Stacking Up Productivity-Molding System 1999

The simplest mold design, from a runner point of view is a single-cavity, single-face mold. The machine nozzle injects plastic directly into the mold cavity. The single-face mold can also be extended to a multi-cavity layout. In this case, the machine nozzle injects the melt into a runner system that feeds each individual cavity.

Development of the two-level stack mold design is widely accepted in the thin-wall injection molding industry, typically with hot-runner designs. In such a mold, the melt is injected into an extended sprue or sprue bar, which is attached to a manifold system. The manifold feeds each cavity simultaneously on both molding levels. From a rheological standpoint, the longer runner results in increased resin residence time and pressure losses in the runner system.
Mold designers must make sure all cavities are fed at the same pressure and temperature. The main advantage of the two-level stack mold design is it essentially doubles machine capacity. The back-to-back cavities of the stack mold take advantage of injection force cancellation, allowing use of the same machine that ran the single-face mold, with a 10-15% increase in tonnage to offset the force the machine nozzle applies to the sprue bar. Although they're not new to injection molding industry, stack molds are still surrounded by myths and misconceptions regarding their applications, benefits, and requirements. The fact is, stack molds can meet a variety of molding demands because they are available in configurations that can help users achieve the optimum tooling solution for their application.

Today's stack-molded plastic parts can enjoy the various gating and ejection options available while providing the product at a lower pan cost than the conventional single face mold. The last few years have brought further technological advances that improve both the productivity and the flexibility of stack molding operations. These advances include:

- Four-face (four-level) stack molds
- Quick-change stack mold systems
- Two-cavity (2 X I) stack molds for large pans
- Three-face (three-level) stack molds

Four-level stack molds essentially quadruple output over single-face molds, and are suited to very high production volumes of shallow parts. Quick Change molds let molders switch from one product to another in less than an hour in both single-face and two-face stack mold applications. Two-cavity slack molds allow molding of large parts in a back-to-back configuration, thus doubling the machine capacity. Three-level stack molds permit molding of deep-draw or tall pans to maximize the productivity of currently available machine shut heights. The key to all these innovations is development of a proprietary melt transfer system to pass the plastic across the mold parting line.
The valveless melt transfer system (VMTS) must provide a tight seal, because it engages and disengages each time the mold cycles at injection pressures that can reach 20.000 psi and higher. It is a self-compensating design that allows for variations in nozzle thermal expansion. The system avoids drooling on mold opening due to the self-decompression of the central hot-runner system. No components of the VMTS suffer particularly heavy wear. Here's a look at the current state of stack mold technology.

Double Double
The four-face stack mold is essentially two stack molds placed back to back. The design's increased mold shut height and plasticizing requirements make it

- Operation in the same molding machine as a conventional slack mold
- Cycle limes identical to those of a conventional mold
- A thermally and rheologically balanced hot-runner system
- Shot-to-shot changeover time of less than one hour for both mechanically and air ejected parts in the stack mold configuration
- Mold design that allows upgrading from a single-face mold to a stack mold
- Machine shut height remains the same from one product to the next

The system consists of two basic components: a unique hot-runner carrier frame, and interchangeable core/cavity sets housed in plate modules. All necessary water, air, and electrical services remain connected within the carrier frame during changeovers; a product change results in no time lost re-installing these services. The sprue bar in the conventional stack mold design presents an obstacle in applying quick mold change techniques, making it difficult to access and remove plates or modules from the stationary platen side while the mold is in the press.
The VMTS eliminates this problem. After injection at the mold centerline, the melt is immediately transferred around the core and cavity modules via a hot-runner manifold. The melt then crosses the mold parting line with the VMTS and passes to a fully balanced,

central distribution manifold. This manifold feeds the individual nozzles for injection into the cavities. Because there is no sprue bar, this configuration does not require the nominal allowance of 10-15% increase in clamp tonnage needed by other stack mold configurations. The VMTS requires a negligible amount of clamp force to maintain its operational seal.
The quick-change stack mold design's major advantage is the flexibility that the quick mold changeover offers.

This includes the ability to minimize inventory levels and costs and maintain Just-In-Time delivery schedules. Molders with high product changeovers will realize lower manufacturing costs per part due to the timesaving in mold changeovers.
The modular system allows molders to start projects initially on a small scale, and even expand from a single-face to a stack mold using the original core and cavity module sets. As a result, molders can compete with high efficiency tooling without a large initial capital investment.

An example of a current application is modular quick-change stack molds for the production of cutlery items. These molds apply hot- and cold-runner technology along with cam-followed ejector systems on both molding levels. Three- and four-level stack molds incorporating the quick-change system also are running production.

Stacking Big Parts
Clamp tonnage and platen size limitations usually dictate molding of large pans in single-cavity tools. Increasing cavitation of the mold in either the single-face or stack mold configuration would require a larger-tonnage machine. The technical challenge, therefore, is increasing mold cavitation without having to change to a higher-tonnage press. Placing the cavities in a back-to-back configuration results in a two-cavity stack mold that runs in the same molding machine as does the single-cavity mold. Like the quick-change mold design, the melt is injected at the mold centerline into a primary hot-runner manifold housed within the stationary core backing plate, then transferred around the core and cavity set on the stationary platen side. It then crosses the VMTS into the main hot-runner manifold that feeds both pans simultaneously.

The 2 X 1 stack arrangement gives molders a considerable advantage over their single-cavity competitors. Output is doubled without an investment in a larger machine to increase cavitation. The technology was first applied in low-pressure molding of heavier wall items with low UT ratios. More recently, it has been used to mold thin-wall containers in a back-to-back configuration with a wall thickness of 0.7 mm (0.028)and a resulting UT ratio of 300.

Three Faces of Molding
The three-level stack mold uses triple VMTS crossover nozzles to provide equal pressure and flow characteristics to the plastic melt to each cavity. This stack mold configuration fills in when a two-level mold cannot produce enough pans and a four-level mold is too large for the machine. Three-level stacks can be used
to mold both shallow draw (for example, packaging lids) and deep draw pans (such as tall containers). They can be combined with quick-change systems to give added flexibility to high-production tooling.

Keeping Up
A misconception many molders have is that stack molds require extensive maintenance. Like any piece of equipment or machinery, stack molds require proper care and preventive maintenance to function properly over a long service life. The added components of a stack mold mean it requires slightly more attention than a single-face mold.