Presseinformation
Press release

Hot-Runner Systems for High Injection Speeds

When Speed Counts

When delicate parts with thin walls and long flow parts are required, quick injections are essential for reliable production processes. Rapid injection processes are often indispensable for large-volume parts too however. An adapted hot-runner technology allows perfect processes and products here.

Even in conventional injection moulding processes high injection speeds are often necessary but there are two variants that set particularly high standards: expansion injection moulding and physical foaming.

In expansion injection moulding the melt is compressed in the screw antechamber or in the hot-runner and used as a pressure storage medium. As shown in the PVT diagram, the plastic melt can be compressed approximately 10 % at a pressure of about 2000 bar. This behaviour is used during expansion injection moulding. It is necessary for a reproducible process however that the pre-compressed melt volume be kept constant. For that purpose the screw must be held in an exact position after compression because it would otherwise be subjected to high pressure at the opening of the valve gate nozzle and an excessive amount of melt would enter the mould. This pre-condition is satisfied by electromechanically driven injection moulding machines, permitting an optional axial positioning within the system's confines and the maintenance of this position even under high pressure.

If a hot-runner system is used in expansion injection moulding, a pressure of up to 2500 bar is built up and maintained for a defined time. This ensures an even pressure in all cavities.

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For the successful use of expansion injection moulding, an absolutely even opening of the needles is essential. Once the needles open, the melt that is precompressed in the hot-runner can expand like an explosion and fill the cavities evenly, allowing very thin-walled components to be filled.

In physical foaming, for example with the MuCell process, the system is fed a physical blowing agent, which first dissolved in the melt under pressure. On injection into the cavity, the pressure reduces, the blowing agent expands and the melt foams. Here too it is necessary to be able to inject the melt at high speeds into the cavity in order to be able to foam the part selectively in the cavity. A light-weight component with a closed outer skin and foamed core emerges. This process can produce foam structures with walls thinner than one millimetre. The internal pressure that arises as a result of the foaming process acts on all points of the component, whereby to a certain degree it takes over the task of the holding pressure and in this way can balance out or at least reduce sink marks, shrinkage and warpage.

For both processes the injection moulding machines must be adapted to the altered requirements. In expansion injection moulding an electric injection moulding machine is necessary for a precise dosage and injection. The MuCell process requires a special screw and special units in order to be able to inject the blowing agent in the super-critical state into the melt. Both processes – with just a few exceptions – can be conducted with all common polymers. LCP cannot be processed with the MuCell method but it is very suitable for expansion injection moulding.

Valve gate systems essential

In both processes valve gate hot-runner systems must be used in order to build up and maintain the required pressure in the hot-runner system. In expansion injection moulding the hot-runner system not only has to withstand very high levels of pressure, it must also be ensured that all needles in a multi-cavity mould open exactly and simultaneously. This even needle movement enables a lifting plate, which works in accordance with the principle of the sliding plate mechanism. Here the hydraulic piston's axial movement is guided through connecting links into the plate's lifting movement and accordingly causes the needles to move. (Picture 1)

In an X-Melt trial conducted in cooperation with the injection moulding machine manufacturer Engel, GÜNTHER Heißkanaltechnik GmbH in Frankenberg, subjected a two-cavity mould to a pressure of 2800 bar for half a second and checked the system for leaks. The injection trials were conducted with a test strip made of various materials with a wall thickness of 0.5 mm. The time for shooting the melt into the cavity varied from material to material and was 0.1 s for polystyrene, for example, and 0.04 s for LCP. The following are the results of the trial: the hot-runner system remained completely leak-tight at 2800 bar. No melt came out of the valve gate nozzles. Both cavities were filled simultaneously. A very high level of reproducibility could be attained.

An example of an application for expansion injection moulding is the friction disk (Picture 2). As trials have shown, reliable processes are possible only with expansion injection moulding. In this application a plastic part is injected onto a metal strip serving as a substrate. The disk is made of LCP, weighs 0.02 g and has a wall thickness of 0.15 mm. The challenge in this project was to inject the very small quantity of material with process reliability. As the weight of the shot is so low, only valve gate systems can be used. A hot-runner nozzle specially designed for LCP processing was selected. The nozzle's material tube diameter was made narrower to reduce the viscosity of the LCP as a result of the higher shear (Picture 3).

Reduced weights and costs

An important factor in physical foaming is that instead of expanding in the hot runner, the melt does not expand until it is the cavity. For that reason the hot-runner nozzles must maintain the pressure in the system after the injection of the melt and the subsequent closing until the blowing agent stays dissolved in the melt. This could be confirmed in trials.

An example of an application is a car door lock housing with a wall thickness of 1.1 mm made of POM, which is produced with MuCell technology (Picture 4). The customer's aims were to cut costs by using less material and to shorten cycle time and reduce warpage and sink marks. The gas in the melt lowered the melt viscosity, which allowed a quicker injection. The microcellular foam allowed homogeneous shrinkage behaviour, which made it possible to avoid sink marks in thicker walls. The hot-runner nozzle used was a type 8NLT80 nozzle from the supplier. The needles were actuated by hydraulically activated single needle valves (Picture 5). When physical foaming is used, the needles are moved by means of single needle valves depending on the number of the cavities. MuCell technology made it possible to reduce the weight of the door lock housing by 10%.

Homogeneous temperature control is important

The valve gate hot-runner nozzle with shaft (N_T nozzle) from GÜNTHER Hot-Runner Technology is very suitable both for expansion injection moulding and also for physical foaming. The advantages of this nozzle are the exact temperature control. In particular in the case of technical polymers, which are semi-crystalline plastics with a narrow processing window, it is essential to have homogeneous temperature control over the entire length of the nozzle. For the purpose of attaining a homogeneous temperature profile, the nozzles have a two-part shaft for insulation and the front area is made of a titanium alloy.

In general it is important in all valve gate systems that the needle be centred exactly when closing and that it dip into the injection gate without the sealing area of the needle coming into contact with the needle guide. This counteracts wear on the system. The needle guide in the GÜNTHER hot-runner technology systems is made of powder metallurgical steel, which has a very high degree of hardness and strength. If an individual component is worn, it can be replaced on its own. As the needle guide dips down as far as the edge of the product, only the guide has to be changed in the case of wear. It is not necessary to work on the mould insert.

Expansion injection moulding and physical foaming offer new prospects for plastic processing operations in terms of saving costs and optimising products and processes. Adapted hot-runner systems are indispensable however to process materials reliably. The GÜNTHER hot-runner technology range includes valve gate systems specially designed for this area of applications and they have proved effective in practice many times.

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Photo 1. A slide lock, pneumatically or hydraulically actuated by means of an external cylinder, allows the simultaneous actuation of all needles. (Photo: GÜNTHER Hot-Runner Technology)

Photo 2. The LCP friction disk weighing 0.02 g can be produced with process reliability only with the expansion injection moulding method. (Photo: Schiebl)

Photo 3. For the expansion injection moulding of the friction disk an eight-cavity hot-runner system with flat nozzles of the type 4NFT60LA is used. (Photo: GÜNTHER Hot-Runner Technology)

Photo 4. This car door lock housing made of POM is produced with MuCell technology. (Photo: ITW)

Photo 5. To produce the car door lock housing, a four-cavity hot-runner system is equipped with type 8NLT80 nozzles. (Photo: GÜNTHER hot-runner Technology)

GÜNTHER Hot-Runner Technology

GÜNTHER Heißkanaltechnik GmbH, Frankenberg (Eder) has about 190 employees and 33 agencies in Germany and abroad. This hot-runner system supplier provides systems and components in almost all areas of the plastics industry. The company's strategy is oriented towards working out customer-specific solutions with a high level of productivity and quality. The standards from Frankenberg are so well-engineered that in the end they serve as the technological basis for all customised solutions. In other words: a lot of requirements set by customers can be satisfied already with GÜNTHER standard products.