ENGINEERING POLYMERS: THE 'TOP TEN' MOULDING PROBLEMS

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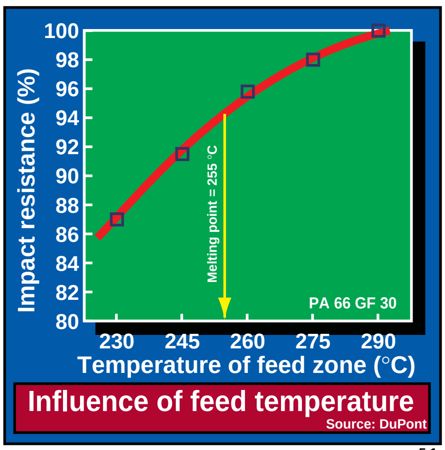
Chapter 5: The Wrong Melt Temperature

1. Moisture in the granules
2. Feed system too small
3. Wrong gate position
4. Hold time too short
5. Wrong melt temperature
6. Wrong tool temperature
7. Poor surface finish
8. Problems with hot runners
9. Warpage
10. Mould deposit

Choosing the right melt temperature is vital for part quality when moulding semi-crystalline engineering polymers. As a rule the margin of tolerance is less than when processing amorphous resins. The moulder at his machine directly influences the properties of the end-product. In the fifth chapter of this ten-part series, the authors consider the question of melt temperature when moulding POM (= acetal), PA (= nylon), PBT and PET (polyesters).



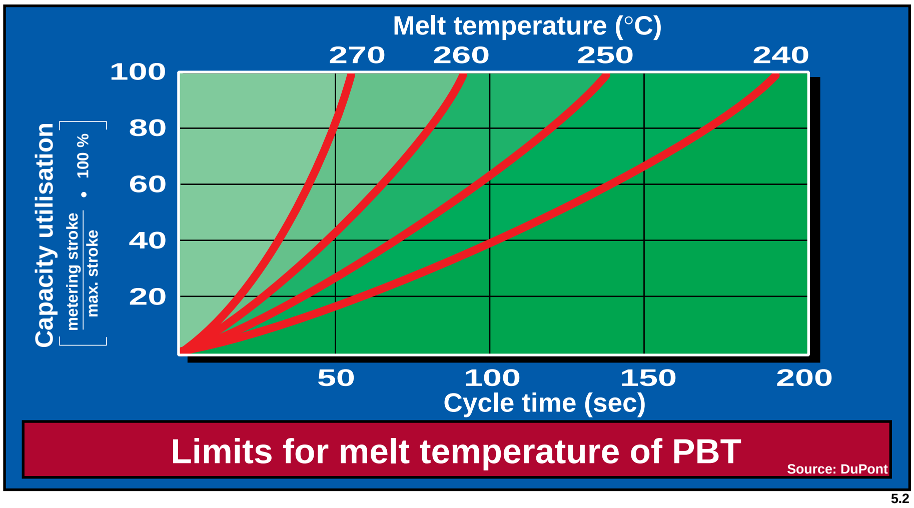
Influence of feed temperature
Source: DuPont
5.1

Material	Melting point	Recommended Melt Temperature °C
POM - H	175 °C	215 ± 5 °C
PA 66	255 °C	290 ± 10 °C
PA 66 GF 30	255 °C	295 ± 10 °C
PA 6	225 °C	250 ± 10 °C
PA 6 GF 30	225 °C	270 ± 10 °C
PBT	225 °C	250 ± 10 °C
PBT GF 30	225 °C	250 ± 10 °C
PET GF 30	255 °C	285 ± 5 °C

Processing temperatures
Source: DuPont
5.3

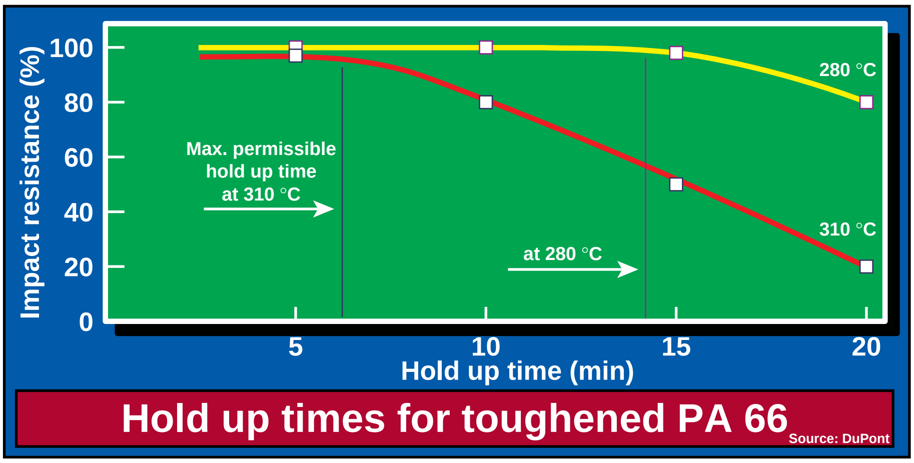
What Happens when the Melt Temperature is Wrong?

Melt temperature can be too high or too low: both are wrong. In addition, even distribution of temperature in the melt is also a factor to be kept in mind.
Temperatures that are too high degrade the polymer, that is, destroy the molecular chains. Another consequence may be that additives in the melt, such as pigments, impact modifiers, etc., also decompose. The results are poorer mechanical properties (as a result of the shorter molecular chains), surface defects (caused by decomposition products) and unpleasant odours.
When the temperature is too low, the structure fails to achieve the required homogeneity. This drastically reduces impact resistance and leads in most cases to considerable variations in physical properties.
Apart from the melt temperature, the polymer’s dwell time in the injection unit also plays an important role. Experience has shown that dwell times of between two and nine minutes are normal. If the dwell time is longer, thermal decomposition may take place in certain circumstances, even if the melt temperature is correct. If the dwell time is very short, the melt usually does not have time to become fully homogeneous.



What are the Signs of Wrong Melt Temperature?

In the case of POM, excessive thermal stress generates decomposition products, causing bubbles to form in the melt. This can be observed clearly in the melt when it is purged. Other symptoms are increased mould deposit and an unpleasant odour. The physical properties of POM homopolymer are, however, hardly affected by too high melt temperatures.
PA discolours under extreme conditions, including if overheating occurs as a result of injection nozzles that are too hot. Thermal decomposition can be recognised in all PA types through reduced mechanical properties. In the laboratory, thermal decomposition can be established by measuring solution viscosity, but as a rule moulders are not in a position to apply this method.
PBT and PET react even more strongly to overheating, leading to reduced toughness. Faults are scarcely discernible during processing. If no suitable quality control measures are carried out, the damage usually becomes apparent only at the assembly stage, or when the part is in use. Discoloration indicates an unusually high degree of damage. In practice, there are tests on random samples with which certain toughness-related properties can be measured. Tests on the viscosity of moulded parts are time-consuming and expensive to carry out.
In the case of unreinforced PA or PBT, if unmelted particles are observed in the purge, it is a sign of too low melt temperature, or excessive shot size in extreme cases.



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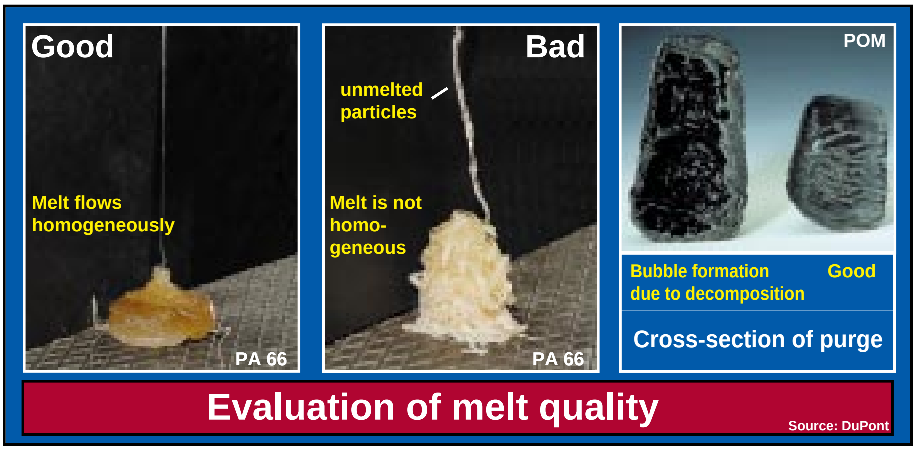
The Right Melt Temperature

The data sheets for engineering polymers indicate the optimum melt temperature range for each. In general, the temperature setting of the barrel heating zones alone is not reliable because, apart from the temperature rise due to the heater bands, friction from the screw rotation also generates heat. How much heat is generated this way depends on screw geometry and rpm as well as on back pressure.
The following recommendations can help to achieve accurate temperature measurements:

- Keep the diameter of the melt temperature probe less than 1,5 mm (response behaviour);
- Pre-heat the probe;
- Collect the melt in a thermally insulated container;
- Stir while taking measurements.

When taking initial temperature measurements or when there are no known values to rely on, a temperature profile should be selected which is 10 to 15° K above the melting point in the feed section and about 5 to 10° K under the required melt temperature in the metering zone. The temperature can be fine-tuned according to the measured melt temperature. In the case of long dwell times and short metering strokes, rising profiles are usually recommended. For short dwell times and long metering strokes flat profiles generally give the best results. A temperature zone should never be set at less than the melting point of the polymer.



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