Weld line with air trap at the end of the flow path (figs: KB Hein)

Standard Elements. Reconsidering mold ventilation, gate design, and temperature regulation will lead to a production without unnecessary maintenance or cleaning breaks and thus to considerable savings regarding production time and energy.

Let Off Some Air!

RUDOLF HEIN
VOLKER NONNENMANN

It is invisible but it nonetheless frequently impedes a process-safe production: Air. Therefore, the injection molder's task is to oust the air from the cavity at least as quickly as the hot plastic melt is injected. Otherwise, there is a risk of air traps, burn marks and deposits that often accumulate close to thin walls. The reason for this phenomenon is that areas with thicker walls fill first, so that the air is trapped close to the thin connecting ribs **(Fig. 1)**.

In addition to the energy-saving mold concept IsoForm [1], Konstruktionsbüro Hein GmbH, Neustadt a. Rbge., Germany, has developed a series of standard elements under the label "HeiNo" – which includes the name of the distributor Nonnenmann GmbH. Once adapted to the materials to be processed as well as to the desired temperature regulation these standard elements render an energy-efficient and process-safe production possible. The product quality that may thus be reached is characteristic of an approach including an early injection molding simulation that already takes into account the projected temperature regulation of the mold using a preliminary mold concept. The result of the simulation will thus be more accurate.

No Process Safety without Qualified Ventilation

When the cavity is filled the plastic melt needs to oust the air from within the cavity. If the air cannot be eliminated fast enough, the plastic's by-products combine with air at the flow front of the mass to be molded and will then be compressed due to the filling pressure. This may lead to a spontaneous ignition (Diesel effect) which can again result in defects and/or burn marks on the molding. Frequently, a deposit is formed on the mold that will also impede a process-safe production without additional cleaning cycles – at worst the mold will be permanently damaged, for example, if the processing of high-temperature materials such as PPA and PPS is involved.

For the past couple of years, new additives in plastic materials, e. g. flame retardants, have called for an appropriate ventilation of injection molds. Up to now, ventilation was mostly limited to ventilation flutes at the end of the flow path. However, this should be avoided today as it reduces the lifetime of the mold and increases the formation of burrs. When high-temperature materials such as PPA and PPS are processed aggressive by-products may deposit in the flutes close to the cavity, thus even destroying the mold structure. The geometries for ventilation presented here feature a comprehensive ventilation of the mold inside of as well as around the cavity and may be implemented easily and at low costs. Evacuating the cavity is also a good solution that can be implemented with little investment with IsoForm molds.

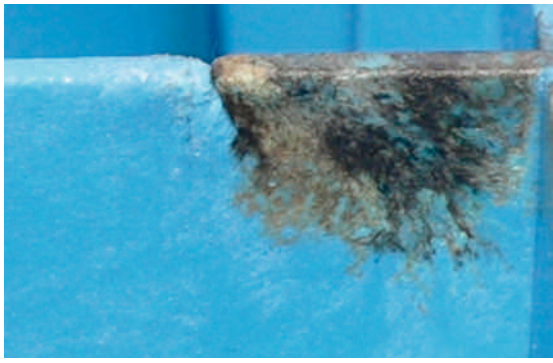

Fig. 1. Entrapped air with burn mark: The reliable ventilation of injection molds prevents defects of the molding as well as damages to and staining of the mold contour area

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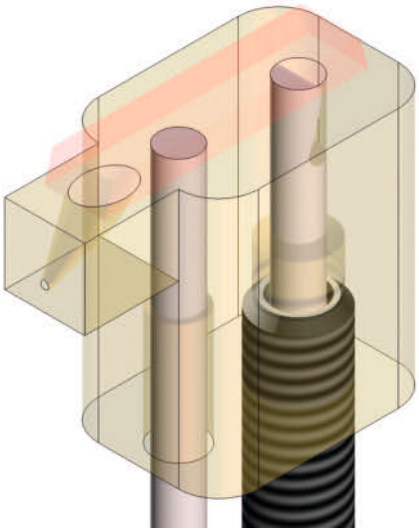

Fig. 2. The overflow ventilation insert mainly serves to improve weld line quality, to reduce the visibility of weld lines and to avoid air traps

Ventilation of Ejectors and Ventilation Insert

By assigning an additional function to the ejectors located in a mold, the cavity can be ventilated using a special groove geometry for round, bush, flat or profiled ejectors. The definition of the groove geometry is subject to the material of the molding and may be polished, compressed or coated, if required. With these standard elements, the air is then discharged using a chamfer. The HeiNo program provides standard elements for different ejector lengths. If the design engineer makes the most of all opportunities for a ventilation using every ejector, insert and separation already in the mold design phase, the effort will be negligible and the result so effective that most ventilation problems will be history.

It makes sense to determine the position of a ventilation insert on the basis of an injection molding simulation. The selected type of insert inside and outside of the cavity (e.g. within the mold separation) allows for a comprehensive ventilation provided that it is adapted to the plastic material of the molding, the geometry is designed accordingly and that the material property, the surface properties and a possible coating are well-chosen. The overflow ventilation insert **(Fig. 2)** was mainly designed in order to improve the quality of weld lines, to conceal the visibility of the weld line (e.g. with metallic effects) and allows for a controlled ventilation of side walls. This geometry is demolded like a tunnel gate.

If areas with thin walls cause air pockets in cavities it is possible to introduce ventilation inserts that are able to be adapted to almost any contour **(Fig. 3)**. Ventilation grooves will then be designed following the contour which can easily be done with state-of-the-art 3-D software. The HeiNo range of elements offers circular bush inserts as well as rectangular inserts that can easily be disassembled to be cleaned.

The solutions adapted to the actual application (and to the material used) reduce deposits in the entire mold to a minimum – thus increasing maintenance intervals. Again, the interesting solution lies in details: special combinations of materials, polished or structured surfaces, coating and compression. For larger ventilation inserts additional systems for temperature regulation are offered that further reduce the risk of clogging with certain materials for the molding.

Effective Redirection Inserts for Temperature Regulation and Tunnel Gate Inserts

Who does not strive for a high part quality? For parts with low distortion, without weld lines and an exact surface? If the shortest possible cycle times and a high process safety shall be obtained the temperature regulation of the mold should already be considered before ejection is discussed. Temperature regulation bores for liquids should always be round and connected for forced circulation. As a temperature regulation using water is particularly effective when it is turbulent the relation of the diameter to the length of the flow path of the medium has to be paid careful attention to.

It is recommendable to particularly mind nickel-coating for temperature regulation bores as well as the choice of the correct medium (e.g. specially spiked water) and of an appropriate temperature regulation system (with heat exchanger).

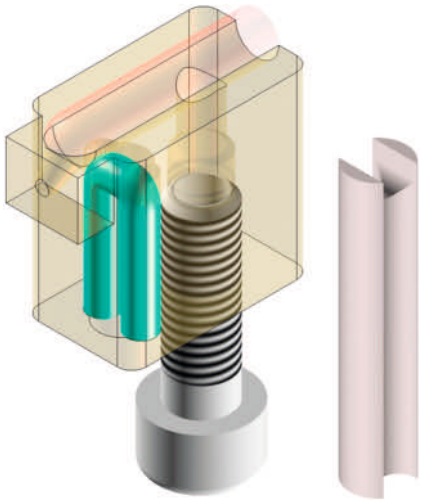

Fig. 4. The tunnel gate including a redirection insert for temperature regulation renders the design of an optimum cold runner system possible

Sheets for redirection, sputterers or cracks within the diameter – from the fitting of temperature regulation to redirection elements – should be avoided as they conflict with the claim for round diameters.

The knack is to select the appropriate, and at the same time most cost-efficient, technology for each temperature regulation task. Today, it is no problem to regulate the temperature of mold contour needles having a diameter of 1 mm at a length of 60 mm using a coolant. Likewise, temperature regulation within mold inserts having a distance of max. 0.5 mm to the contour surface can be implemented if cycle-dependent temperature regulation is also asked for with thin-walled parts.

Especially for materials highly reinforced with fibers and for high temperature plastics special steels and special surface treatment are used. The HeiNo gate insert for temperature regulation is characterized by a maximum effect of holding pressure, smooth redirection of glass →

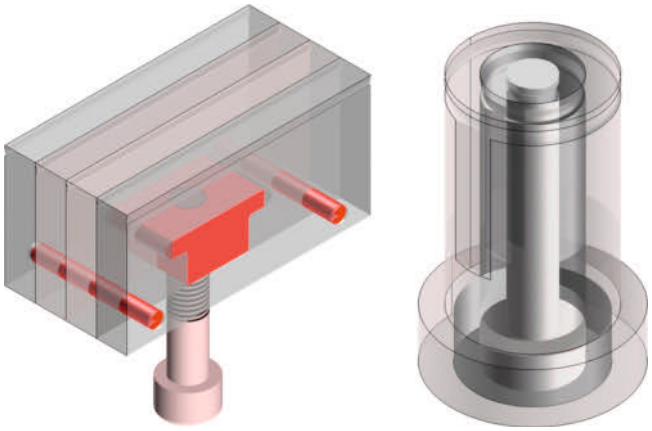

Fig. 3. Circular bush inserts and rectangular ventilation inserts: Ventilation grooves are designed following the contour using 3-D software

fibers, low shear force, short cooling time for thick cold runner geometries and, on the other hand, long holding times for smaller diameters as the temperature may be adapted to the task. This, again, reduces cycle times and energy demand while increasing part quality.

The Cold Runner: Often Neglected and Badly Designed

Compared to state-of-the-art hot runners that mostly are on a high level technologically, the cold runner is still being strongly neglected and is often designed incorrectly. Frequently, this leads to an increased energy demand (pressure), damage to the material (due to increased shear) and a variety of undesired marks (matt halo, streaks) on the part. For most thermoplastics, feeding needs to ensure that the mass is injected into the cavity by means of a cold manifold at the lowest possible pressure and with the lowest possible shear while allowing for an optimum holding pressure. From elastomers to rubber materials a controlled shear is usually necessary during feeding. HeiNo cold manifold inserts without central ejector, with dead runners for housing the cold slug and, on demand, with centered temperature regulation prevent that air and plastic mass mix already in the cold manifold.

The protected geometry for tunnel gates is available as an electrode version for eroding or as a complete insert from Nonnenmann GmbH. The HeiNo tunnel gate allows for permanent and low-shear injection of parts even with flow speed reduction for decreasing halo formation. Beside a variety of other methods for fastening, the space-saving fastening by means of pierced screws for the gate ejector should be mentioned here **(Fig. 4)**.

Curved tunnel connections are also a reasonable alternative for some applications. However, it needs to be pointed out that the percentage of fibers that can be used in polymers is limited then. A matrix combined with parameters from the customer's experience helps to determine the tunnel geometry in accordance with the plastic material and the wall thickness of the molding.

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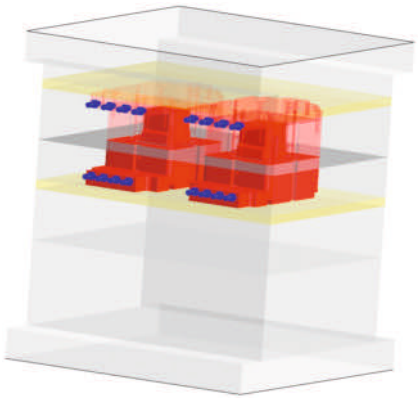

Fig. 5. With the IsoForm concept the process may be initiated a lot more quickly and precision as well as process safety are increased due to isolated mold inserts while energy requirements for temperature regulation are considerably reduced

Preventive Investment Improves Process Safety

The end-customer is looking for a low-cost injection molded part that is both technically and visually perfect and that ensures a precisely repeatable process with reasonable temperature regulation, ventilation and gate design over a long period of time – provided that the injection molding machine does not fail. A holistic monitoring of current procedures is urgently needed in order to be able to include or to enforce an injection molding simulation and a first mold concept already for the product development budget.

It is recommended to start immediately to record all costs incurring with regard to a manufactured part. If only a fraction of the enormous follow-up costs for inefficient procedures, maintenance and repair is invested in preventive measures during product development the profit margin will increase year after year – as opposed to those who decide not to take this course.

Conclusion

Together with HeiNo standard elements, the IsoForm mold concept with isolated mold inserts **(Fig. 5)** forms the basis for a holistic approach offering considerable advantages for efficiency regarding costs, cycle time, molding quality, maintenance intervals and energy requirements. The protected concept may be configured using an Internet tool with subsequent download function in order that geometries (incl. their history) rebuild themselves in the user's CAD system where they can comfortably be processed. ■

REFERENCES

1 Hein, R.: Energieeffizientes Werkzeugkonzept. Kunststoffe 100 (2010) 2, pp. 28–32

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