sonably well when some experience factors are employed.

Some examples of these alterations to the drag flow estimation include a 0.85 multiplier when mixing sections are employed and a 0.5 multiplier when cold water is circulated through the screw's core. When a barrier screw is used, the metering section may not control the output, so this equation could give poor results.

Wear Effects on Pumping

As screw flights and barrel I.D.'s wear, the pumping ability of the screw is diminished. Some materials and some additives will cause higher wear than others; for example, linear low-density polyethylene (LLDPE) will cause more wear than conventional LDPE or polypropylene. Many fillers, such as titanium dioxide (used for white colors) and reinforcing fibers, also create high wear situations. Under some conditions, screw/barrel wear can lead to instability of the extruder's output, but typically the main effect is output reduction. At some point, extruder wear will create an unacceptable situation that necessitates rebuilding or replacement of machinery parts such as the screws, barrel, and feed sections. Changes in the ability to increase the screw speed and still produce an acceptable melt contribute to the decision about when wear has passed acceptable limits.

Variations involved in production operations, including the materials run, screw speeds used, die system pressures, barrel set temperatures, screw design, screw flight hardening material, and barrel lining material, make it impossible to predict wear life accurately. The suggested way to understand the wear in a process is to set base conditions when the equipment is new and unworn; that is, run a commonly used material, and record all performance parameters, including output rate, screw speed, drive amperage, barrel temperature profile, product quality, and dimensional consistency. Whenever the opportunity to perform scheduled maintenance occurs, measure equipment clearances and rerun the process at the base conditions to compare performances to determine the extent of deterioration. The wear pattern then can be plotted to show the screw and barrel life for the given production case.

Mixing

Many extrusion processes require better mixing than a single screw delivers. For example, good dispersion of color masterbatches and proper mixing of polymer blends need higher shear mixing devices. This is particularly true where the masterbatch is based on a dissimilar material to the one being colored, and where polymers being blended have different melting temperatures and flow properties.

Two types of mixing usually are discussed in polymer processing, distributive and dispersive. In distributive mixing the material(s) are uniformly blended on a scale where any small particles or agglomerates are not broken down. These particles can be "gels" from various sources or small clusters of a material such as carbon black, which is not physically broken down without very high shear levels. Dispersive mixing includes very high shear mixing from extremely tight clearances (about 0.001 to 0.005 inch) where small particles or agglomerates are physically broken down to smaller pieces and distributed into the main mass of material. Such high shear, dispersive mixing can be seen with some of the kneading block geometries on compounding twin screw extruders. Mixing in single screw extruders is generally not on the scale of the very high shear levels characteristic of dispersive mixing. Typical mixing elements can yield very good distribution of a material's mass and its additives, but any small particles (gels) or agglomerates will still be present, although well spread throughout the melt. Should the presence of these undispersed particles create a problem in the final product, the origin of the particles must be determined, and their cause must be avoided in polymer blending methods or base material particle size selection. Examples of common mixing devices can be seen later in the screw design discussion. These mixing devices can be placed on the screw proper, can be attached to the screw tip, or can be placed after the screw in the die adaptor pieces.

The need for specialized and highly effective