Melt spinning of polypropylene

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INTRODUCTION

Melt spinning of polypropylene is done, almost exclusively, with the semicrystalline isotactic form. Melt spun isotactic polypropylene (iPP) filaments and fibers have many textile applications, including apparel, home furnishings, wall coverings and carpets. One of the largest markets for iPP filaments and fibers is the nonwovens industry, in both staple fiber nonwovens and in 'spunbonded' and 'melt-blown' nonwoven materials. Staple fiber nonwovens and spunbonded nonwovens compete for such applications as diaper coverstock, feminine hygiene products, surgical gowns and numerous other applications. Melt blowing is a special form of melt spinning process which produces very fine but weak fibers which are useful for filters and other applications where high surface area is important and strength is a secondary factor. In this article, we will deal primarily with classical melt spinning of yarns, but the information will apply directly to the formation of filaments during spunbonding. In general, we will not cover here the secondary processes that generally follow the filament formation step, such as drawing or texturing of the as-spun yarns or bonding of the filaments into a spunbonded nonwoven web.

THE MELT SPINNING PROCESS

A basic design of a melt spinning process is illustrated in Figure 1. Polymer, in the form of pellets or granules, is fed into an extruder, where it is melted and pumped via a positive displacement pump to the melt spin pack. The spin pack consists of filters and channels that supply...
molten polymer to a multifilament spinneret. The molten filaments that exit the spinneret enter a cooling zone which cools and solidifies the filaments. The cooling zone can be as simple as a region in which quenching air is blown across the filaments, or it may be an elaborate chamber constructed so the cooling environment can be strictly controlled. In addition to being cooled and solidified, the molten filaments exiting the spinneret are simultaneously drawn down to a smaller cross-sectional area by the application of a drawdown force. This force is applied by action of a godet which controls the final linear velocity, or take-up velocity, of the spinning filaments. This force can also be supplied by air drag in special cases such as spunbonding. The take-up process is largely dependent upon the end use of the polymer filaments. In the case of yarn production, the multifilament yarn is usually wound onto a bobbin or sent directly to a drawing and/or texturing process.

The key variables of the melt spinning process are (1) take-up velocity, (2) length of the spinline, (3) cooling conditions along the spinline, (4) extrusion temperature, (5) mass throughput per spinneret orifice, and (6) the size and shape of the spinneret holes. These process variables interact