SECTION 1

General Design Considerations

Chairman: L.C. Roy Oberholtzer, Rockwell International, Collins Avionics Division

Introduction

THE SCOPE OF THIS VOLUME is engineering plastics, which the dedicated efforts of scientists, engineers, technicians, and marketers have created and maintained as one of the most dynamic and responsive industries in the world. This Section of the Volume presents general background information directed to those engineers not generally familiar with plastics technology. Therefore, the articles in this Section are primarily overviews to promote an understanding of the more detailed articles in the remainder of the Volume.

Engineering plastics all have, as their principal constituent, one or more synthetic polymer resins, and almost universally have other constituents, such as fillers, plasticizers, and colorants. Because this Handbook is intended for users of engineering plastics, rather than suppliers, the use of the term plastics is deemed more appropriate than the term polymers, which is much in vogue with some writers in the field.

The most fundamental question a design engineer must address is whether it is appropriate to consider the use of engineering plastics for a given application. The characteristics of plastics that render them advantageous in many applications include thermal and electrical insulation, low density, self-lubrication, atmospheric-corrosion resistance, chemical resistance, inherent color, and design freedom.

In a free-enterprise economy, cost must be a prime adjunct to the technical considerations involved in materials selection and application. However, materials selection and application that are based solely on cost considerations can have devastating results. This practice, which was very popular in the 1950s and 1960s, caused the disenchantment of the general public with plastic materials because their plastic products failed soon after purchase. To this day, the term plastic still retains a residual connotation of poor quality. Therefore, in the interest of corporate financial health and industry reputation, sound engineering judgment must prevail in material selection, product design, and production parameters.

Conversely, a design engineer should immediately disqualify engineering plastics if the application requires maximum efficiency of heat transfer or electrical conductivity, or nonflammable properties. Although some plastics can be formulated to retard flames, their organic nature makes them inherently flammable. Applications under constant stress for which a close tolerance must be held need to be scrutinized in terms of the effects of creep at the application temperature. The design engineer also must be cognizant of the poor ultraviolet (UV) resistance of most, though not all, engineering plastics, and the resulting requirement for a UV absorber. It is also incumbent upon the design engineer to realize the greatest reliability of a part at a tolerable cost. Practitioners of failure analysis will affirm that most part failures result from a lack of attention during design, either to the relatively high coefficient of expansion of unfilled engineering plastics or to the chemical compatibility of the plastic with another material it will be in contact with. The articles "Cost Considerations" and "Characteristics Crucial to the Application of Engineering Plastics" will expand on this topic.

Material selection is now more complex by virtue of the great number of engineering plastics available to the design engineer. It would be too time consuming to research all the literature for every new application. The design engineer risks application failure or unnecessary cost by deciding on a formulation strictly because it was previously used in a similar application. The use of computer data banks to reduce the options to a practical number is encouraged. After a complete analysis, which is described in the article "Design Approach for Engineering Plastics," if there is still more than one option, a data bank that includes material costs can provide a fast and accurate means of ranking the candidates in terms of value. It cannot be inferred that the computer makes the decision. It provides information that allows the design engineer to make a sound decision. Thus, there can be discrete reasons for not selecting the candidate with the highest value rating. Although commercial data banks are available, many large companies have elected to develop their own.

In this dynamic electronic age of rapid information dissemination, many practitioners need to remember the importance of a triangular flow of information between the design engineer, the tool designer, and the material converter. Procedures at some companies assume that the drawings, notes, and referenced specifications provided by a design engineer enable a purchasing department to manage vendor relationships completely. There are also converters who have a similar relationship with tool makers. Each party has options unknown to the other two parties, and each wants to select from among his own options those that will result in a product with the lowest cost and highest reliability. Only direct communication among the three can bring about the best possible choice among all options available, and thus ensure the success of a given application.