In commingling process the area-dependent mechanical properties of the filaments vary with shape of their cross-sections effecting the forces required to deflect the filaments.
- The forces acting on the filaments will also vary owing to the different surface and projected areas arising from non-circular cross sectional shapes. These factors mainly affect the nip formation in case of glass filament leading to poor nip stability.
- The glass filaments are having rod like structure, smooth surface and perfectly circular in cross section. During the mingling process due to swiveling effect of air flow the filament is subject to both bending moment and torque.

1.5 OBJECTIVES

The main object of this project is to produce various types of hybrid yarns incorporating polypropylene matrix filaments with reinforced filaments (glass) using commingling process. The detailed objectives of research work are:

- To study processes pertaining the hybrid yarns manufacture using covering process (Hollow spindle wrapping technique) and commingling process (Mingling technique) and to study the different machine parameters affecting their characteristics.
- To study the different aspects of conductive hybrid yarn made using hollow spindle technique.
- To study the effect of yarn passage and processing parameters on various properties of hybrid yarns.
- To develop commingling machine to produce varieties of hybrid yarns on the same machine.
- To study the effect of jet design on characteristics of various glass/polypropylene hybrid yarns.
- To study the mixing behaviour of component elements of glass/polypropylene in hybrid yarns using SEM technique.