Flat Die Cuts Color-Change Time by 75%

A new constant-shear manifold for film and sheet balances the flow of virtually any polymer or blend, regardless of viscosity, for dies up to 36 in. wide, according to Premier Dies Corp., Chippewa Falls, Wis. The constant-shear principle was developed in the early 1980s to balance flow using a rounded “horseshoe” manifold shape instead of a “coat-hanger” shape. The horseshoe causes polymer to reach full width across the die faster, providing more uniform residence time than a coat-hanger die, in which polymer flows from the center out with longer residence at the die ends.

Early constant-shear manifolds were largely for R&D, since they could only be used for narrow dies of 8 to 14 in. Two years ago, Premier contracted with software consultant Prof. Mohamad Elgindi of the Univ. of Wisconsin, Eau Claire, to optimize a horseshoe for wider dies. The result is a new die with a distribution channel following the horseshoe curve, which gets deeper as the die widens. Premier has built five of the new dies, which cost 10% to 20% more than conventional coat-hanger dies but can run polyolefins as efficiently as polyesters, Premier says. In one application for rigid PVC, the die reportedly reduced color-change time by as much as 75%. The principle is also applicable to pelletizing and fibers.

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Premier Dies CS Manifold Die

A new “Patent Applied For” die design has been commercialized by Premier Dies Corporation which results in improved polymer flow across the width of a die. This new design, known as the “CS Manifold” (Constant Shear) spreads materials uniformly over the die width with the following benefits and improvements over other conventional designs:

- The design is independent of the material properties and will process most any material in the same die.
- The design achieves a uniform residence time for the flow across the entire width which reduces degradation and polymer or color changeover times.
- The design is more streamlined and reduces degradation at the ends.

The new design is a variation of research and development originally conducted at the [University of Massachusetts by H.H. Winter and by H.G. Fritz at the University of Stuttgart] in the early 1980s that culminated in a technical paper published by ANTEC in 1984. The paper, “Design of Dies for the Extrusion of Sheets and Annular Parisons: The Distribution Problem,” proposed a new concept for the design of extrusion dies. The concept was based upon the use of a slit cross-section manifold as opposed to the continued...
more common round or tear-drop shaped manifold. The change allows a flow channel to be designed that has the same shear rate at all points inside the die from center to ends. The “Constant Shear” design yields the benefits of uniformity of flow and is independent of the influences of the viscosity variations at varying shear rates and between different polymers.

The original design investigated and developed by Winters was not widely adopted in film and sheet dies. The primary reason is the flow channel must get deeper in the front to back direction as the width of the die exit slot is increased in the side to side direction. A successful design generally had a front to back depth of approximately 0.3 as compared to the side to side width. Because of this drawback the design was only applicable to narrow applications up to around 14” (350 mm) in width. Using the constant shear flow channel design concept at wider widths resulted in a manifold design that was excessively large in the front to back direction and was not practical due to the possible increase in die body “clam shelling.”

Premier Dies Corporation has overcome some of the previous width limitations. Our new CS Manifold extends the range of widths by substantially reducing the front to back depth penalty while still achieving a constant shear rate inside the die. Using our custom developed computer modeling software, we are able to design and manufacture dies that are practical to widths up to 35” (900 mm) using a single manifold. Wider widths can be supplied using two or more manifolds in a side-by-side layout.

There are many practical applications for this technology. The design is applicable to the manufacture of single layer polymer film and sheeting in any thickness and widths up to around 35” (900 mm). It is also very suited for the distribution of materials feeding into a stranding plate or single or multiple spinneret plate(s) in pellet manufacture or fiber production. Other applications include extrusion coating and liquid or emulsion coating.

Depending upon the actual viscosity of the application, the practical width can be much wider in coating applications. The design is also applicable to multi-layer applications by incorporating the design into multi-manifold arrangements. The relatively shallow depth of the manifold allows for efficient stacking of 3, 4, 5, or even more layers in a very compact package. The CS Manifold is not recommended for use with Coextrusion feedblocks as the individual layer integrity is generally not maintained in the manifold.