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KEP

Polyacetal Mold Deposits

R&D Center

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1. Outline

Mold deposits(hereinafter refered to as M/D) are mainly white precipitates that occur when decomposition factors during long-term plastic injection molding are attached to the product in mold. Polyacetal resin in particular can readily form M/D, and occasionally, attached M/D cannot be removed easily.

M/D can cause injection issues, poor gloss, weight loss, and surface issues of injection parts, in addition to ejection. Volatile gases from polyacetal resin can be easily deposited on the surface of the mold if the mold temperature is too low.

2. Root causes of M/D

(1) The polyacetal resin (pellets absorbed moisture)

(2) Migrated additives from polyacetal resin are left behind on the surface of the injection part

(3) Paraformaldehyde[$HO(CH_2O)_nH$] re-polymerized on the surface of the mold caused by a small amount of remaining formaldehyde(HCHO) in the polyacetal resin.

Of the above causes, paraformaldehyde is the most difficult to remove as the binding force between it and the mold surface is very strong.

3. The effect of injection parameters for M/D

(1) Resin temperature : The lower the resin temperature is, the fewer M/D occurrences it has.

1) Cylinder temperature : 180 ~ 210 ℃

(2) Injection speed : The faster the injection speed is, the more M/D occurs.

A too-fast injection speed can stimulate the occurrence of M/D due to adiabatic air compression resulting from poor air emissions in the cavity.

[Table 1] Effects of Injection Parameter

Classification	Resin Temperature (℃)	Injection Speed (%)	M/D Occurrence Quantity (Relative Value)		
			Solid Part	Gas Part	Total
Condition 1	230	85	10	90	100
Condition 2	190	50	4	36	40

Footnote) 1. Grade used : KEPITAL F20-03

(3) Residence time of resin in the cylinder : The longer the residence time is, the more M/D occurs.

(4) Injection machine : Proper injection machines must be used based on part weight(weight per shot). A too-high injection capacity compare to part weight can cause higher M/D due to longer residence time in the injection machine.

(5) Mold temperature : The higher the mold temperature is, the less M/D occurs.

1) Mold temperature : 60 ~ 80℃

[Table 2] Effects of Mold Temperature

Mold Temperature	Cylinder Temperature	Injection Speed	Numbers of shot when M/D occurs	Remarks
25℃	230℃	85%	400	
90℃	230℃	85%	1,400 ↑	

Footnote) 1. Grade used : KEPITAL F20-03 non-dried

(6) Drying of resin : Sufficient drying is recommended because the moisture and formaldehyde in the pellet can stimulate the occurrence of M/D.

1) Drying condition : 80 ~ 100℃, 3 ~ 4h (100 ~ 120℃ if needed.)

[Table 3] Effects of Pre-drying

Classification	Water Absorption (%)	M/D occurrence quantity (Relative value)		
		Solid Part	Gas Part	Total
Non-dry	0.4	65	53	118
Dry	0.0	15	85	100

Footnote) 1. Grade used : KEPITAL F20-03

[Table 4] Effects of Water Absorption

Classification	Water Absorption (%)	M/D Quantity (μg)	Remarks
Air conditioning(96h) under 75% relative humidity	0.45	6	
Air conditioning(96h) under 60% relative humidity	0.26	4	
Pre-drying 80℃, 2h	0.00	3	

4. Precaution from mold

(1) Sufficient installation of gas vents is needed.

(2) Injection parts have to be designed to eliminate gas residence.

(3) Gas vents must be set up to direct flow to the front of the resin.

(4) It is recommended to design with sufficient room rather than real resin flow distance, so that the product can be eased from the injection parameter.

(5) Insert-type cavities, which are the structures putting the separately processed part (insert) into the mold, are preferred over direct types directly made by template .

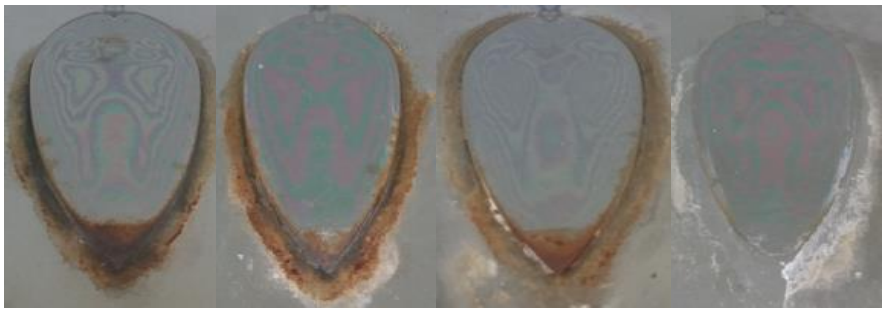
(6) Sufficient installation of cooling circuits is recommended.

(7) It is better to use decompression or vacuum conditions in the cavity while injecting the resin.

(8) Sharp corners must be avoided as much as possible.

(9) Proper mold design is needed to facilitate better mold cleaning.

(10) Corrosion-resistant materials have to be used as mold ingredients, in particular SUS-types like STAVAX, and NAK101 are recommended in regards to corrosion. Chrome plating, and surface coatings are also effective methods.



KP4M SKD61 NAK80 STAVAX

[Figure 1] The shape of M/D from each mold ingredient

(Test condition : Resin temperature 220℃, 2000 shots, no gas vent)

(11) Mold deposit reduction method

1) Balzers Coating

① An outline : 1/1,000mm thickness coating using PVD(Physical Vaper Deposition) which is harder than steel despite being a thin film and also has good friction/wear resistance.

② Advantage

- Reduces possibility of M/D due to the slippery surface of the mold.
- Can be applied to the mold of complex parts as a thin film coating.

③ Disadvantage : In the case of large parts, Balzers coating cannot be applied.

2) Chromium plating

① An outline : Plating a mold surface with chromium.

② Mainly applied for flat-shaped molds.

③ Occasionally, it's hard to be apply to complex or precise molds as it is a plating-type.

5. Mold gas vents

Securing gas vents in the mold is the most efficient way to reduce mold deposits. Although there are several gas vent methods the following three are the most common :

◎ Gas vents at the parting line of the mold

◎ Gas vents at the cavity or core

◎) Gas vents by other special methods

(1) Gas vents at the parting line of mold

The most general method of gas vent is to set up a thin rabbet at the parting line. The size of the vent depth has to be selected to avoid the flash when the melted resin is filled in, and to emit gas components well.

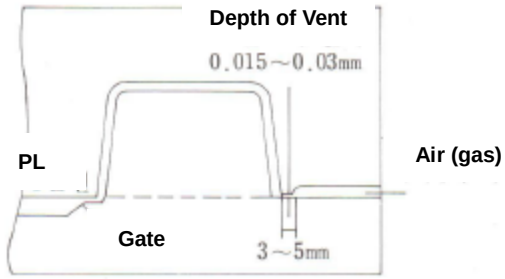
The table below shows the vent depth necessary to prevent flash.

[Table 5] Vent depth to prevent flash

Resin	Vent Depth (mm)
POM	0.01 ~ 0.02
ABS	0.01 ~ 0.03
M-PPO	0.02 ~ 0.03
PPS	0.01 ~ 0.03
PBT	0.005 ~ 0.015
PA	0.005 ~ 0.015
PC	0.02 ~ 0.03

[The location of gas vents]

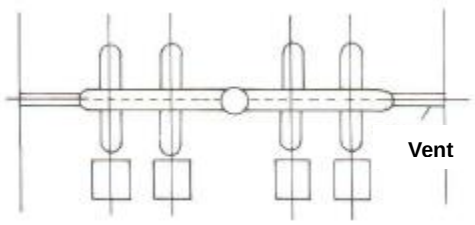
① Farthest point from the gate



[Figure 2] Location of gas vent

② Weld line (The contact area of melted resin)

③ End part of runner or sub-runner



[Figure 3] Gas vent at runner

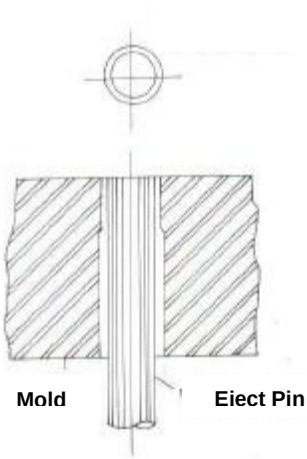
(2) Gas vent at the cavity or core

If sufficient air and gas venting from the around of cavity is impossible, the following methods are recommended.

1) Ejector Pin Method

Using the gap between the ejector pin and the pinhole, if the ejector pin is located in the point where the air and gas are gather, it is an effective method.

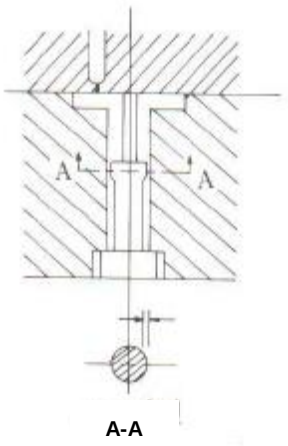
The standard size of the gap between the ejector pin and pinhole is 0.02~0.03 mm with 5~10 mm of pin diameter, and 0.01~0.02 mm with a smaller one.



[Figure 4] Gas vent by ejector pin

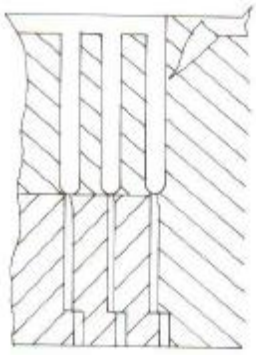
2) Core Pin Method

Gas vents using the ejector pin are sometimes difficult because of high boss or rib in the product. In this case, gas vents can also be created by setting up clearance around the ejector pin.



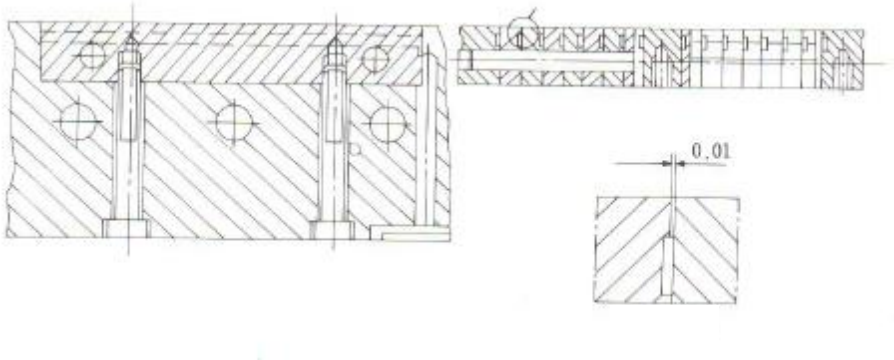
[Figure 5] Gas vent by core pin

3) This is the gas vent method used when high ribs by the insert block the partition part, using the clearance of the thin plate after overlapping it like a layer and putting it in as an insert.



[Figure 6] Gas vent of high rib

Further, there is a method to put in the plate which overlaps the thinner plate at the flat portion of one side of the cavity as the insert, and vent the gas component from the clearance of the thin plate.



[Figure 7] Gas vents rabbet by overlapping thin plates like layers

(3) Gas venting by other special methods

1) The ***Logic Seal Method*** .

This method is a cooling water circulation system developed by Logic Devices Inc. of the United States. Cooling water is circulated by additional pressure. (For this, the pressure in the channel is lower than the atmospheric pressure.)

2) Gas venting by vacuum intake

The instantaneous gas vent method to make an internal cavity under high vacuum pressure by using a vacuum pump. This method is well-known as the most ideal way of gas venting, but currently not practically used because of high facility cost in addition to complex mold structure.

The main purpose of gas venting by vacuum intake has been to prevent gas burning or filling issues by emission of air, gas component so far, in parallel, it is expected that the improvement of the accuracy for mold cavities and corresponding dimensional accuracy will improve in the future.

6. Precaution for removing M/D and mold keeping

(1) Frequent mold cleaning is required. Small amounts of M/D can be easily removed with a rag.

(2) Failure to clean residual M/D might cause rusting.

In particular, close attention is required during rainy seasons due to high temperature and humidity.

(3) When you see M/D :

1) If M/D is strongly attached, use a spatula made of bamboo, copper, or brass to avoid damaging the mold.

2) Metal abrasives are also efficient.

3) Alternatively, use a M/D remover.

4) Using dry ice for removing M/D is effective as well.

① A method for removing M/D through air after freezing it by using dry ice.

② Possible to remove M/D without disassembly of mold from the injection machine.

(4) M/D Remover

1) Slide Resin Remover

This can inhibit the occurrence of M/D by spraying it before M/D attaches. Not efficient when M/D is already abundant, it is widely used for M/D prevention and removal under a general continuous molding process.

2) MG Cleaner-S Type

The main component of this solvent is to melt M/D at room temperature, so if spraying it into the mold during injection, injection parts can melt and adhere to the surface of mold, so must be carefully cleaned after use. Even though such cautions are required, the results are quite excellent.

3) Valid reagents for removing M/D

① Benzyl Alcohol[$(C_6H_7)CH_2OH$]

Dissolves M/D by soaking the inserted portion of the mold in this reagent for 10 minutes at 150℃. However, beware of the risk of fire due to its combustibility.

② Sodium Bisulfite [$NaHSO_4$]

Though it can dissolved M/D at room temperature, it must be properly cleaned from the mold after using it. Otherwise, it can corrode the mold.

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