Technical guide

Envalior
Imagine the Future

Hot runner recommendations for molding high heat performance engineering materials

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This guideline is applicable for all Engineering Materials within the Envalior Engineering Materials product portfolio. The high heat performance materials Stanyl®, ForTii®, Xytron™ and thermal conductive materials do need extra attention to use them in combination with a hot runner. This due to their thermal processing properties.

This flyer is showing hot runner principles and helps you to find the right type of hot runner lay out, to overcome technical disadvantages using a hot runner and to profit as maximal as possible from the use of the hot runner.

1. When to use a hot runner

A hot runner is in fact an extended nozzle of the barrel of an injection molding machine. Almost all DEM polymers are applicable to use in combination with a hot runner but due to the high processing temperatures and a narrow processing window, the use of a hot runner system is not always easy. This because of their faster crystallization speed, more narrow processing window and rather sensitivity towards material degradation. In case of thermal conductive materials, an even more complex process is to be expected as the processing window is even smaller. For these reasons, it is very important to choose the best lay out for the hot runner system and only use it when it is economically and technical feasible.

Main reasons for the use of a hot runner can beMain be:

- No de-gating (no after treatment)
- More design freedom (gating positions, multi cavity)
- Reduction of material waste (no cold runners)

Disadvantages for the use of a hot runner in combination with high heat performance materials can be:

- Heat loss at gate (gate freeze, surface defects)
- Less easy start up (high melting temperature of the melt)
- Material degradation (not optimal hot runner design, additional melt residence time,discoloration)
- Narrowing of the processing window (more shear and additional melt residence time)
- Higher tooling (cost and) maintenance cost in terms of maintenance time and hot runnersystem ware & tear replacement
- Larger tool size
- Pressure loss before the cavity

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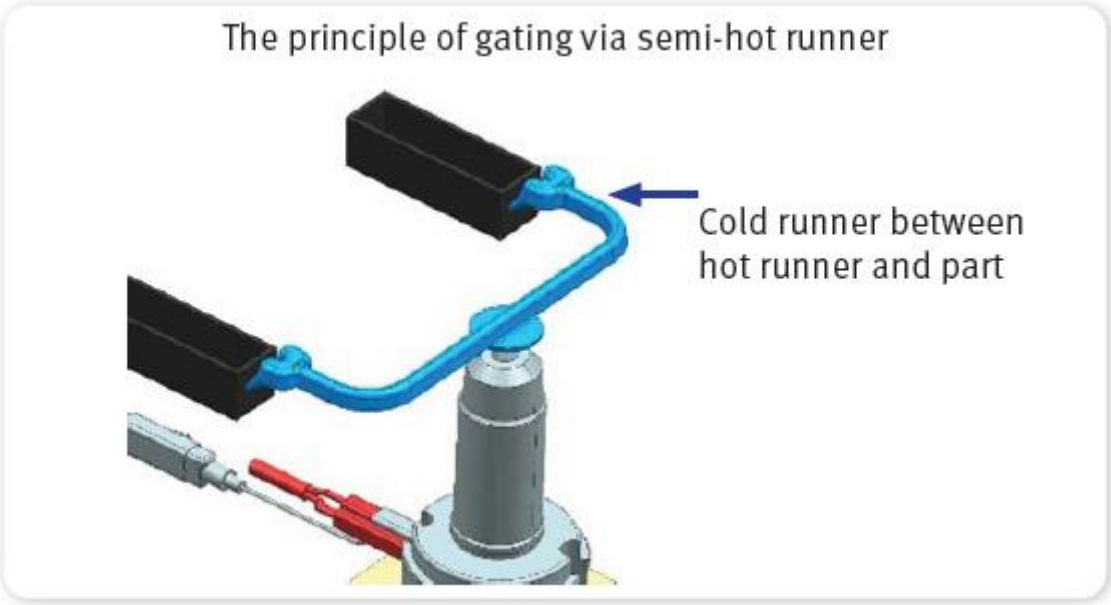
2. Important points of attention using a hot runner in combination with highheat polymers

There are several items that are very important for a well-designed hot runner for processing high heat polymers:
2.1 Preferable use a semi hot runner
2.2 Take care of overall good temperature control. Hence, it is advisable to engage a reliable brand or hot runner supplier. A wrong design or selection could be irreversible, and the outcome may be very costly
2.3 Fitting dimensions of the channels manifold as nozzles towards hot runner volume, shear and pressure loss
2.4 Mold lay out
2.5 Type of polymer to be molded (composition and crystallization speed).

2.1 Preferable use a semi hot runner
Parts can be gated directly by the hot runner to the part. This is normal when using a cascade gating system.
Advantage by direct gating is:
• No scrap/loss of material.

Disadvantages by direct gating are:
• Balancing issues due to temperature differences in the hot runner nozzle tips
• Surface defects in the molded parts due to gate freeze/frozen slug
• For direct gating with shut-off valve pin design, there will be a confuse on gate seal time and pre-seal time. Comparing to cold runner system, there is actually no more gate seal time. The packing time (or time to activate shut-off pin) will depends on the resin crystallization speed
• Difficulty in start up and balance of drops. The lower the number of drops the lower the system cost and better part to part repeatability.



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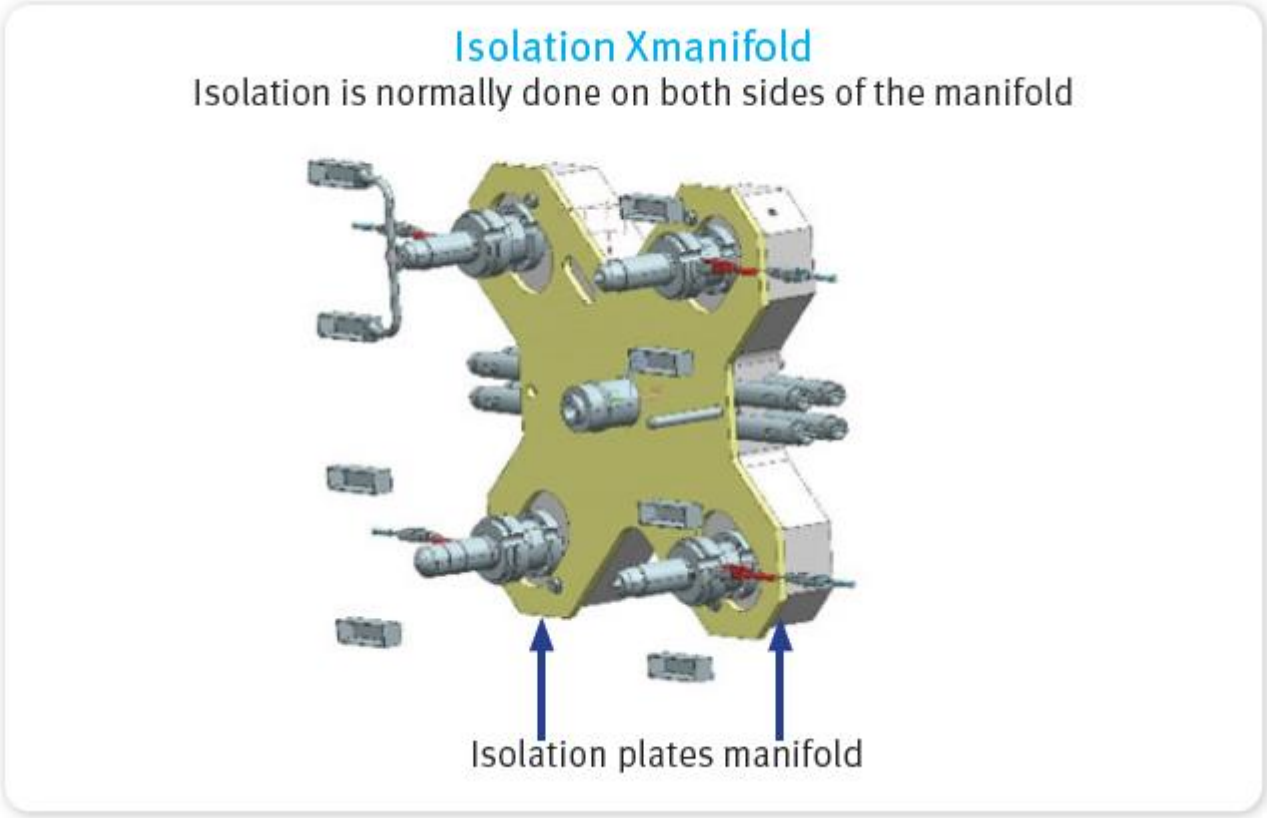
2.2 Take care of overall good temperature control

An adequate temperature control through the complete hot runner system is of most importance. This can be achieved by:

- Optimum temperature control starting from central bore, the manifold to the nozzle tip. The correct thermocouple position to achieve a correct heat input in the nozzle, the thermocouple should be located as close as possible to the tip of the nozzle.
- A well-defined split hot runner nozzle contact area to the colder tool to prevent heat exchange. In short, minimum contact between the hot-tip bushing and the cavity block.
- As there will be heat losses to the tooling (cavity block), it is advisable to select a highly thermal conductive type of g ate bushing in order to get rapid heat fed from the nozzle heater.
- A minimum distance of 25mm for cooling channels.
- The heating capacity of the heater bands should have a sufficient heating capacity and react correctly according to the signals of the thermocouple.
- A melt intake via the central hot runner should also be also heated via separate heating zone.
- The manifold should be kept in a close frame and isolation plates to prevent heat loss.
- The temperature control unit should match the hot runner system itself.



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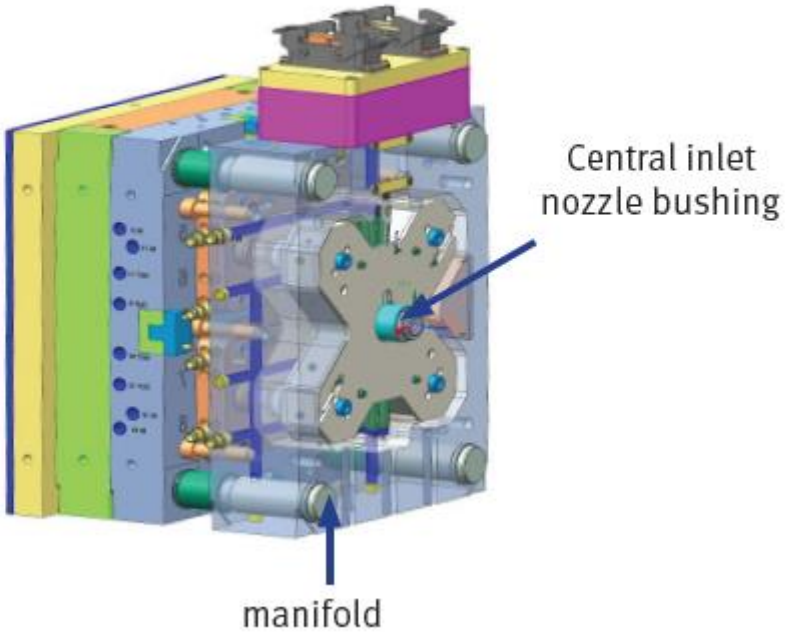
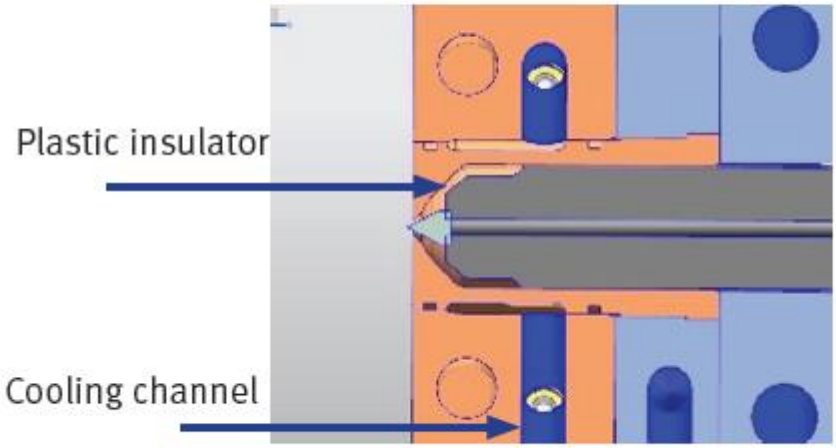
Melt intake via the central hot runner

The melt intake zone should also be heated via separate heating zone



Split hot runner nozzle/mold & cooling channel near nozzle tip

All to create best temperature control near the nozzle tip area



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2.3 Fitting dimensions of the channels manifold as nozzles towards hot runner volume
The dimensions of manifold channels are very important to minimize the melt residence time of the material in the melt phase. When the hot runner volume is too large the melt residence time of the material is too long and severe degradation is possible.
On the other hand, too small dimensions the hot runner channels shear, pressure losses as temperature generation of the material becomes too high which also causes severe degradation. Moldflow study will support to define best applicable lay out.

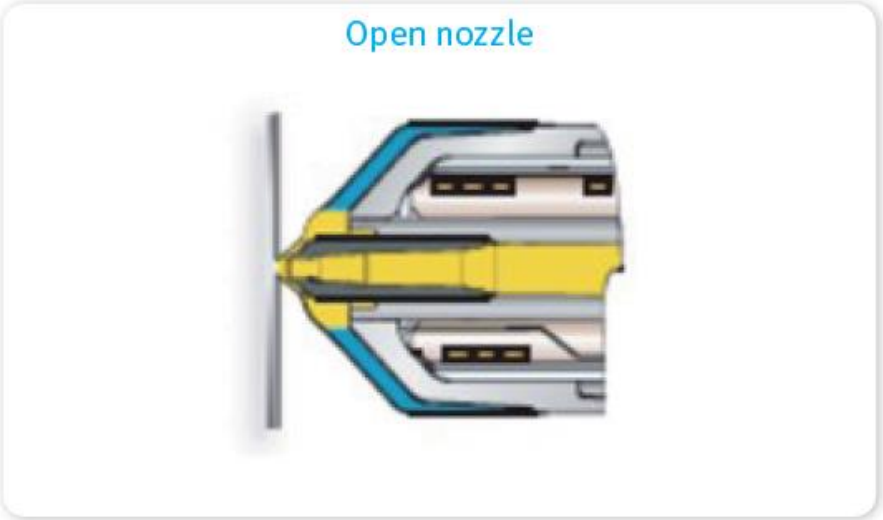
2.4 Mold lay out
A solid construction of the mold base is essential to support the hot runner. Nevertheless contact/ support points between the hot runner and the mold base should guarantee a minimum heat exchange. To do so support are usually made of titanium rings or blocks Furthermore, the hot runner is built in the mold base at a certain pre-load. This is to prevent leakage or damage to the complete system. The manifold should be kept in a close frame and isolation plates to prevent heat loss.

2.5 Type of polymer to be molded
All Envalior polymers are applicable to use in combination with a hot runner. The best combination hardware-polymer is set by means of a matching hot runner configuration to the polymer grade. For example, abrasive reinforcements (wear resistance steel), corrosive flame retardant additives (anti-corrosion steel), thermal properties as melting point and crystallization speed (related to gate freeze) & crystallization point should be taken into account in the hot runner selection.

3. Type of hot runner nozzle tip

Envalior has evaluated different types of hot runners for use in combination with high heat performance materials. Nowadays systems are always external heated systems. The nozzle tip lay out is simplified divided them in three main systems:

3.1 Open Nozzle
The melt is able to free flow through the system. As a result, minimum pressure loss is seen but the melt shut off or wire pulling is not guaranteed. Envalior does not recommend this style for semi-crystalline materials like Stanyl® and ForTii® due to gate freeze the material's fast crystallization.
Also for appearance surface requirement parts, it is not recommended as there will be surface imperfection marks due to frozen slug.



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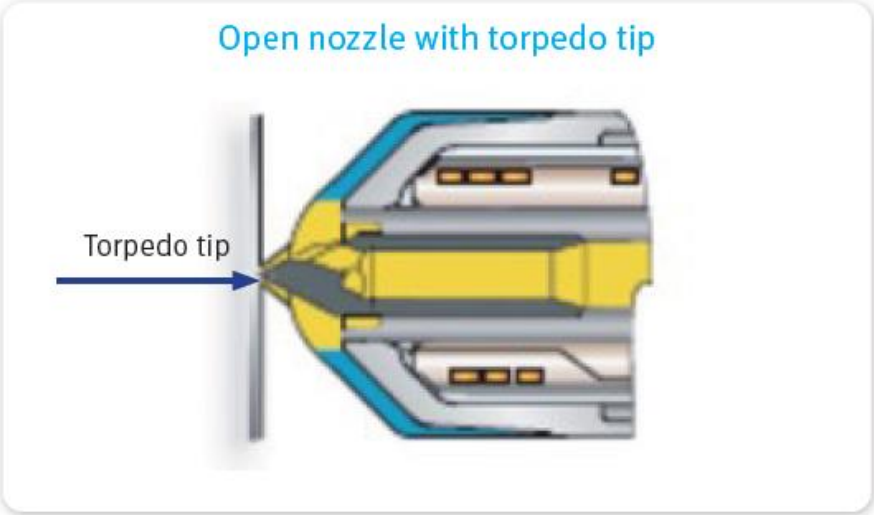
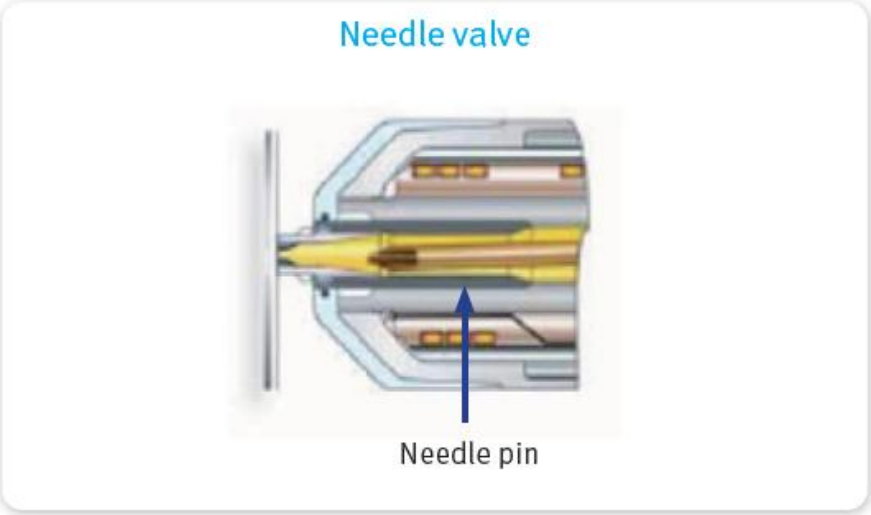
3.2 Open nozzle with torpedo tip

The melt is passing the torpedo before entering the part or semi-hot runner. The torpedo will prevent the early freeze off the nozzle since the torpedo is maximizing the heat to the front.
Even high conductive metals are used to better the heat transfer to the tip area. A well defined mark will be seen at the molded part working with torpedo tip. This system is very often seen processing high heat performance materials but also now the narrow flow path in the tip area can narrow down the ease of processing due to cold slug creation.



3.3 Needle valve

A defined opening and closing of the nozzle tip by external factors (hydraulic/pneumatic valve) are secured. This system is often used as cascade system. Nozzle with needle valve could cause problems closing the valve. This due to the fast crystallization speed of high heat polymers. A small amount of frozen material may than be pushed into the part showing mechanical cracks near the gating point. Furthermore, a so called “needle shadow” may show up in the molded parts. This is caused as a result of melt flow around the needle.



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4.Trouble shooting, frequently seen problems

Often seen problems using a hot runner system in combination with DEM are directly related to a non-optimum combination of the hot runner lay out and the polymer to be processed
-Less optimum temperature control
-Too large melt volume in the system
-Too high shear in the system
-Hot runner not designed for the polymer
-Gate freeze
-Cooling too close and set too low

As a result the molded parts can show discolorations, lower mechanicals, surface defects, not able to fill them.

Furthermore, starting up problems like contaminations in the parts, blocking of the system or even wear and corrosion are frequently seen. These problems pop up when the hardware metal choice is not optimum or cleaning of the hot runner system after production is not done. See chapter hot runner safety for more information.

5.Safety first when using hot runners

Material degradation in the hot runner system leading to unsafe situations is one of the most seen topics. The root cause often is the too long melt residence time in the system.
As a result, discoloration of the polymer or in worst case total material degradation, blocking the hot runner system and potential material burst out. This can and should be prevented by working according safety procedures as following:

- Take into account the polymer grade injection molding recommendations for best and safe processing.
- During short stops, the hot runner system should be released from the tool to lower the risk of pressure build up in the system.
- During unexpected longer production stops, the complete hot runner system should be purged, cleaned and lowered in temperature.
- Wear personal safety protections for hand/eye/body during startup/serial production/stop of the process.

Safety Stanyl® , ForTii®, flame retardant grades
When processing Stanyl® or ForTii® the hot runner system should always be cleaned and stored using a cleaning agent or PA6(6)-GF natural color. This to guaranty an easier process start up during next serial production.

When processing polymer grades flame retardant the hot runner system also should be cleaned and stored using applicable cleaning agent or polymer having same melting characteristics as serial production material. This to prevent corrosion in the system.
Envalior does not support using torches to start up a hot runner system. Severe burns can happen without notice. Due to build up gases in the manifold.