ENGINEERING POLYMERS: THE 'TOP TEN' INJECTION MOULDING PROBLEMS

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Part 10. Deposits on mould surface.

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

These can occur with nearly all thermoplastics. As demands on end-products increase, so do the amounts of additives which have to be incorporated, e.g. modifiers, flame retardants, etc. These additives may quite often cause deposits to form on the mould cavity surface.
There are many other associated reasons for the formation of mould deposits. The most common ones are
• thermal decomposition
• excessive shear
• inadequate venting.
Such deposits are often due to a combination of different factors and a great deal of trouble has to be taken to find out exactly what causes these deposits to form and how to prevent them. One problem is that deposits often build up only after a few days.

Types of deposit

Each group of additives produces a specific type of deposit. Flame retardants can react at high temperatures, forming decomposition products which may produce deposits. Impact modifiers are affected not only by excessively high temperatures but also by excessive shear. Modifiers can, under unfavourable conditions, separate from the polymer and form deposits on the cavity surface.
Pigments in engineering thermoplastics needing high melt temperatures, can reduce the thermal stability of the moulding compound, resulting in deposits consisting of polymer degradation products and decomposed pigments.

In parts of the mould which become especially hot (such as cores), modifiers, stabilisers and other additives may stick to the surface and build up deposits. In such cases, steps must be taken to achieve better mould temperature control or use special stabilisers. The table lists the possible causes of mould deposits and ways and means of preventing them.

	Possible causes	Possible elimination
Thermal decomposition	Melt temperature too high, residence time too high	• measure melt temperature and reduce to recommended level • check ejected compound for signs of decomposition, e.g. formation of bubbles, or gas in the melt • match cylinder temperature to residence time • ensure thermal insulation of hot runner, check temperature control and lower temperature
Thermal decomposition	Dead spots in nozzle, near non-return valve, wear in cylinder, dead spots in hot runner	• show up dead spots through changing colour. Long cleaning cycles mean poor purging • examine suspicious components (nozzle, adapter, screw, hot runner) for dead spots and repair or exchange
Thermal decomposition	Polymers or additives with insufficient thermal stability	• reduce residence time by using smaller cylinder. Operate with delayed feed. Ensure small melt cushion. Keep melt decompression to a minimum to prevent oxidation through sucked-in air. • use standard product (without modifiers, pigments etc.) experimentally. • pre-dry to reduce volatile constituents
Too high shear	Walls too thin or flow distance too long, resulting in high shear stress	• make walls thicker or incorporate flow aids • increase number of gates to reduce flow distances • change gating system, possibly use hot runner. • possibly increase melt temperature
Too high shear	High shear due to too small a gate	• increase gate cross-section • redesign gate • increase number of gates
Too high shear	High shear due to fast injection	• reduce or profile injection fill speed • increase melt temperature
Insufficient venting		• provide cavities with vents or improve venting system • fit self-cleaning vents to ensure consistent removal of air.
Mould surface temperature too high		• measure mould temperature after the starting-up phase and reduce to recommended level • reduce overheating of cores by adjusting mould temperature control

Possible causes and remedies for mould deposits

Source: DuPont

10.1

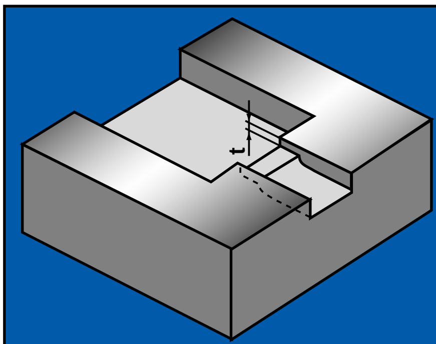
Deposits which appear suddenly

If deposits appear suddenly, this may be due to changed moulding conditions, or the moulding compound when batches are changed. The following comments may be helpful.

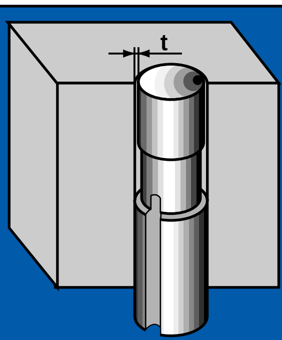
First of all, the melt temperature should be measured and the melt visually checked for signs of decomposition, i.e. the presence of charred particles. One should also check whether the moulding compound has become contaminated by foreign substances and that no incompatible purging compound has been used. Mould venting should also be checked. The next step should be to run the machine with natural or pastel-coloured moulding compound (but not black). The machine is then switched off after about 20 minutes' moulding. Nozzle, adapter and possibly the screw are then dismantled. Inspection of the material for charred particles, and comparing its colour with that of the original moulding compound will quickly indicate the source of the problem.
This technique has in many instances uncovered surprising weaknesses, but is really applicable only to small machines (up to, say, 40 mm screw diameter). Their elimination will also result in definite quality improvements when processing other materials. A similar procedure can be adopted for hot runner systems.

Care of moulds

If deposits cannot be prevented from forming by any of the measures described above, special care and attention will have to be given to the moulds.
It has been found that deposits on the mould surface can be removed relatively easily in the early stages. Cavities and vents should therefore be cleaned at specified intervals, e.g. at the end of each shift. Once the deposit has formed a thick layer it is extremely difficult and time-consuming to remove it.
Because deposits vary so widely in their chemical composition, trials have to be carried out to find the most suitable solvent which will shift them. Besides the classic solvents, it has often been found that unconventional products can solve the problem, e.g. oven sprays or lemonades containing caffeine. Another trick is to use cleansing rubbers as used in model railways.



in mould parting surface



using ejector

Material	t*
POM	0,03 mm
PA	0,02 mm
PET	0,02 mm
PBT	0,02 mm
TEEE	0,03 mm

* in the case of low viscosity grades and where there must be a minimum amount of flash, vent slits should be shallower to start with

Recommendation for vent depth

Typical vent designs

Source: DuPont

10.2

Recommendations on preventing deposits

If thermally sensitive compounds are moulded using hot runners, it should be remembered that the residence time will be longer, so that the risk of deposits consisting of degradation products will be greater.

Shear sensitive materials should always be processed using generously dimensioned runners and gates. Multi-point gating, which reduces flow distances and thus enables moulders to reduce injection speeds, have given good results.

Generally speaking, efficient mould venting reduces the tendency to form deposits. Adequate venting should therefore be provided at the mould design stage. Self-cleaning vents, or those from which deposits can be easily removed, are to be preferred. Improvements in the venting system have often led to reduced deposits on the tool.

In some instances it is possible to apply a special non-stick coating to the cavity surface, which will prevent deposits building up. Tests should be carried out to assess the effectiveness of such coatings. Titanium nitriding has often reduced the rate at which deposits build up on the tool.

Deposit on overheated core

Source: DuPont

10.3