Minimizing gas porosity in die castings

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The issue of minimizing porosity is and continues to be a challenge to die casters. Since porosity is inherit in the high pressure die casting process we are all faced with the challenge of determining the best method of venting the die cast die to control porosity.

We will look at two aspects of minimizing porosity- in the metal feed system and the evacuation of the cavity. We first need to determine the type of porosity before we can correct it. Each type of porosity has a different corrective action so identification is critical. It can be difficult to positively identify the type so some time should be taken to make the correct determination.

There are three major causes of gas porosity in die castings; trapped air, stream and gas from lubricants.

The turbulent nature of the filling method used in die casting is a major factor in causing gas porosity. The need to atomize the metal during cavity fill is a reality. Even though we know that the metal must be atomized as it reaches the gates and fills the cavity we need to control the creation of turbulence. Our goal is to reduce turbulence as much as possible from the shot sleeve until the metal enters the cavity via the gate at which point we lose some flow control.

The following settings should be considered when setting up the process to help minimize air entrapment; metal pour rate, delay time before beginning shot, slow shot speed, transition point from pour hole to slow shot speed, slow shot speed and transition point from slow shot to fast shot.

The runners also need to be considered as a potential for creating turbulence and trapping air. If we utilize basic fluid flow techniques in designing the runner system the problems of creating turbulence and air entrapment will be gone. Runners should not be designed today with sharp corners, sharp turns, dead ends, out of proportion, and variations in cross sections. Basic flow principles suggest designs with smooth turns, decreasing areas from the plunger to the gate and ejector pins located on runners and gates to be flush and contoured to match there configuration. This same proportioning concept should be used in the designing of gates, either fan or tangent.

To this point we have a good chance of minimizing turbulence and air entrapment if we engineer the metal feed system properly, utilizing basic fluid flow and physics principles.

Once the metal begins entering the cavity it should be traveling at a velocity to attain the minimum atomization speed, which is a very turbulent flow condition. This means that we will lose control of the flow pattern to a degree due to the casting configuration. We can over come some of this tendency by locating the gates in areas of the casting that will provide the least restriction and turbulence possible along with maintaining the shortest distance for the metal to flow until cavity fill is reached. Ideally we have a minimum volume of air entrapped in the metal at this point of fill. Regardless of how good our metal feed system design, air will be present in the shot sleeve, runners, gates, and cavity during injection. This air will have to be either evacuated or be mixed with the metal as it solidifies, creating porosity.

The evacuation of this air is critical to the quality of the castings and is the major cause for rejects in the die casting process. This is due in part to the resistance created when the air is compressed during injection, requiring the die casting machine to over power trapped air. During the injection process this is usually addressed by adding a means of allowing the air to escape the cavity. This ranges from reducing locking force and allowing the "tool to breathe", to the application of what has become termed as "vacuum die casting". The first option, reducing locking force, should not exist today since we know that not holding pressure on the metal creates porous castings.

The majority of die casting continue to utilize the conventional venting system, which consist of a series overflows and vents to atmosphere through a .005" to .008" gap machined in the mold base. This conventional thinking works in some cases but we are suggesting that a more scientific approach be taken to determining the area required for adequately evacuating a cavity. Appling basic physics to the question of cavity evacuation, we have a space with a volume of air and the air must be evacuated in a specific amount of time through an area large enough to allow it to escape. This volume, time = area is the key to minimizing gas porosity in high pressure die castings. The real key is determining the best method to use for a specific die casting application. This is where the real issue exists, what method should be considered and how do we determine the area necessary.

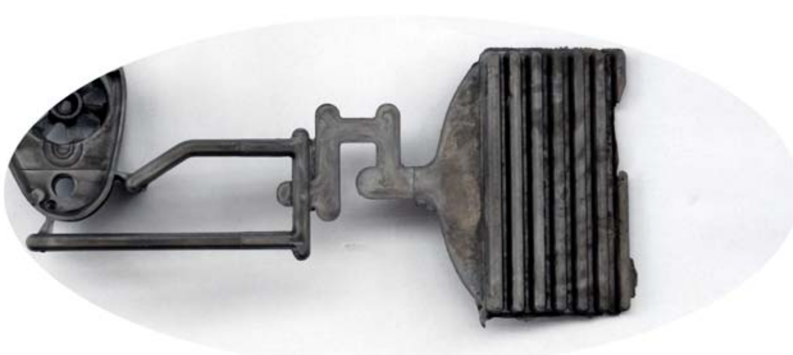
As an example a 1 pound casting needed a .006" thick vent thickness, the total vent to atmosphere would be 12.8". This calculation would apply to vents only.

Several things to keep in mind when considering vents is the tendency to plug with spray build up or stick to the mold base. When running with automation this becomes even more of a challenge since the operator is not looking at the tool as it opens each shot. All the process control will not overcome plugged vents.

Another consideration is the loss due to flash not being capable of recycling. Flash is scrap and can not be reclaimed.

Overflows provide a space for air to be trapped and if located properly function for some applications in conjunctions with vents.

Vent blocks are the next consideration for several reasons, they utilize a vent runner which provides more area than a series of .005" thick vents and the majority of the metal can be reclaimed. The vent runners can either be tied into an overflow or a vent gate which can be attached



to the cavity in the last places to fill. Vent blocks allow for a thicker vent to achieve enough area required for cavity evacuation. It is critical that the proper design basics be utilized when configuring a vent runner-block system. Make sure that enough resistance to metal flow in the vent runners is provided. Installation of the blocks and the method keying is important since a shift in the blocks will prevent venting from occurring.

With both conventional vents and vent blocks the air must be pushed out of the cavity. The most efficient and effective way to evacuate the cavity is with vacuum assistance.

Vacuum has the advantage of pulling, which reduces pressure in the cavity, removes gases that are created when the metal comes in contact with die spray and lubricants.

Vacuum also has the benefit of removing a portion of the residue materials prior to the metal entering the cavity. This will minimize the chance of gas porosity forming during solidification.

The calculations for vacuum block areas are similar to the one used for venting, however the required areas is less due to the pulling effect of the vacuum. It is just as critical to design the vacuum system as the inlet feed system. Locating both vent and vacuum runner-gates at the last places to fill is needed to assure adequate evacuation. Consideration in the sizing of the vacuum runners is necessary since a large runner will provide no benefit if the vacuum blocks area is not as large, metal will be wasted. Conversely too small a vacuum runner can cause problems during ejection. Providing the necessary resistance in the runner will also be needed to prevent blowing metal through the block.

Conclusion

Today, even more than in the past, reducing gas porosity poses a major challenge to the die caster. Customer's ever-increasing requirements for high quality, near free porosity castings demands improved evacuation of air from the die cavity. The die caster must be aware of this problem and select the proper corrective action and equipment for reducing porosity, and improving yields. Conventional vents and overflows may be adequate for attaining average die casting quality; on the other hand the average castings are not saleable in today's worldwide marketplace.

Vacuum assist, or vent blocks properly designed and applied, can be one of the answers to the challenge of producing higher quality castings and dies.