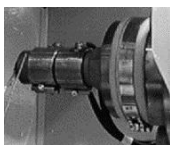


Typical Injection Molding Defect

Case 1

Nozzle clogging



Due to the rapid solidification characteristics of INNOKETONE® PK resin, material may solidify in the nozzle when either the nozzle inner diameter is too small or the nozzle heater band is insufficiently long to fully cover the entire nozzle.

Corrective measures

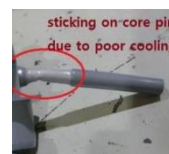
Positioning the thermocouple sensor near the nozzle tip can more effectively prevent potential material solidification. The nozzle diameter should not be too small to avoid premature freezing, typically recommended to exceed Ø3.5mm.

Case 2

Unbalanced filling or deep core pins may lead to overpacking and subsequent part sticking. Filling imbalance or deep core pins may cause overpacking and subsequent part sticking. Due to its lower modulus, PK is more difficult to demold compared to other engineering plastics. Opening the mold before complete cooling at lower mold temperatures can lead to sticking.

Corrective measures

If molded parts are difficult to release from the cavity, appropriately reduce the mold temperature and increase cooling time. Additionally, excessively high fixed mold temperatures can cause gate or part sticking. For deep-core parts, ensure the mold surface is well-polished and cooling channels are defect-free.



Sticking

Case 3

Black Specks



When you observe black or brown spots on INNOKETONE® PK molded parts, they typically indicate material degradation to a burnt state, which usually means the PK polymer has been exposed to high temperatures for too long.

Corrective measures

Immediately purge the screw with a low melt index resin. High-density polyethylene (HDPE) or polypropylene (PP) are suitable for purging. Considering shear heating during processing, set the barrel temperature between 240°C (465°F) and 255°C (491°F).

Immediate Machine Shutdown Required Under Following Conditions



An unusual aspect of PK's rheological behavior is that its **melt viscosity gradually increases with extended residence time** in the screw barrel, as slow aldol condensation occurs at melt temperatures, leading to increased molecular weight, long-chain branching, and ultimately crosslinking. **After injection molding PK components, the machine must be thoroughly purged immediately** to reduce startup time for subsequent runs and minimize contamination risks. Excessive screw temperature and prolonged residence time pose significant crosslinking risks, which become visually apparent as black specks in the material. In such cases, immediately purge the machine with PP purging compounds.

Case 4

Unstable Metering



Due to excessive temperatures, the polyketone (PK) pellets moving downward through the feed throat may prematurely melt and agglomerate. This can partially obstruct resin flow into the screw channel, effectively starving the machine of material while simultaneously trapping process gases within the barrel.

Corrective measures

Adequate feed throat cooling must be provided to prevent bridging. Otherwise, low-temperature setpoints should be applied at the feed throat – though colder temperatures are not always better. Excessively low feed throat temperatures may lead to additional recirculation in downstream barrel sections and potential moisture condensation when material enters the screw.

Black Specks Reduction Guidelines

INNOKETONE® PK will generate carbides and black specks when exposed to high temperatures in the **barrel** and **nozzle** for extended periods. To reduce black specks during injection molding, it is necessary to lower the temperature and decrease residence time.

Here are **6** recommended solutions to reduce black specks



1、Use appropriate colorants and additives

To minimize the risk of black specks, avoid using colorants or additives that are incompatible with INNOKETONE® PK. It is recommended to use color masterbatches instead of powdered pigments.

Mixing PK with other materials that have poor process compatibility (such as nylon) may cause black specks. Consult the manufacturer to verify the raw materials used in the masterbatch, and avoid pigments or additives that may cause black specks or other defects.



2、Maintain barrel temperatures at the minimum required level

To ensure uniform melting of INNOKETONE® PK and minimize the risk of black specks caused by overheating, maintain relatively low barrel temperatures. It is recommended to monitor the temperature profile during processing and make adjustments as needed.

The optimal injection molding melt temperature for PK is 240°C (465°F) to 250°C (482°F). Considering additional heating from shear friction during processing, the barrel temperature settings should be maintained between 230°C (446°F) and 245°C (473°F). **Under no circumstances should the barrel or nozzle temperature exceed 260°C (500°F).**



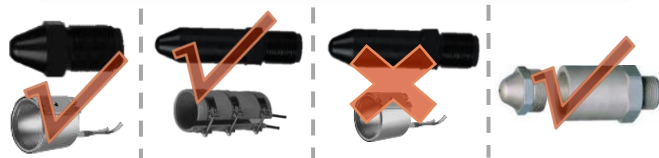
3、Ensure the barrel and nozzle are thoroughly clean before processing

Thorough machine purging immediately before and after INNOKETONE® PK injection molding is critical to minimize the potential for black speck formation. High-viscosity PP is the most suitable purging material. Particularly after PK molding, failure to perform immediate and complete purging will significantly increase the likelihood of excessive black specks upon machine restart the following day. If black specks appear during operation at proper barrel temperatures, review the purging records from the previous production shutdown.



4、Verify whether nozzle design causes overheating

The nozzle length must be properly specified for INNOKETONE® PK processing. Excessively long nozzles increase residence time, leading to overheating and carbonization - such designs should be avoided. If extended nozzle length is required, ensure the heater band provides uniform heating across the entire nozzle. In many cases, nozzle overheating (rather than barrel overheating) is the primary cause of black speck formation. Replaceable nozzle tips allow frequent cleaning, effectively removing accumulated contaminants.



5、Verify the suitability of screw design

The screw's L/D ratio must be properly matched to the specific PK material being processed. L/D ratio **too short** will cause excessive shear heating leading to material degradation and black speck formation, while L/D ratio **too long** prolongs residence time and may also result in thermal decomposition. Maddock-type screws are particularly unsuitable for PK injection molding. It causes material stagnation, leading to decomposition and black speck formation.



6、Minimize residence time

Minimizing cushion volume and cooling time is critical for reducing black speck formation during PK injection molding. Reducing cushion volume directly decreases residence time and minimizes cooling duration. PK's rapid crystallization allows shorter cooling times, thereby further reducing overall material exposure.

INNOKETONE® PK Injection Molding Defect Case Studies & Improvement Guide

Hot Runner Processing Precautions

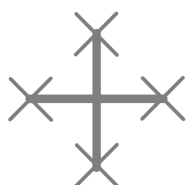
Hot runner systems have been successfully used worldwide for injection molding of PK materials. Like other thermally sensitive materials, INNOKETONE® PK requires more meticulous management when using hot runners.

Below are tips to minimize processing issues:

Essential

- Use only balanced hot runner manifold systems specifically designed for the product.
- Employ streamlined flow path designs for cavities with external heating.
- Utilize complete systems from a single manufacturer.

Manifold



It is recommended to use **externally heated systems**. Internally heated manifolds are not suitable for PK, as they typically develop hot spots and stagnation zones, causing partially cured material to adhere to cooler manifold walls.

All channels should feature highly polished circular cross-sections with gentle bends to minimize the risk of stagnation zones.

Nozzle



The nozzle and gate components (for valve gates and hot tips) must be thermally insulated from the mold plate to maintain proper temperature control. **Smaller gate sizes are not recommended**, as they may lead to freezing issues due to rapid PK solidification.

All internal nozzle channels should be highly polished and streamlined to minimize stagnation and material degradation zones. Each gate requires an individual temperature controller.

Temperature



The typical hot runner temperature range is 230 °C (446 °F) to 245 °C (473 °F) with additional shear heating during processing. If the gate temperature is too low, the melt at the gate will overcool, making the valve pin difficult to close and open.

【Mold Cooling】

Field tests demonstrate that maintaining mold temperatures above 70 °C around the gate is essential to minimize hot runner nozzle tip freezing. **Do not increase hot runner temperatures** to address gate blockage – **raising mold temperature alone** resolves freezing issues.

【Nozzle head insulator】

It is recommended to install an insulator cap on the nozzle tip. This prevents melt channel blockage and avoids PK solidification while awaiting injection in the hot runner system.



Machine Purge



After processing, immediately purge the hot runner system using HDPE or PP. PK resin must be thoroughly cleaned without delay to prevent contamination risks such as black specks and material degradation.

Typical injection molding problems

Black specks

- **Cause:** When **black or brown specks** appear on INNOKETONE® PK molded parts, it is typically a **sign of material degradation**, as the PK resin has been exposed to high temperatures for too long.
- **Corrective Action:** Immediately purge the barrel and hot runner system using a **low melt-flow resin**, and set the hot runner temperature to 230 °C (446 °F) to 245 °C (473 °F).

Nozzle clogging

- **Cause:** Gate freeze-off typically occurs due to **insufficient melt temperature**, **undersized gate design**, **excessive cooling around the gate area**, **improper nozzle-to-mold contact**, or **selection of an incompatible gate type**.
- **Corrective Action:** **Increase the mold temperature around the gate area to above 70 °C**, optimize nozzle cavity machining to minimize contact, verify gate profile machining accuracy, and modify the design if necessary.