ety, with several other types of machines used in some situations. These single screw extruders are simply comprised of a flighted screw that rotates within a heated cylinder (barrel). The screw is rotated by a drive motor through a gear reducer. Alternate extruders to the single screw include multiscrew machines (usually twin screw), rotary extruders (screwless), and ram extruders. The twin screw and also the less popular quad-screw extruders are comprised of multiple screws within a heated barrel and are most popular for making rigid PVC (polyvinyl chloride) powders into pipe and various profiles (window profiles, house siding profiles, etc.). The melting performance of this material lends itself to the low shear pumping seen with these types of extruders. Most polymers require more energy to thoroughly melt and homogenize them than a typical twin screw extruder can efficiently produce. When a twin screw extruder is designed to develop shear levels comparable to those of single screw extruders, the performance is not improved over the single screw machines, and the economics and operational advantages favor the single screw extruder. That is why twin screw extruders have not widely penetrated the single screw marketplace, except for the PVC powder extrusion applications. Another use of twin screw extruders is in compounding where additives must be dispersed into a polymer. Here special mixing twin screw machines have been developed, which do a good job and are very expensive. These compounding twin screw extruders typically can deliver high output levels (2000–10,000 pounds/hour and greater) and are not economically practical for the extrusion of everyday products as described above.

Rotary extruders have been in use for the last ten to fifteen years but have seen limited use due to their sealing problems against melt leakages and their low pressure-generating capabilities. These machines are made up of heated discs that rotate with polymer between the plates where shear is developed and melting takes place. Some pressure can be developed, but nowhere near the typical 2000 to 10,000 psi levels of single screw or twin screw extruders. The possibility of melt leakage leads to concern for contamination due to degrading polymer because the system is not totally self-cleaning. Some large rotary units are being used for pelletizing or compounding applications, and a few smaller units are being used for products such as polypropylene sheet; but the single screw extruder still is and will remain the workhorse in polymer extrusion for the foreseeable future.

There are some materials in the fluoropolymer area and some materials such as ultra-high molecular weight polyethylene that will not process acceptably on the screw extruders mentioned above. For these materials, a ram extruder is employed. This device is a non-steady-state machine that discharges its volume by using a ram or a plunger to extrude the melted material. The polymer is melted by conducted heat through the barrel in which the ram travels. This extruder is not a substantial influence on today's extrusion markets.

SINGLE SCREW FUNCTIONAL DESCRIPTION

Because the single screw extruder is by far the predominant machine used in polymer extrusion, its operation is mainly described, with comments regarding alternative extrusion means added as appropriate. The basic function of this type of extruder is to accept material in the feed section of the screw and convey this material along a flighted screw enclosed in a barrel. (See Fig. 4-1.) The conveying is forced by the rotation of the screw via a drive motor and gear reducer. The material usually must be melted (plasticated) along the path through the extruder screw although some processes introduce the feed material already in melt form so the extruder need only convey it. The melting of the polymer is aided by heaters that tightly encapsulate the barrel's outside diameter and are separated on the barrel into zones. These zones can be set at different temperatures as appropriate for the particular process involved. The screw must develop enough pumping efficiency to force the material through the die system. The pressure developed can be substantial for highly restrictive die systems and can reach 8000 to 12,000 psi. Typically the die pressure levels encountered are in the 1000 to 5000 psi range.

The design of the screw greatly impacts the