Hot runner recommendations for Stanyl®, Stanyl® ForTii™and Thermally Conductive Materials

In the text below were Stanyl is mentioned, also Stanyl ForTii and Thermally Conductive Materials can be read.
It is possible by means of the selection of the right type of hot runner to process Stanyl correctly. This has been proven in the market for Stanyl and Stanyl ForTii. This flyer helps you to find the right type of hot runner to overcome the mentioned disadvantages and to profit as maximal as possible from the use of the hot runner.

1. Hot runners, why?

A hot runner is in fact an extended nozzle of an injection moulding machine, built into the tool.

There are five main reasons for the use of a hot runner:

- No degating, no after treatment.
- Design freedom; gate position.
- Reduction of material waste
- Reduction of cycle time.
- Less pressure drop

For a high-temperature resistant plastic as Stanyl® the use of a hot runner system is not always easy because this material crystallizes very fast and is rather sensitive to degradation. In case of Thermally Conductive Materials an even more complex process is to be expected as the processing window is even smaller

Disadvantages of the use of a hot runner in combination with high performance polymers like Stanyl® are:

- Heat loss at gate can cause gate freeze problems (see figure 1)
- No extra advantage in cycle time (only holds for not fast crystallizing materials)
- Less easy start up due to the high temperature of the melt
- Degraded material (in the hot runner) due to not optimal hot runner design or too long residence time.

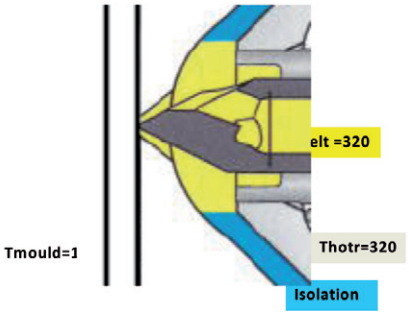

Figure 1: Heat loss at nozzle gate

In the high heat resistant thermoplastic market where expensive materials are used for small applications, hot runners are a favourable tool to reduce costs. But especially in the high heat materials severe problems can occur.

Due to the high melting temperatures of Stanyl® and Stanyl® ForTii™ and the relative low mould temperatures the ΔT becomes larger, which implies a higher chance of a premature freeze off of the tip. Apart from that Stanyl® is also a material with a high crystallisation speed, which means that the ΔT between melting point (295° or 325°C) and no flow temperature (270°C or 300°C) is very small whereas the ΔT between processing temperature (315° or 330°C) and mould temperature (80° or 120°C) is very large.
This is one of the main reasons why the use of a hot runner in combination with Stanyl® or Stanyl® ForTii™ can be more difficult than for instance with PA66.

For these reasons it is very important to use a hot runner only when it is economically and technically feasible.

2. Which type of hot runner?

DSM has evaluated different types of hot runners for use in combination with Stanyl®. Simplified there are three main systems:

1. Externally heated, open nozzle
2. Externally heated with tip
3. Externally heated with needle valve

2.1 Externally heated, open nozzles

The externally heated nozzle is shown in figure 2.
The low ΔT between hot runner and melt in the case of an externally heated system explains the suitability of these systems for the processing of Stanyl®.

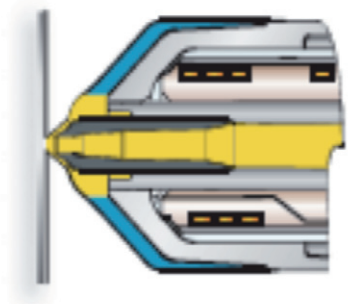

Figure 2: Externally heated nozzle
Foto Günther Heisskanaltechnik

2.2 Externally heated system with a tip

The externally heated nozzle with tip is shown in figure 3.

The tip or in other cases the torpedo will prevent the early freeze off of the nozzle. Tip should be through the hole to get maximal heat to the front.

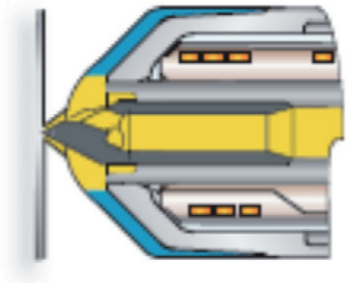

Figure 3: Externally heated nozzle with tip
Foto Günther Heisskanaltechnik

2.3 Externally heated system with a needle valve

The externally heated nozzle with needle valve is shown in figure 4.
Advantage of this system is a defined opening and closing of the nozzle by external factor (hydraulic/pneumatic valve) Closing of the stem could cause problems as Stanyl® will crystallise very fast and short holding times should be in place.

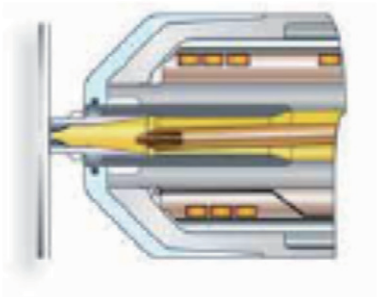

Figure 4: Externally heated nozzle with needle valve
Foto Günther Heisskanaltechnik

3. Recommendations for the externally heated nozzle.

Stanyl® or Stanyl® ForTii™

- Always use a nozzle with tip or torpedo. This will bring more temperature to the front and therefore broaden the processing window

Thermally Conductive Materials

- Try to use a needle valve system, as thermally conductive materials tend to freeze off easier. Keep in mind that short holding times should be applied.
- Use a molded PEEK cup as thermal insulation
- If for Thermal Conductive Material systems with a tip are used, be sure that the tip is moved even further through the tool where gate dimensions should be bigger as normal. This to prevent a too small nozzle opening and excessive shear.
- Consider to use higher conductive steel for the tip

There are several items that are very important for a well-defined hot runner. These items are:

1. Use a semi hot runner
2. Temperature control and the position of the thermocouple
3. Dimensions of the nozzle and dimensions of the gate
4. Type of material to insulate the nozzle (e.g. PEEK ring to insulate)

A schematic view of a hot runner tip is shown in figure 5

3.1 Use a semi hot runner

Try not to gate directly on the part. This could cause balancing issues due to temperature differences.

3.2 Temperature control

The most important item of a hot runner is an adequate temperature control. This can be achieved by:

- 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
- The heating capacity of the heater bands, the heater bands should have a sufficient heating capacity (≈ 12-14 W/cm²) and react correctly according to the signals of the thermocouple
- Gate size and gate location. To avoid a premature freeze off of the nozzle tip, the gate diameter D should be as large as possible (a guide line is › 1.5 mm) and located in the thickest section of the article
- Mould temperature. The mould temperature is an important influence because the higher the mould temperature the lower the ΔT between mould and melt. A low ΔT means a low heat loss to the mould and therefore a higher possibility to control the tip temperature more adequate

3.3 Dimensions of the nozzle and dimensions of the gate

The dimensions of the nozzle in combination with the manifold are very important to minimise the residence time of the material in the melt phase. When the hot runner volume is too large the residence time of the material is too long and severe degradation is possible. This degradation can cause black streaks, burn marks and silver streaks (like wet material). If the dimensions of the hot runner channels are chosen too small, the shear of the material becomes too high which also causes severe degradation. The suppliers of hot runner systems know how to design their hot runner with minimal residence time.

3.4 Type of material

The type of insulation at the tip of the nozzle should be a good isolation material with an adequate insulation (e.g. PEEK ring) to avoid a premature freeze off and provide a well functioning hot runner

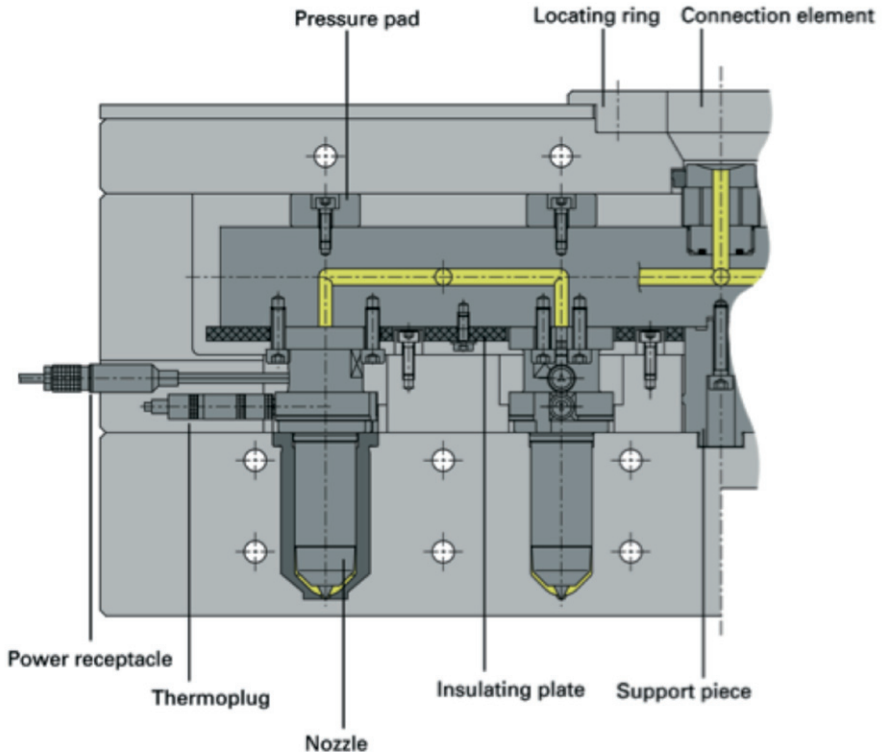

Figure 5: Schematic view hot runner
Foto Günther Heisskanaltechnik

4. General recommendations

Stanyl® has some regrind approvals at UL for some grades, which gives the possibility to regrind instead of using a hot runner.

As a conclusion we give the following recommendations:

- For Stanyl® use externally heated nozzle tips with an adequate temperature control.
- Use hot runners only if it is economically feasible.
- Use a mould temperature as high as possible for Stanyl®.
- The gate location should be in the thickest section.
- The gate should not be too small (D › 1.5 mm; $d_{hotrunner}$ › 8 mm).
- Use PA66 to start up a hot runner before processing Stanyl®.
- Stop and clean the hot runner with PA66 to have an easier start up.
- Moulding flame retardant Stanyl® grades, corrosion and wear resistant steels for hot runners should be applied.

Most hot runner suppliers are capable to deliver adequate hot runners, but if you are not sure please contact your local sales person. He can put you in contact with a technical person within DSM were we offer you to discuss all items about the use of a hot runner in combination with one of our materials.

5. Safety when processing hot runners

During short production stops the injection unit must be pulled back, the screw should be in the most forward position and when downtimes are relatively long, thorough purging through the hot runner is required. Hot runner temperatures should be decreased during longer production stops. Take care when the hot runner is blocked due to a frozen nozzle, tip, adapter or sprue bushing. If the melt is present for a longer period of time, it will lead to degradation. This may be followed by pressure build up in the barrel, nozzle and the hot runner system. Be aware that under these conditions a sudden outburst of molten material can take place. Always wear safety protection whenever working inside a mould opening, or when working on the nozzle!

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