A NEW APPROACH TO MOLD VENTING: ALTERNATIVE VENTING VALVES

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Abstract

The article discusses commonly used systems for mold venting and their limitations, introducing therefore alternative dynamic venting valves that can help overcome such limitations and improve mold performance.

Introduction

Proper mold venting is essential for producing quality parts. During the molding process, the air contained in the mold needs a way to escape. If this doesn’t happen, the melt will compress and trap the air in the cavity. A combination of melt pressure and high temperature will then ignite the oxygen, in a process known as “diesel effect”, causing burning, gloss marks and stress cracks in the finished plastic part, compromising part quality and appearance. Poor venting, together with the diesel effect, can also cause the mold to wear on the parting lines, resulting in flash on the injected part.

Reducing injection speed will allow the air to escape from the cavity and to limit the problems indicated, but this will lead to other problems such as short shots. As injection speed slows, the temperature of the plastic decreases. The lower the temperature of the plastic, the higher the melt viscosity: the plastic will begin to harden before the mold is completely full and therefore produce incomplete parts. Packing is possible as long as a center-core flow path of melted material can transfer the packing pressure from the injection point to the entire injected part. Long filling time will cause the material to cool down which can result in poor packing, causing warpage and less conformity to the cavity design and texture. Efficient filling time is essential for achieving proper welding lines and quality parts.

To avoid all these problems “standard” ways are used during design and machining, to realize a proper venting of the mold.

The goal of this paper is discuss these ways, and to introduce some “non-standard” venting solution that can overcome the limitations of the conventional technology.

Furthermore, a few new “alternative” venting solutions will be introduced that give a new approach to mold venting and aim to solve some of the issues in both “standard” and “non-standard” solutions.

Standard mold venting

Standard mold venting involves machining pathways between the mold’s mechanical elements through which air can escape. Typical vent locations may include, for example, the space between parting lines, around pins or ejector pins, or at sliding elements such as sliders and cams. When parting lines and sliding elements do not allow space for enough venting, the mold cavity can be divided into several inserts in order to increase the number of possible venting areas.

Material viscosity limits the recommended size of vents that should be used in a mold. Lower the viscosities require shallower than recommended vent depth. Industry standards for vent depths are determined by the material to be injected into the mold. Viscosity is also a function of melt temperature and injection pressure. Moreover, gases produced during molding also impact venting. Materials such as polyamide (PA), polyphenylene sulfide (PPS), polyetherether ketone (PEEK), polycarbonate (PC) with glass fiber, polyethylene terephthalate (PET), polyoxymethylene (POM) and materials with flame retardant properties, produce gases during molding. This gas production generates oily deposits that contaminate and with time block venting grooves, channels, and the cavity surfaces, causing part defects. This can also lead to an increase of mold cleaning frequency and mold cavity’s contamination.

Although there are well known guidelines for designing and machining vents to optimize venting capacity, without removing excessive parting-line bearing surface, standard venting systems offer a limited venting capacity and performance that most of time is not sufficient to achieve reasonable part quality.

In the following sections we will discuss a few “non-standard” and “alternative” venting solutions that can be added to cavity venting in order to improve mold performance.
Non-standard Venting Solutions

Porous sintered materials

These materials can be inserted into the cavity to act as vent passage.

The thicker the porous material, the smaller the venting capacity, so proper venting channels must be machined to collect the gases. Frequent cleaning is necessary, as gas deposit can build up and partially or completely block the removal of air and gas from the cavity.

Vacuum technology

Vacuum can remove the air from cavity before the injection process begins.

Although this addresses the problem upstream, it also causes limitations in application and performance. For example, the cavity must be completely sealed. This is costly and sometime not possible in molds with sliding elements. Furthermore, vacuum technology can solve air problems, but it is not effective in dealing with gases produced during filling phase. The intake valves close before filling begins, so gases can’t find a way out of the cavity.

Overflow system

It consists of an area connected to the cavity via a channel. It can be created by machining an exit gate that connects the cavity’s last filling point with a cold runner that ends in a venting area with a vent measuring about 0,1 mm. A groove is then machined around the vent to collect the gases and allow them to exit from the mold. During filling phase, air can flow through the gate, cold runner, vent and gas-venting groove. Plastic will freeze in the vent and is removed after every shot.

Filling analyses, or trial and error, can be used to determine the proper size of this type of system. The designer can start with a vent height of 0,1 mm and length of 10 mm, and adjust as needed.

The main benefit of an overflow system is the ability to overcome vent limits. Flash in the overflow area should not be a problem as long as it will be cut from the part after every shot.

Limitations include extra material being wasted for every shot, overflow cutting operation, and additional space requirements. Also, the position of the venting gate needs to be at a mold parting lines, and this doesn’t solve air-traps issues.

Alternative Venting Solutions

“Dynamic” venting valves are an alternative venting solution that can be either external or internal to the cavity. They are designed to allow the air and resin gases to rapidly leave the cavity via a venting channel that is a few square millimeters wide, just big enough to overcome the geometrical limits of standard venting grooves

External Dynamic Valve

The external dynamic valve consists of a body that houses a guide or a slide. Both the body and the guide are designed to guarantee a conical closure when the sliding element moves. A spring keeps the slide in an open position to create an increased venting space for the mold cavity. The body also contains wide venting channels connected to the venting area between the body and slide.

Figure 1 and 2 shows this kind of valve.

Figure 1. External Dynamic Valve: position of body, slide and venting channels
The venting valve is connected to the cavity or cold runner by a groove that allows the gas to flow from the mold cavity to the valve. When the injected plastic reaches the vent, it applies pressure on the slide, compressing the spring, causing the conical closure and preventing the plastic from flowing into the valve.

The venting grooves on the valve body are connected to the open venting space outside of the mold by machined channels. These channels must be as straight as possible to maximize the performance of the valve. The valve itself can be located in different positions in the mold to achieve various benefits and mold performance.

The main benefit of external mold venting at “runner side” is the ability to vent gases through the cold runners during molding. Gases are usually pushed into the cavity with the plastic material, and with an external venting approach, the gases naturally flow where the drag is lower. Drag to the flow at the end of the cold runner is very low compared to the drag inside the cavity, where the number and dimensions of vents are limited.

In addition to the “runner side” use, another option for External Dynamic Valve is to be used at the “last filling point”, whereby, while the melt flows forward in the cavity, air and gases flows out through the valve. Thanks to the low air counter pressure in the cavity, this allows injection parameters to be managed in a larger window of options, optimizing injection time, part aesthetics and mechanical characteristic.

Although external venting generates a small plastic protrusion on the part that must be removed after every shots, a tunnel gate will allow for automatic cutting of this extra material during the ejection of the part.
Internal Dynamic Valve

As opposed to the External Dynamic Valve, this Valve can be placed inside the cavity of the mold and allows gas to escape from a venting hole that automatically closes under the pressure of the injected plastic.

This type of valve consists of an outer sleeve, a sliding shaft and a central pin that it is used to close off the venting hole. During filling, a spring of the appropriate length, wire diameter and preload, pushes the sliding shaft forward in open position. While in this position, air and gases can flow through the central hole and along the wide internal venting channel. When the injected plastic arrives at the valve, it applies pressure on the shaft surface, compressing the spring and closing the valve. While in closed position, the central pin seals off the venting hole, ensuring that the plastic does not fill the valve. The proper working of the valve is guaranteed by accurate sizing of the venting hole, the safety zone and spring preload. These parameters allow the valve to close before the melt fills the wide venting channels.

The design of this type of valve requires the sliding shaft to stick into the cavity while the valve is in open position. This guarantees open venting channels. The central shaft moves up and down for a defined stroke to suit plastic part wall thickness. A shorter stroke requires a longer plastic protrusion of the part, as shown by the dimension N into figure 7. The thinner the plastic part, the shorter the stroke should be. Part thickness and aesthetic requirements also determine the necessary overall size. If the thickness is adequate, it is possible to set up the valve in order to avoid any protrusion.

Figure 7. An outer sleeve, a sliding shaft and a central pin make up the Internal Dynamic Valve

Figure 8. Internal Dynamic Valves

The Internal Dynamic Valve can have different shapes and dimensions, as can be seen in figure 8, and can be used in all the cases where it is not possible to accept the External Dynamic Valve because of space issues or because it is not possible to accept the extra material out of the part. Also, the Internal Dynamic Valve is particularly efficient at solving the air-trap problem because it can be placed closer to the area where those traps occur, helping to release the air before it gets trapped from the plastic flows.

Comparison between Standard mold venting and Non-standard venting solutions

The test described below compares the effectiveness of standard venting solution with dynamic venting solutions.
A pneumatic cylinder having 1570 cm³ chamber volume is actuated by a 5 bar air inlet able to apply a force of 368 Kgf on the piston. Different venting devices have been connected to the air outlet of the cylinder’s chamber. Recording and comparing the time necessary to vent the air contained into the chamber it is possible to evaluate the venting performance of each solution.

The first test has been performed with a standard venting solution, see figure 9. The venting device connected to the air outlet of the cylinder is a so called “super ejector pin” diameter 8 mm: a ring vent around the pin with 0.03 mm (venting land 0.75 mm²) and then the full diameter grinded and connected to atmosphere. The recorded venting time is 6.5 seconds.

![Figure 9](image9.png)

Figure 9. Testing the performance of a Standard Mold Venting: “Super ejector pin”

The second test has been performed with a Non-Standard venting solution, see figure 10. A SGD-605, with external diameter of 6 mm and a venting surface of 1.13 mm² has been connected to the outlet of the cylinder. The recorded venting time is 3.5 seconds.

![Figure 10](image10.png)

Figure 10. Testing the performance of a Non-Standard Mold Venting: SGD-605

The third test has been performed also with a Non-Standard venting solution, as can be seen in figure 11. A SGD-1410, with external diameter of 14 mm and a venting surface of 3.14 mm² has been connected to the outlet of the cylinder. The recorded venting time is 2.5 seconds.

![Figure 11](image11.png)

Figure 11. Testing the performance of a Non-Standard Mold Venting: SGD-1410

**Conclusions**

The performance of dynamic venting valves overcomes most of the limits of standard venting solution. This innovative technology is able to help resolve the most common effects of poor cavity venting allowing achieving better quality parts and reducing scraps during production. Moreover, dynamic valves allow reducing injection pressure and injection time leading to energy saving during the molding process.

**References**

2. Randy Kerkstra, “The Designer’s Edge: Venting of Mold Components”, Moldmaking Technology Article 7/10/2015