Dr. Die Cast

Hot Chamber Process Improvement Tip: Controlling that Nuisance Drip

We frequently see problems with nozzle or sprue drips on zinc hot chamber machines. During die open, a small amount of liquid zinc will "drool" down the face of the cover half die. In many cases, this drip is chronic and happens 100% of the time. Other times it may happen less frequently but still it occurs frequently enough to cause problems.

What kind of problems are related to drips?

1. Cycle interruption and productivity. If the drip is thick enough it will stall out the next closing cycle. The operator then has to open the die and remove the now flattened drip and restart the process. Due to the loss of die temperature during an interruption, there is also an increase of "start-up" scrap each time the machine is restarted.
2. Holder block/parting line damage. When the drip is chronic, even zinc will eventually coin the parting line. This will create a gap that allows blow-by (flash) out the bottom of the die. At best, the flash creates a mess under the die space that must be cleaned out frequently. At worst, it is a hazard to personnel.
3. Excessive melt loss. When the metal is repeatedly allowed to flash the accumulation will end up as unusable or at least reduced value scrap due to becoming contaminated with grease, quench fluid and debris under the die space.
4. Increased casting scrap. Casting scrap is increased both at the machine and at later processes. Flash causes a loss of cavity pressure during the critical steps of filling and solidification which can result in a higher level of porosity. This loss of cavity pressure happens when one or more of the following conditions exist.
   a. The parting line is damaged.
   b. The die is flashing out the bottom.
   c. The process is allowed to continue with layers of flash that progressively increases the gap between the parting lines until the machine can no longer lock up.
5. Damage to the sprue post. If the drip is thick enough it can "pinch" the sprue post during die close and break or crack the sprue post. A cracked sprue post can force water into the nozzle and gooseneck. The resulting steam pressure buildup inside the gooseneck can raise the level of the molten metal and cause the pot to run over and spill on the floor. This is not theory! I have personally witnessed this. (Figure 1.)

In short, drips are costly! In an ideal process, the unused molten metal will return to the pot simply by the force of gravity. Any condition that inhibits that will contribute to drips.

What causes drips?

Drips are the result of one or more of the following conditions:

1. Excess shot time. When the shot time is excessive, metal will freeze in the nozzle and/or gooseneck. This prevents the molten metal that remains in the nozzle from returning to the pot.
2. As the frozen metal re-melts near the sprue, the expanding metal will take the path of least resistance and exit toward the ejector half.
3. If the cover half of the die is located such that the nozzle is level, or even worse, aimed slightly downhill toward the die, gravity will allow molten metal to exit toward the die face instead of returning to the pot.
4. Water leaks in the sprue post or bushing. If water leaks into the sprue, the resulting steam will force molten metal in all directions. The path of least resistance may be the die face. This is not only a detriment to part quality but also a safety hazard that should never be tolerated.
5. Excess die spray collecting in the sprue bushing. Die spay that enters the sprue bushing can create steam pressure that forces molten metal toward the open die.
6. The die starts to open after the plunger is fully retracted. The vacuum created by the sprue as the die opens creates a vacuum that draws molten metal out of the nozzle. If the plunger is already fully returned there is nothing to counteract the vacuum created by the sprue.

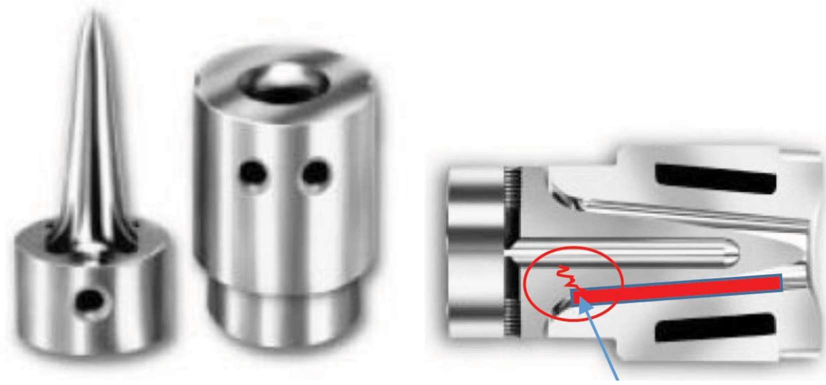

Figure 1 – A drip that gets "pinched" between the sprue bushing and the sprue post can crack the post and allow water to enter the nozzle and gooseneck!

Solutions:

Manage the die set:
The die should be set so that the nozzle exits at a slightly higher point than the gooseneck. Even though most manuals and training materials clearly show the nozzle setting at a slight angle there is nothing on the machine that would force the set-up technician to set the die higher than the gooseneck centerline. Some have found that a three degree angle is sufficient to help empty the nozzle each cycle.

One way to insure this is to create a keyed location for all your dies. This would insure that the nozzle was always at the desired angle. (Figure 2.)

Manage the process:

1. Avoid spraying excess die spray in to the sprue bushing. This will reduce the steam buildup in the sprue area.
2. Manage the nozzle and gooseneck temperatures. It is essential that the nozzle and gooseneck temperatures exceed the melting point of the material.
3. In order to accomplish this it is necessary to heat not only the nozzle but also the gooseneck. This will insure that the metal can return to the pot freely.
4. Manage the sprue temperature. Tune the cooling flow to both the sprue bushing and post so that it isn't excessively cooled. The sprue should be solid, not porous with a "wet" tip on the sprue.
5. **Manage the shot return:**
   a. The shot timer should begin the return sequence as soon as the sprue is solidified. You can monitor this by watching the condition at the tip of the cast sprue. If the shot timer is excessive there will be a cold break at the tip of the cast sprue.
   b. The die should begin to open just prior to the plunger clearing the intake holes in the gooseneck. This will insure that the plunger is pulling a vacuum in the nozzle and reliably clearing the nozzle. This may require adjusting and "tuning" both hydraulic and limit switch settings.
      i. Adjust the shot return speed to a slower speed to maintain a vacuum in the nozzle.
      ii. In order to accomplish the above it may be necessary to adjust the shot returned limit switch to allow the die to open before the gooseneck intake holes are exposed. (This is approximately the last ¾" of return stroke on a 250 ton and above machine.)
6. **Regulate the "die open speed"**: especially the acceleration during the first inch or two of stroke. This will minimize the vacuum generated when the sprue is extracted from the sprue bushing. The setting for this is titled "Decompress" on some machines. As soon as the die is parted an inch or two the sequence should allow the die to accelerate to open faster to optimize the overall cycle time.

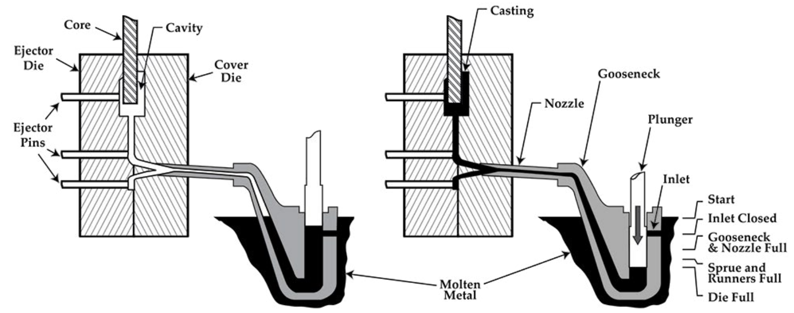

Figure 2 – Clearing the nozzle of molten metal must happen each and every cycle. Set the die slightly above the platen centerline in order to create a slight uphill angle in the nozzle. Setting the nozzle at a slight angle will help to accomplish this.

Nozzle to sprue contact:
The nozzle to sprue surface is generally designed with different radii in order to accomplish two benefits. That is the nozzle tip has a smaller radius than the nozzle seat on the sprue bushing.

1. The first benefit is that this magnifies the seal-off force between the nozzle and the sprue bushing. This improves the seal-off and reduces leaks.
2. The second benefit is a reduction in heat transfer (loss of nozzle heat) from the nozzle into the sprue bushing. This improves the temperature control of the nozzle nearest the sprue where the tendency is to plug up from excessive cooling.

In order to maintain the radius on the nozzle tip it is recommended to resurface this area after each use. Some people use special radius fixtures and machine the nozzles on their own lathes.

Avoid applying excess torque to the "gooseneck A-frame nuts". Stack the Bellville washers end to end to get the greatest benefit. Don't crush them and run them solid. This will crush the nozzle seat and bend the nozzle.

Improving die conditions:
If the die holder block has already been damaged it may be necessary to repair the holder in order to restore proper cavity pressure and eliminate flash.

1. Install a hardened H13 plate under the sprue area on both the cover and ejector halves. This will provide a more reliable shutoff and resists coining.
2. Avoid placing water lines immediately below the sprue. These may become damaged by the previous coining. Water lines that are in-line with the sprue post and bushing should all be accessed from the top or sides of the die to prevent getting pinched by sprue drips.

Acknowledgements:
- *Figure 1: DME, Die Casting Catalogue.*
- *Figure 2: 2003 Edition NADCA E-410, "Die Casting Process Control"*

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