Cavity-Specific Handling. Now, more than ever, plastics-processing plants are faced with trying to maintain a balance between meeting market demand for cost reductions and zero-defect quality on one hand and achieving higher productivity on the other. The proven concept of cavity-specific parts handling offers often unnoticed ways of realizing efficiency increases and seamless quality control.

Putting the Seal of Quality into Handling

The molded parts emerging from the clean room cell are sorted into individual containers for further processing or shipping (photos: Hekuma)

KLAUS WANNER

Surprisingly, injection molding processes with gravity ejection are still widespread in medical technology, an industry in which safety is paramount – think of the production of syringe barrels or valves for catheters. Drop parts, particularly small parts, have an annoying habit of flying uncontrollably around the mold zone after ejection and, in some cases, of landing next to the collection hopper. Molds become damaged, material is wasted, and production losses of up to 20 % are not uncommon.

With its "Sigma Inside" production philosophy, Hekuma GmbH is now working to dispel once and for all the prejudice that the use of automation in connection with drop parts is nothing but a cycle-time killer. In fact, controlled parts removal leads in many cases to targeted and faster closing movements, and thus shorter cycle times – without the risk of damage to the mold. In gravity ejection, by contrast, a certain safety margin must be allowed before the mold can close again.

However, there is something else more important than the cycle time advantage: the use of a side entry, high-performance robot to remove the plastic parts, as envisaged in the "Sigma Inside" concept, enables the parts to be passed directly to quality control, e.g. a camera system. Consequently, bad parts never get as far as shipment or a downstream finishing process. This allows errors that could be bad for business to be avoided, such as defective blood-sampling devices whose slight curvature is not noticed until assembly some days later. During parts removal, sensors interrogate the gripper to confirm that all the parts have been removed, ensuring that no parts are left behind in the mold and ruling out this common source of costly repairs and downtimes.

Separate Processing, Documented Quality

Presorting the parts into trays or individual containers also allows them to be processed on the basis of cavity in downstream processes. This can prove helpful, →

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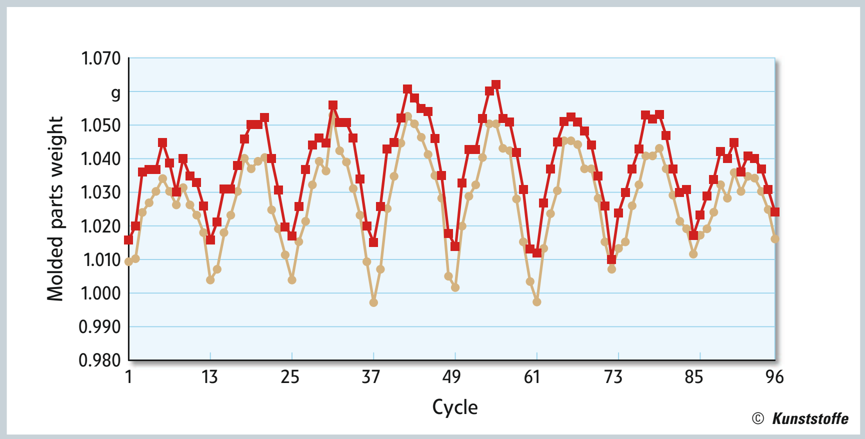
Contact

Hekuma GmbH
D-85386 Eching/Germany
TEL +49 8165 633-0
www.hekuma.com
→ www.hekuma.com



Mold map for a 96-cavity high-precision mold. A change was made during the test to increase the melt temperature and thus the molded parts weight (red line). The sample remains unchanged, however; maxima and minima are still predictable

for example, if the individual parts produced in the cavities of a multi-cavity injection mold have different tolerances. Without the presorting, problems might arise during assembly. Another advantage is that the manufacturer knows exactly how many parts are in each packaging unit at the end. The time needed for the machine operator to swap full containers for empty ones is bridged by a buffer system. It is even possible to automate pallet changes and thus to set up unmanned production.

If the worst-case scenario should materialize, namely that an error goes undetected for a while, there is also no need to dispose of an entire shift's or even several days' production. Liability issues and associated negative impacts can be averted by simply separating out or recalling the parts made by the cavities in question. If a defect regularly occurs in a specific cavity, the cavity can be shut off or its output systematically rejected, without unplanned downtime being incurred. In the program controller, the defective cavity is marked as "Not OK", and the appropriate collection container can be removed. Meanwhile production continues without hindrance, and mold repair work can be scheduled and carried out at a more convenient date.

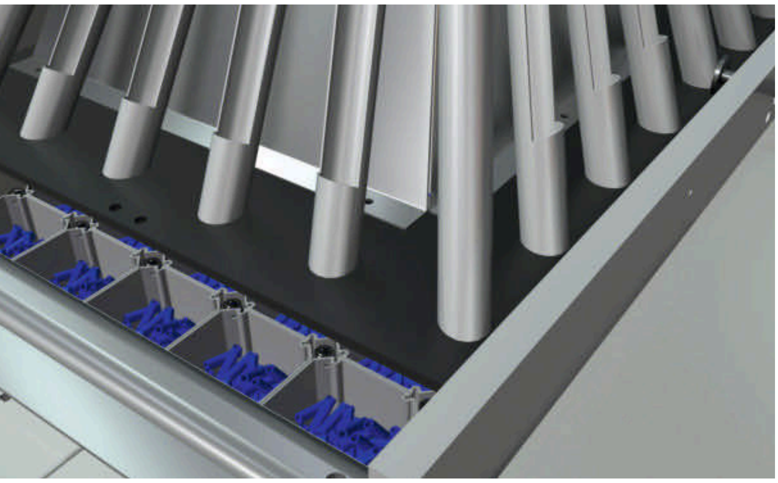
It goes without saying that this production concept complies with all standards and traceability requirements and the documentation obligations of Good Manufacturing Practice (GMP). Like many other rules, GMP has its roots in medical technology. For full traceability back to individual cavities, it is essential that the production of sensitive high-precision parts comply with current standards on packaging and labeling. This includes, e. g., the date of manufacture and documentation of the processing conditions.

Nowadays, seamless documentation of the production history is a must. It is therefore very important to retain a set of samples that are representative of production and, if necessary, permit retroactive tracing. To this end, as well as for manual random sampling, the operator removes the parts via a "quality drawer". This ensures that the parts are always matched up to the right cavity.

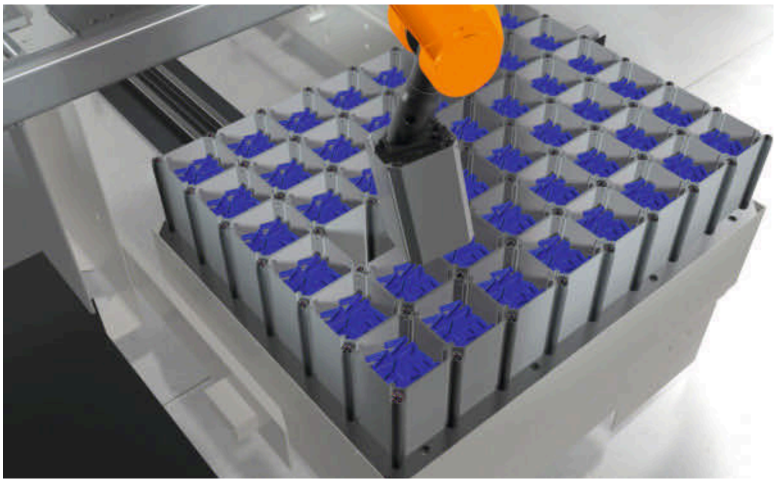
Simplified Determination of Correct Tolerances

This production concept also ties in with a different aspect. Every applications expert is well aware that even small fluctuations in mold temperature or melt properties can affect parts quality. And that determining the correct tolerances is time consuming and labor intensive. Targeted shot-count information can be used to establish a DoE (Design of Experiments) which determines inadmissible process tolerances on one hand and allows an efficient mold-maintenance schedule to be created on the other. The simpler and more efficient this DoE process is, the more accurate the outcome will be. Overly narrow tolerances are just as bad as overly generous ones.

The first step in determining the correct tolerances in a DoE is usually a mold-filling study. Frequently, however, multi-cavity molds do not lend themselves to "short shots"; so physical variables such as weight and dimensions must be used for the correlation. Each mold has a unique signature, regardless of the mold quality and hot runner balance. Although a full analysis is required for mold qualification, the DoE can concentrate on those cavities which exhibit extensive deviation (see **chart**). These will



The molded parts are blown into the manifold, where they fall through a chute system into the various containers. This makes it possible to trace the history of each part.



During a drawer change, a slide briefly closes the manifold. Parts coming from cavities which have been identified as defective can be disposed of directly

also be the most important metrics for an efficient mold maintenance plan. For, observing the borderline cavities identified by the DoE enables a fairly accurate prediction of the number of cycles before the tolerance is exceeded. Coordinating service and maintenance schedules on the basis of this information can go a long way to preventing unscheduled downtimes.

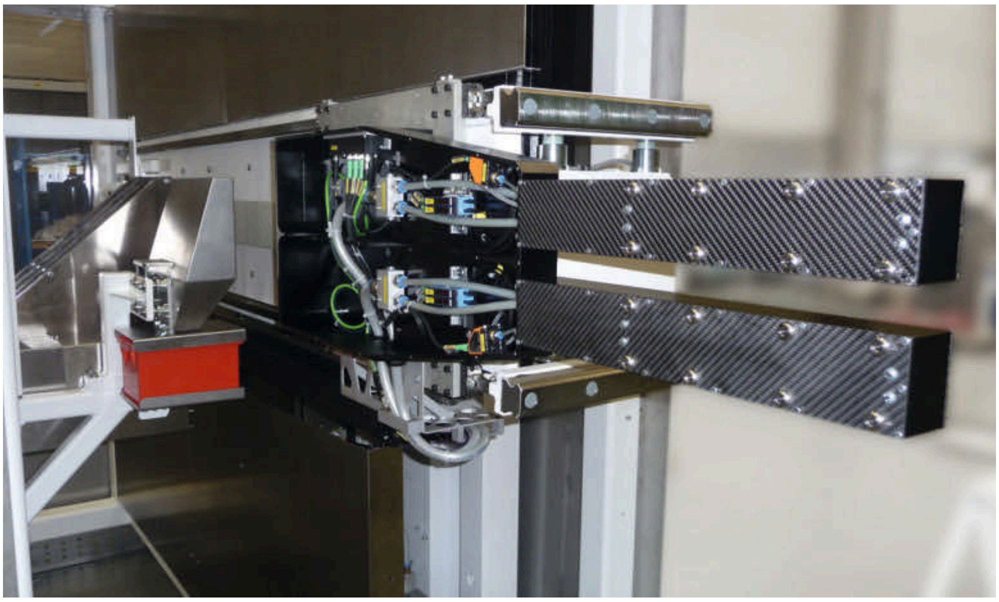
This "mold-mapping" would be a tedious task without cavity-specific handling. The process parameters of the injection molding machine along with the date and exact production time of every molded part can be stored for quality control purposes. This ensures full traceability of the process conditions in a fraction of the usual time.

Efficiency of quality control does not stop there, though. The same procedure is then brought to bear on the extended documentation, which specifies the qualification of technical and, especially, medical parts for compliance with Good Manufacturing Practice. A defined procedure allows these parts to be logged for test purposes and samples to be retained for documenting the history of the process and mold quality.

Low Vibration, Fast Acceleration

The concept of "Sigma Inside" is based on a largely standardized and modular design that allows rapid product changes – provided that the mold map and molded parts size of the various applications are similar. Dedicated, replaceable grippers are employed for this. The distribution system, which is subdivided by cavity and opens into the individual containers via separate chutes, is retained. The modular concept of operation and mold loading allows very short change-over times. The sorting also makes it possible to produce different parts in a single mold, while maintaining their integrity during packaging and shipping.

At the NPE plastic show in Orlando, Florida, in April, Hekuma will be demonstrating a clean room facility with "Sigma Inside" that has a 16-cavity mold for making a "bursting disc" (a micro part for a syringe) at the booth staffed by Engel, a maker of injection molding machines. The cell, containing the integrated switching cabinet for the automation, features an airflow module at the top; the through-flowing clean air is discharged through slits at the bottom of the stainless steel cladding.



The new Heku DS reaches accelerations of 30 G

As the mold halves are opening, the Heku DS removal robot traverses into the mold at high speed. The ejectors hand the parts to the suction receivers of the grippers and a vacuum monitor confirms that the robot has all the parts when it leaves the mold. In the transfer station, the parts are blown into the manifold, and then fall through a chute system into a drawer containing a tray in which 16 bags replicating the arrangement of cavities are suspended. During a drawer change, a slide closes the manifold for a short time, and the parts are collected temporarily in the chute.

The Heku DS will premiere in this exhibit. This new drive concept features two communicating servo axes. As a result, the robot reaches a speed of 10 m/s – currently the absolute maximum for guide rails that utilize ceramic balls – and an acceleration of 300 m/s2. By comparison, the corresponding values for Hekuma SI entry-level model presented at Fakuma 2011 are 5 m/s and 50 m/s2. The combination of high acceleration and 450 mm travel gives the new model a theoretical removal time of 0.17 s. This performance stems not least from the lightweight construction of the removal arm, in which hollow-milled aluminum components are capped with carbon fiber plates. As an added extra, the vibration characteristics of the two materials cancel each other out, thereby minimizing vibrations.

Conclusion

The production concept of cavity-specific handling facilitates quality control in sensitive production areas and ensures 100 % traceability in injection molding. When the principle is applied to drop parts, the gain in cycle time accruing from targeted, high-speed removal enables companies to boost not only quality but also productivity – at least in the case of parts which have long drop times or become electrostatically charged. Additionally, "Sigma Inside" offers processors considerable added value for internal process optimization in the form of predictable mold repairs and scrap minimization. ■

THE AUTHOR

DIPL.-ING. KLAUS WANNER, born in 1965, is head of Sales and Marketing at Hekuma GmbH, Eching, Germany; sales@hekuma.com