R&D/Leverage Brings Liberty to IBM Tooling

By Karen Hanna,
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Misalignments. Poor temperature control. Constant, time-consuming upkeep.

What started as a litany of difficulties has culminated for R&D/Leverage with a new way to do injection blow molding (IBM) — the Liberty tooling system.

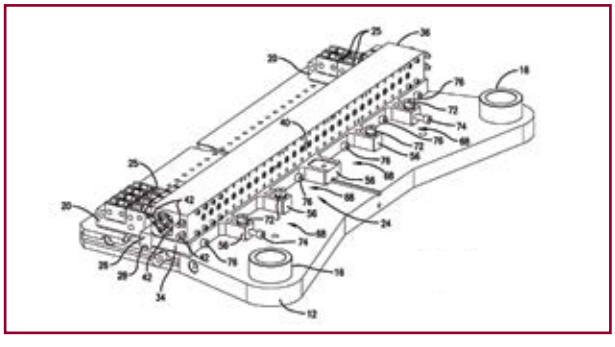
"It's really a long-term type of development," said Jeff Chen, director of research and simulation. "We just keep discovering new things and new solutions to an old problem."

The system addresses many issues that are inherent in conventionally-designed IBM tooling by:

- eliminating the effect of thermal expansion-related problems like bowing of the die-set;
- making it possible for process technicians to do "cold starts" without having to torch the nozzles;
- minimizing thermal expansion-induced wear at the nozzle tip and gate area, which also eliminates frequent replacement of the nozzle;
- eliminating the need for engaging and disengaging the manifold from the injection cavity for start-up and shutdown;
- allowing a high degree of manifold balance;
- minimizing temperature bleed-over between neck insert and cavity;
- offering a solution for the galling and wear of traditional bottom mold retract components by using a unique retract system;
- and minimizing parting line mismatch.

Developed over time to address issues such as uneven thermal expansion and unpredictable product quality, the system differs in various ways from traditional IBM tooling. During the past year, R&D has furthered the technology by creating a way to allow the top mold half to "float" to improve alignment and extending the sizes of available molds — to up to 38 cavities and 42 inches (1,066mm) across.

Developed over time, the Liberty injection blow molding tooling system from R&D/Leverage features a variety of innovations to compensate for thermal expansion, improve alignment and simplify maintenance.



U.S. Patent and Trademark Office

An injection station, as proposed in a patent awarded to R&D/Leverage, features a die plate with a keyway.

Overall, in about the past two decades, R&D has filed 15 patents dealing with IBM, many involving the system. In that time, Chen said the system has conquered all the problems he and others first observed in 2000, when they took on the process through a partnership with a plastics division of Owens-Illinois

R&D/Leverage

Inc. that eventually became part of Berry Global Inc. of Evansville, Ind.

At the time the partnership began, R&D was a relative newcomer to IBM. An expert in injection stretch blow molding (ISBM), R&D wasn't accustomed to the pitfalls of IBM. For one thing, Chen said IBM requires higher temperatures and can produce a parting-line mismatch.

In traditional tooling, keyways and all-thread tie rods locate the cavities on the die-set in a rigid design that does not offer much room to compensate for thermal expansion. Such a system, Chen said, can cause "the plate to curl up like a potato chip." Bigger tooling, in particular, presents challenges, as it exacerbates problems with mold-half alignment.

In addition, poor temperature control can cause problems with neck-finish ovality. With traditional tooling, Chen said mold makers must employ a trial-and-error approach to establish the right temperatures for molding good bottles. For operators, the process window is narrow because managing temperatures in the neck area is tricky. To cure the plastic to final dimensions, the neck must be cooled in the preform mold. At the same time, the body of the preform, which has steel-to-steel contact with the neck finish insert, must be kept at a higher temperature to allow blowing of the container body.

The nozzles in traditional IBM also require more art than science. Because plastic that flows to the nozzles at the outermost edges of the mold is under considerably less pressure than the plastic closer to the center, the openings of the nozzles at the ends are typically bigger than those in the middle. How much bigger can require guesswork, Chen said.

And, he added, the wedge bottom-plug actuating system traditionally used to create the dome shape of the bottom of the bottle requires grease and wears quickly. This adds to the cost of IBM, while presenting a risk of contamination.

A trip to a medical molding plant in Puerto Rico drove home another issue. On an island where power outages have long been common, Chen took note of the many inefficiencies with machine stops and restarts. When this happens Chen said, the manifold contracts — at a rate that's faster than the rate at which the cavities contract. "So, when you shut [the machine] down, something's going to be damaged. Usually, it's going to be the nozzle tips or the gate of the cavity," he said.

Restarting is a laborious affair. Both the manifold mounting bolts and nozzle clamping bolts must be loosened, then tightened. The nozzles themselves must be preheated with a propane torch on restart. "Very often, you use two people to torch them because you go one by one," Chen said.

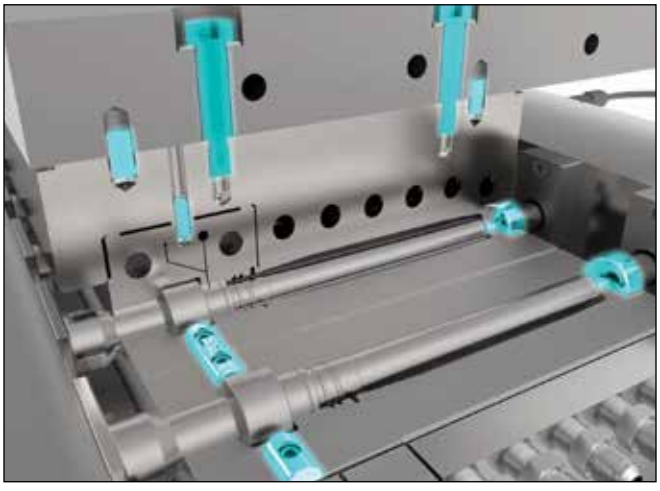
To compensate for all the issues that they've encountered over the years, R&D's engineers have applied a range of features to the Liberty system.

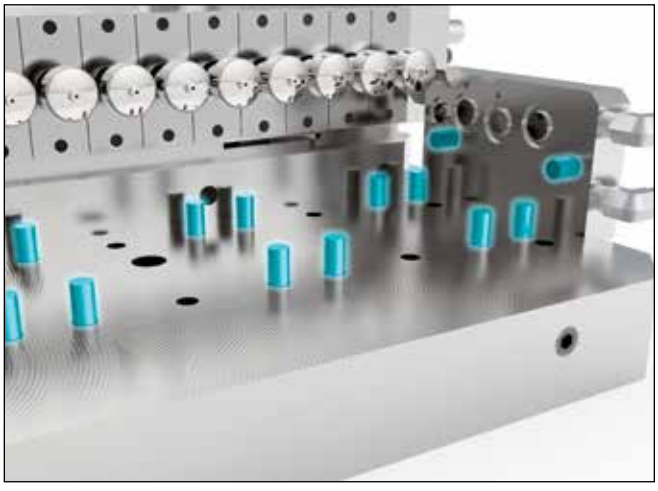
To achieve better alignment, the system employs a dowel, which is strung through precision holes in both die plates to exactly locate the cavity to the die set. Gaps between the cavities alleviate the cumulative effects of thermal expansion.

"Each cavity, each cavity block, they're not pushing against each other; they are individually located on the dowel," Chen said.

R&D/Leverage

To compensate for the effects of thermal expansion, R&D/Leverage has designed gaps between cavities of its Liberty tooling system, so the metal can expand without compromising part quality.





R&D/Leverage photos

To improve mold alignment during the injection blow molding process, R&D/Leverage has created a way to allow the top cavity halves of its Liberty tooling system to float. Dowels, seen at right, are strung through precision holes in both die plates to exactly locate the cavity to the die set.

As part of its work with the Liberty system, R&D created its patented Genesis manifold system, which has undergone evolution through the years. Unlike traditional tooling, the Genesis manifold employs nozzle gate inserts that provide a flexible connection between the manifold and the cavity blocks, thus reducing wear. An elongated draw bar is secured within a keyway formed through a top surface of a die plate, according to a U.S. patent awarded March 21, 2017.

"A next step," the patent states, "includes engaging a base plate with the draw bar, with the base plate including at least one notch such that during the engaging step, the tab of the draw bar is engaged with the notch of the base plate. Next, the base plate is secured to the draw bar, a rear portion of the base plate is secured to the die plate, and a manifold is secured to a top portion of the base plate."

The nozzles also have changed. Using a ball-and-socket system to connect the nozzles to the manifold creates more flexibility, while thermally conductive inserts inside the nozzles eliminate the need for manual torching on start-up. Nozzle gates within the cavity contribute to better alignment. All nozzle openings are of identical size. Balance is achieved with internal flow pins.

To further reduce maintenance, R&D also took on the wedge bottom-plug actuating system, replacing it with a proprietary cam-activated system that requires no grease.

To permit accurate control of temperatures in the adjacent neck and body areas, the Liberty system makes use of patent-protected thermal isolation techniques. It establishes three discrete thermal zones, Chen said — the neck area, interlock insert area and body area. Where appropriate, the system incorporates heat-transfer channels, as well as insulating gaps and grooves.

"As such, temperatures of the body mold halves and the neck mold halves can be independently controlled," states U.S. Patent 9,481,110, which was awarded Nov. 1, 2016.

The result is reduced maintenance and cost, according to a statement issued by Bruce Wardlow, the company's engineering manager of IBM.

"Through thermal isolation in our Liberty IBM system, we can achieve appropriate process temperatures without having to excessively run the [temperature-control unit] to achieve a lesser result," Wardlow said in a press release. "With superior isolation in those areas, you can achieve appropriate temperatures easier and without as much strain on your equipment."

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