

INNOKETONE® PK Mold Design Guidelines

1、Mold Material Selection

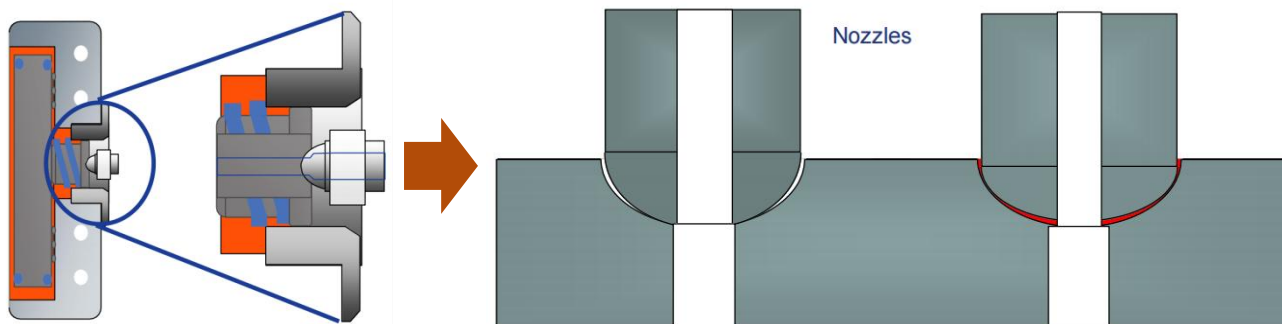
Under normal molding conditions, **PK does not corrode the mold**. For cold-runner molds, hard steels such as 1.2344, H13, and 8407 are generally used. For hot-runner molds and molds prone to gas entrapment and carbon deposits, corrosion-resistant steels such as S136 ESR, 1.2083 ESR, and 420 ESR are recommended.

2、Venting

The design of vent slots enables rapid filling while also improving the surface quality of molded parts.

Vent slots are primarily located at **the end of runners** or **in areas where gas is difficult to evacuate**. The recommended vent slot depth is 0.008–0.013 mm.

3、Nozzle Interface Position



- The nozzle orifice diameter must match the hot runner gate diameter.
- Traditional nozzle designs create significant flow resistance.

Gate radius - Nozzle radius $\leq 0.13\text{mm}$

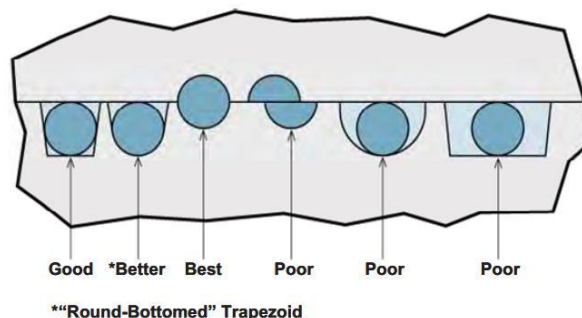
Gate orifice diameter - Nozzle orifice diameter $\leq 0.8\text{mm}$

- Prevent material accumulation
- Reduce pressure drop
- Minimize shear

4、Runner & Gate Design

The design of runner structure/dimensions can reference other engineering plastics, typically requiring **full-round or near-round flow channel** designs to reduce pressure drop and slow the material's cooling rate.

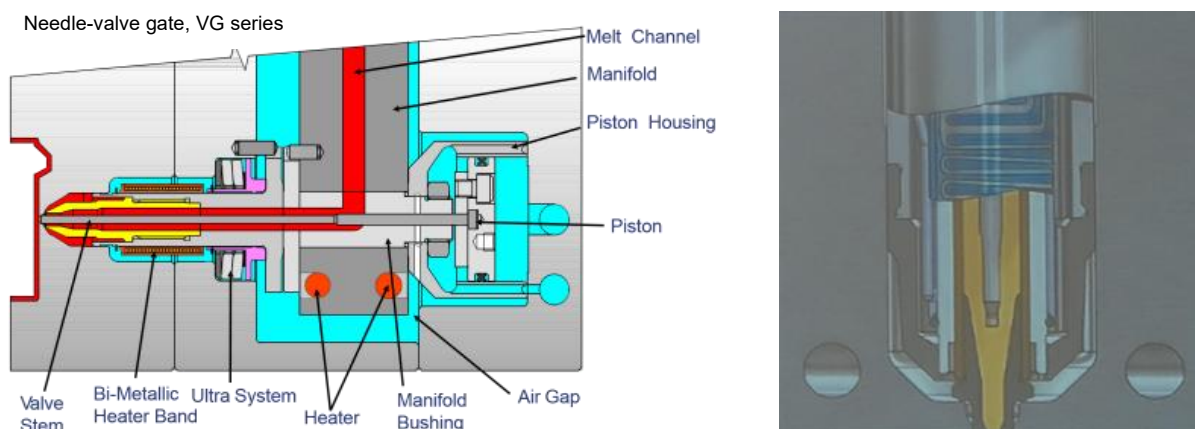
A cold slug well must be designed at the flow terminus, and its design approach may also reference other materials.



*"Round-Bottomed" Trapezoid

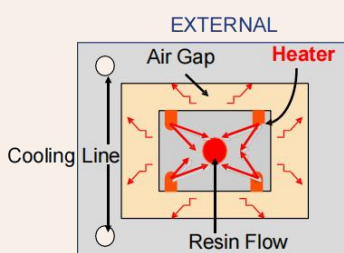
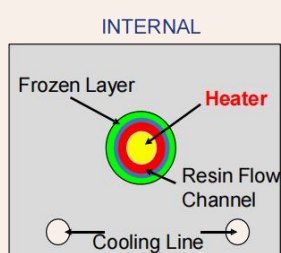
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INNOKETONE® PK can use conventional gate types, including sprue gates, pin gates, edge gates, and disk gates. However, considering the fast crystallization of PK, the gate size is generally 25–50% larger than that of POM of the same specification and 40–75% larger than that of PA66. **A cold-runner gating system should normally be used, and hot runners are not recommended.** If a hot-runner system must be used, select a needle-valve hot-runner system from a reputable leading brand** (see the illustration for the recommended gate type). The gate dimensions should be designed based on the same principles used for cold-runner gates.

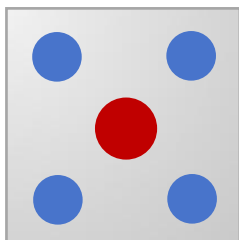


5、Basic Requirements for Hot-Runner Selection

Internal Heating Mode VS External Heating Mode

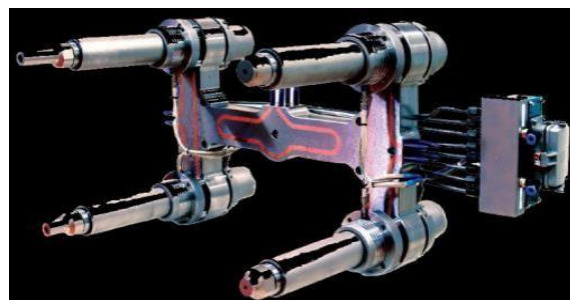
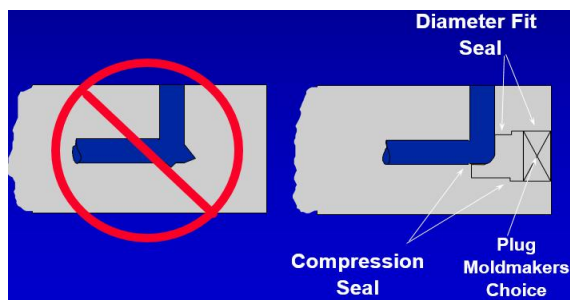


- Excellent thermal insulation
- Unrestricted melt flow
- Reduced melt residue

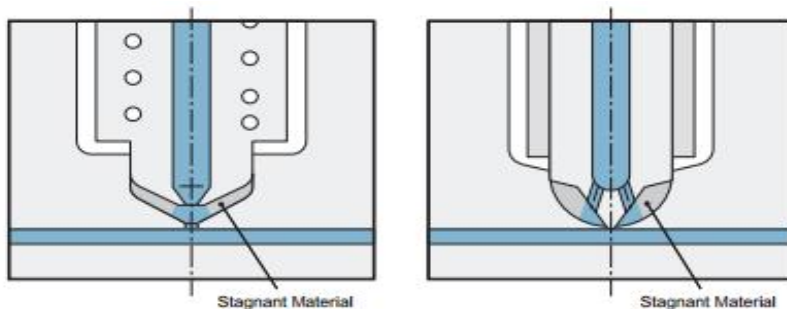


- The melt flow path should be equipped with four heaters for temperature control.
- The melt flow path diameter should be greater than 0.5 inch (12.7 mm).
- The melt flow path must be smooth and free of burrs, dead spots, or other areas where material may accumulate.
- The runner design must ensure balanced flow.
- Uniform and highly precise heating** is required, with temperature control accuracy of $\pm 2^{\circ}\text{C}$
- The gate should have an independent cooling system for temperature control.

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Resin buildup risk



Based on the product's appearance requirements and ease of processing, the hot-runner system used for processing INNOKETONE® PK must not have any areas where material can accumulate.

The minimum volume of molten plastic contained within the hot-runner system (manifold + hot nozzle + runner) should be as small as possible to shorten the residence time and reduce material degradation. Under normal production conditions, it is recommended to purge the system completely within three molding cycles.

6、Shrinkage:

The difference in shrinkage rates between the MD and TD for non-reinforced grades typically ranges from 10% to 15%, with nearly uniform behavior (shrinkage in the flow direction is slightly lower). Fine-tuning of molded part dimensions can be achieved by adjusting mold temperature.

When using a POM mold to produce PK parts, mold modification is generally unnecessary. However, for thick-walled products or applications requiring high dimensional precision, a dedicated mold for INNOKETONE® PK must be designed with the following shrinkage rates: 1.4% ~ 1.6% 2mm; 1.8% ~ 2.0% 3mm.

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7、Draft Angle

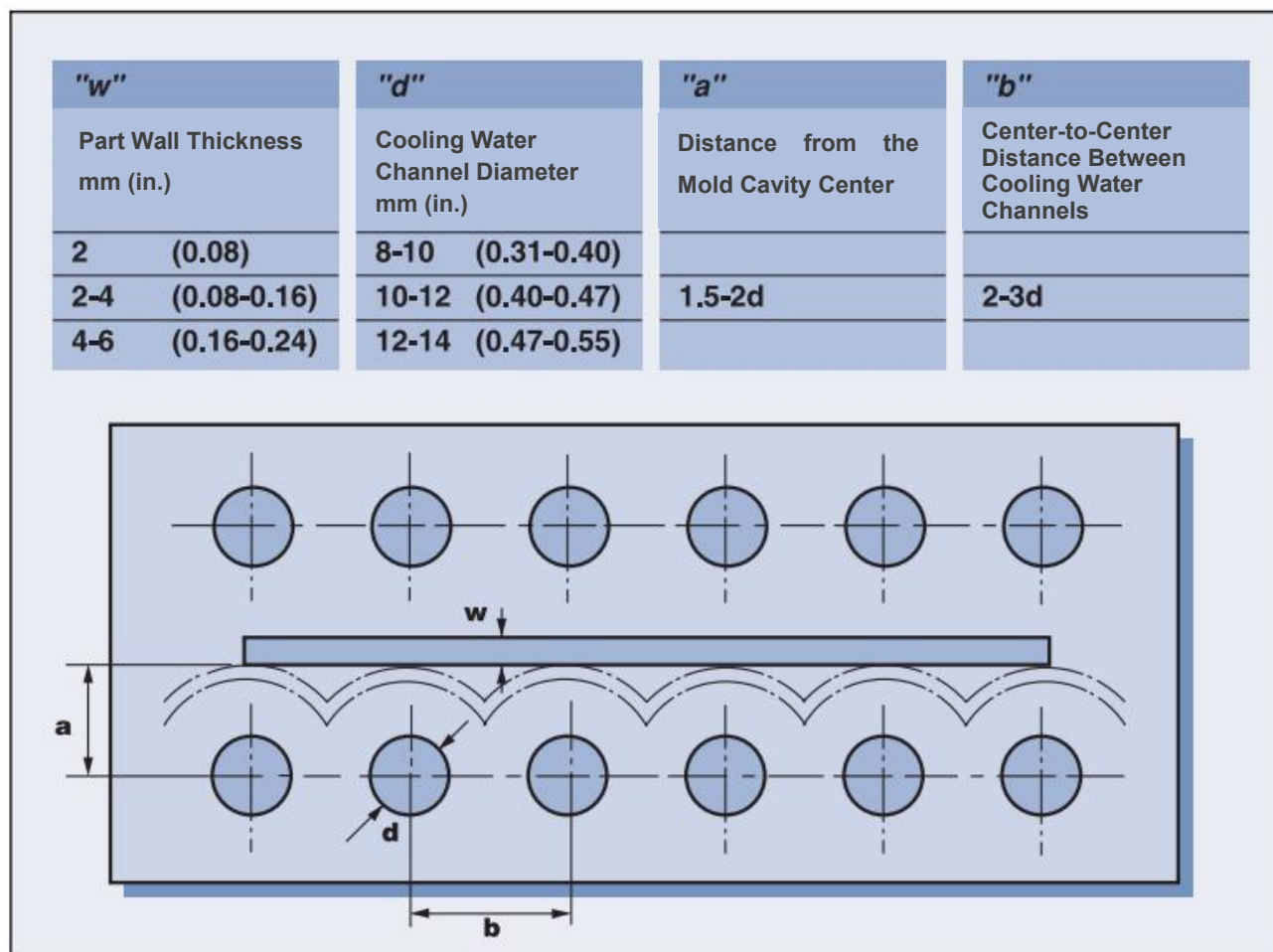
To ensure smooth demolding and minimize cycle time, the draft angle is typically designed between 0.5° to 2° . For textured surfaces, an additional 1° of draft angle should be added for every 0.03 mm increase in etch depth.

(Depending on product design or mold cooling conditions, larger draft angles may sometimes be required.)

8、Mold Cooling

Mold cooling refers to the rapid and uniform removal of heat from the injection-molded part. Rapid cooling enables economical production, while uniform cooling helps ensure product quality.

The basic principles of cooling water channel design are as follows:



Adequate control of the mold temperature is essential for stable injection molding.

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Careful attention should be paid to the design of the cooling circuit, particularly when cooling time accounts for two-thirds of the total molding cycle.

During processing, the properties of engineering plastics can be optimized only when the mold temperature is properly set and maintained consistently.

This is particularly important for PK, a semi-crystalline thermoplastic, as its cooling process should be controlled within an appropriate crystallization rate range as much as possible.

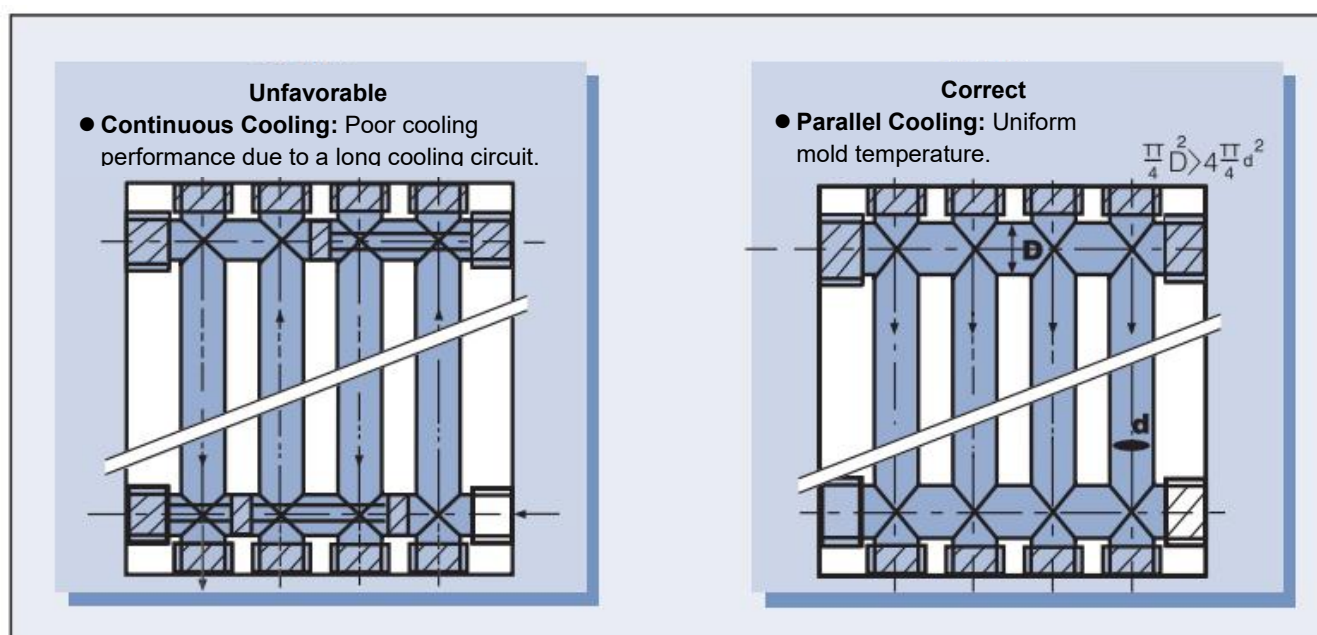
For parts with varying wall thicknesses, differences in cooling rates and crystallinity between different areas can easily lead to warpage or deformation. In addition, as wall thickness increases, the required cooling time can increase significantly.

Mold temperature has a significant impact on the following properties:

- Mechanical properties
- Shrinkage characteristics
- Warpage
- Surface quality
- Flow length in thin-walled parts
- Cycle time

Guidelines for Optimized Mold Temperature Control Include:

- The cooling circuits around the mold cavity should be independent and symmetrical.
- The core must be effectively cooled (e.g., using baffles, bubblers, and heat pipes).
- Cooling water channels should be short enough to ensure that the temperature difference between the inlet and outlet does not exceed 5°C.
- For continuous cooling, parallel circuits are preferred.



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Cooling Circuit:

- Avoid dead spots and/or air pockets in the cooling circuit.
- Minimize heat exchange between the mold and the machine.
- Avoid differences in cooling-water flow resistance caused by variations in channel diameter.

Overheated areas of the molded part should be cooled intensively. The use of high-thermal-conductivity metals, such as beryllium copper alloys, can provide faster and more uniform cooling. Such materials are particularly effective where sufficient cooling channels cannot be installed.

The heat transfer rate of beryllium copper alloys is approximately twice that of carbon steel and four times that of stainless steel. However, for some thin-walled parts, the heat dissipation path within the part itself is relatively short. As a result, even with a stainless-steel mold, heat transfer efficiency may already be relatively high, and the actual heat-transfer advantage of beryllium copper may not necessarily reach the stated “4×” level.

For applications requiring a relatively high mold temperature, beryllium copper alloys are not recommended. Due to their high thermal conductivity, heat can be dissipated from the mold too quickly, which not only makes temperature control more difficult but also increases heating energy consumption. From the perspectives of cost efficiency and temperature stability, they may therefore not be advantageous.