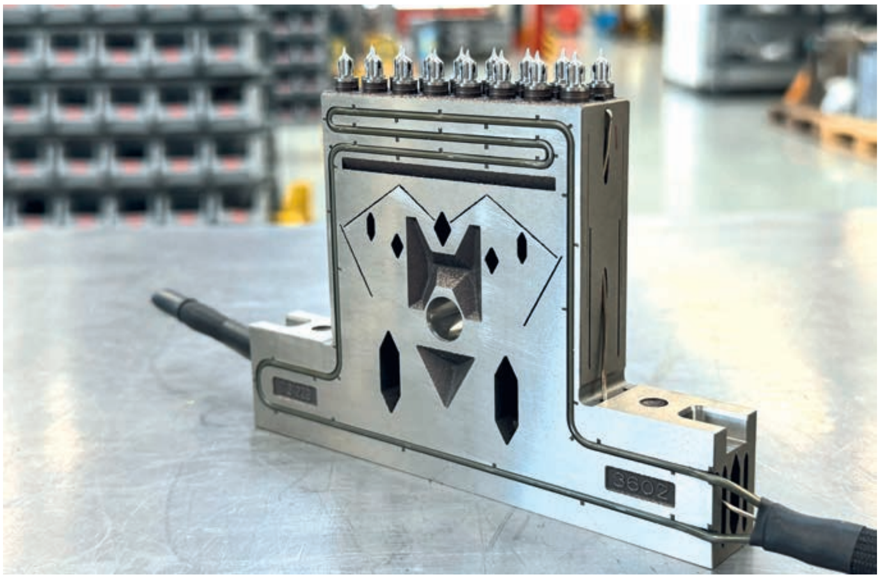
Witosa Sets Standards in the Precision Manufacturing of 96-Well Plates

Zero Defect Titration Plates in Record Cycles

The production of high-quality 96-well plates poses considerable technical challenges for toolmakers and injection molders. Particularly thin-walled structures, demanding cavity geometries, and the high number of injection points require process control that operates within a very narrow tolerance range, both thermally and rheologically. A new hot runner system from Witosa solves the problem.



16-cavity "Monolith Plus Multi-Well" stack with integrated cooling. © Witosa

A leading international manufacturer in the medical and diagnostics industry approached Witosa with a request for an ambitious project: an injection molding tool for 96-well plates, in which each of the 96 conical wells in the titration plate is individually connected via a full hot runner. Just like in the three-plate technology commonly available on the market today, completely sprue-free. The mold was to be developed to produce the well plates in high quantities, with very tight tolerances, homogeneous filling, minimal warping, and high reproducibility – and to do so in a shorter cycle time and with a mold service life that significantly exceeds that of previous systems. The quality criteria had to be implemented without compromise, because even the smallest deviations can negatively affect pipetting accuracy, optical measurability, and functional integrity in medical diagnostics applications.

This list of requirements gave rise to the impetus to develop a completely new system concept.

True Full Balancing of all 96 Points

The development of the open hot runner was guided by the goal of completely synchronizing the melt flow across all 96 injection points. The fixed grid spacing of 9 mm within a total format of 63 × 99 mm creates extremely compact cavity areas in which even slight local temperature or pressure deviations have a critical impact on the quality of the molded part.

The breakthrough was achieved through a system architecture that was consistently designed with additive manufacturing in mind: The hot runner system was completely 3D-printed (**Fig. 1**) – this made it possible to realize geometries that would neither be feasible nor economically viable using conventional manufacturing methods. The three-dimensional channel routing allows true full balancing of all 96 points – without the restrictions that are unavoidable with conventional manifold plates or milled structures. This results in almost isotropic filling behavior with identical pressure and temperature conditions at each individual cavity.

Design with Integrated Thermal Separation between Hot and Cold

In addition, the additive design enables exceptionally good insulation between

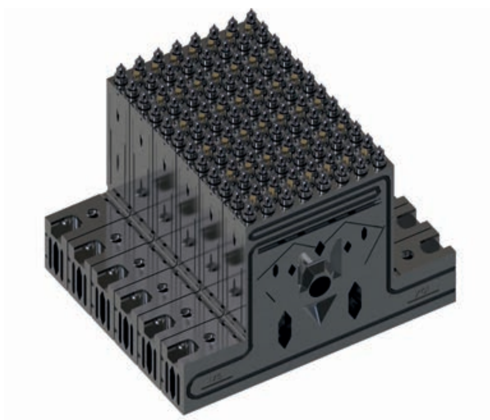


Fig. 1. Six 16-cavity stacks combine to form the complete 96-cavity Monolith Plus Multi-Well hot runner system with internal cooling. © Witosa

the hot runner system and the cooled mold areas. The customizable shell structures act as a thermal separator, allowing hot and cold to coexist with virtually no contact – a significant advantage for stable operation in high-performance applications and a prerequisite for very short cycle times.

The "Plus" in the name of the hot runner system (Monolith Plus) stands for a key enhancement that is unique to date: the hot runner is not only responsible for heating the melt flow, but also performs a cooling function for the cavities. This system feature is not provided for in classic injection molding tool design and opens up completely new possibilities for process control.

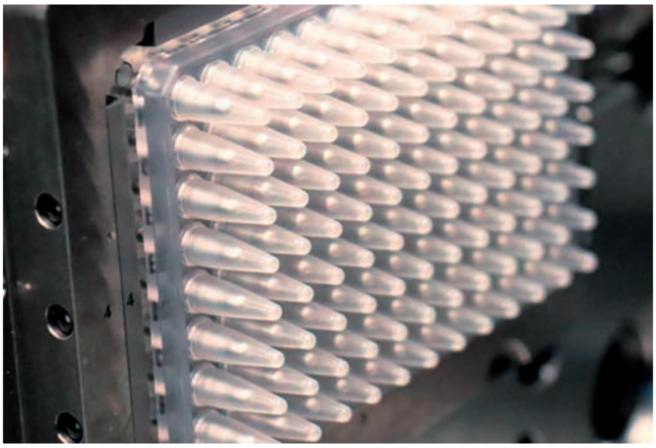


Fig. 3. The tear-off quality of the open 96-cavity Monolith Plus Multi Well hot runner system is flawless. © Witosa

The Mold Cooling Is Integrated into the Hot Runner – Thermally Independent

The mold cooling is integrated into the hot runner and yet is almost completely thermally decoupled (**Fig. 2**). This was achieved by two alternative cooling structures: Either the cooling is carried out via specifically positioned cooled contact pins, which are located in the hot runner structure and dissipate the heat selectively from the mold insert. Or the cooling water is fed directly into the mold insert through the hot runner structure.

Both variants enable active, precisely controlled cooling of the mold insert, while the melt inlet continues to be actively heated. This achieves, for the first time, a state in which the hot runner and cavity area can be operated independently of each other, yet within the same system.

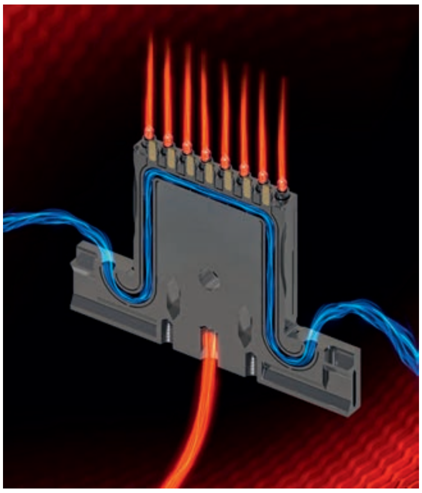


Fig 2. Thermal separation of melt and cooling – Monolith Plus Multi Well in cross-section.
© Witosa

Temperature control is modular via 16-fold stack elements (**Title figure**), resulting in homogeneous thermal characteristics across the entire width of the 96-fold system. Each of these units operates within narrow thermal parameters, ensuring that part quality remains stable even over millions of cycles.

Process Behavior, Molded Part Quality, and Cost-Effectiveness

The result is a process that operates with significantly reduced injection pressure, thereby mechanically relieving the thin-walled structures of the wells. The complete absence of sprues ensures that all material goes directly into the molded part and no sprue waste is produced – a clear advantage in terms of resource efficiency and cleanroom suitability. The precise outlet design enables particularly small injection points with minimal tear-off height (**Fig. 3**), which are ideal for applications in the medical environment and meet both visual and functional requirements.

Precise balancing and a stable thermal environment result in molded parts with high dimensional accuracy, minimal gate marks, virtually no warping, and excellent optical homogeneity. The flawless tear-off points meet the requirements for medical applications, so that subsequent processes are not affected.

In series production, "Monolith Plus Multi-Well" can achieve very short cycle times, which, depending on the material and system parameters, are around 10 s shorter than with the previous three-plate technology. In combination with the sprue-less process, this results in a production system that, according to Witosa, operates well above the existing industry standard in terms of both energy efficiency and material consumption. Tool life, supported by uniform pressure and temperature distribution, achieves enormous shot counts and reduces the number of unplanned downtimes.

Conclusion

Monolith Plus Multi-Well is more than a hot runner – it is an integral manufacturing system that combines heating, cooling, balancing, and insulation in a previously unknown form. The combination of additive manufactured structure, modular temperature control, integrated cooling function, and complete balancing could thus serve as a blueprint for future high-performance tools for applications with high demands on precision, reproducibility, and cost-effectiveness, opening up new possibilities in the series production of medical and diagnostic laboratory equipment. ■

Info

Text

Franciska Thomas is responsible for marketing at Witosa GmbH, Frankenberg, Germany; franciska.thomas@witosa.de
Torsten Glittenberg is the managing director of Witosa.

Service

More information on the manufacturer: ***www.witosa.de/en***