ALUMINUM & ZINC DIE CASTING

Casting Porosity

INTRODUCTION

Porosity in castings is a fairly common complaint of casting users and heightens customer concerns about part reliability and quality. Although porosity is inherent in all castings, the solution is to control the porosity which in turn depends on understanding and determining its sources.

POROSITY

Porosity in a casting is air entrapment during solidification. It is usually necessary to address porosity when specifying die castings. Minimizing porosity begins with up-front planning in the design of the part and die casting die and control during the casting process.

Sophisticated process control and monitoring equipment as well as simulation software is best utilized for castings with stringent porosity requirements.

If specific porosity will be detrimental to the use of the product being cast, the die caster must be informed of the areas that will require special control to reduce the incidence of such porosity. This information must be supplied in detail at the time of the RFQ, so that measures such as part design change requests, accountability for higher scrap or utilization of special processes, can be taken in advance of die design and construction.

The skin, which has a finer grain structure, begins at each surface and extends inward to a typical thickness of .015 to .020 in. The finer grain structure and relative absence of porosity give the skin superior mechanical properties. The removal of the skin to a depth greater than

.015 in. by secondary processes, such as machining, increases the chance of exposing porosity. These important points are not widely recognized by designers. The as-cast surface or skin is more dense than the core, so removal by machining should be minimized.

The die caster should be aware of critical areas as porosity can be managed to a large extent via gating, overflows, vacuum-assist including chill or vent blocks and various process parameters.

Since zero (0) porosity is virtually impossible to achieve in a die casting, the size, nature and location of permissible porosity should be identified by the customer, with the agreement of the die caster. The user should be agreeable to accepting a specified amount of porosity in areas of the casting where it does not impact fit, form or function.

INTERNAL POROSITY

Part prints should call out the areas where only the lowest levels of porosity can be tolerated, areas where additional porosity can be tolerated and areas where larger porosity will have no effect on the casting application.

It is important that the user not specify porosity limits that are more stringent than required for the application. It is also usually necessary to establish specific porosity standards independently for each component design. The specification of special porosity detection operations will increase the cost of the castings.

The type of porosity may be important in defining porosity standards. A small dispersion of smooth, round holes (salt & pepper generally less than 1mm in diameter), which are caused by the release of dissolved hydrogen or entrapped gas bubbles, may have a minimal effect on part strength and will not tend to cause leaks.

In critical areas of a casting, where porosity is a concern, the acceptable porosity can be specified in the following format:

1. The maximum allowable size of individual porosity pores
2. The maximum allowable density of pores in a defined area

For example: Porosity specification in crosshatched marked areas on print: .050 in. maximum porosity pore size, maximum of 10 pores per .500 in^2.

More jagged-shaped shrinkage porosity, caused by solidification, can cause more distinct problems. This is typically a part design-related issue, and is caused by heavy sections in the casting. Shrink porosity can be interconnected and may result in leakers. The shrink porosity does not have to be visible to cause leakers and is often microscopic in nature. Shrinkage porosity, when exposed, can be larger than gas porosity.

POROSITY SOURCES

Sources include, but are not limited to, the following:

1. the particular design of a part which can have areas that interrupt metal flow, including thin wall areas

2. lack of vacuum-assist die casting processes, including vent blocks, to instantaneously remove air in the mold cavities prior to the molten metal being injected and flowing into a die.
3. improper gating design which controls the metal flow into and out of a part
4. improper overflows or vents preventing air or air/gas bubbles to flow out of a part,
5. cores or other part design obstructions that may cause metal flow disturbances,
6. high temperatures of molten metal causing excessive heat concentrations such as at gate entries,
7. solidification shrinkage,
8. reactions of die steels to high temperature molten metal alloys,
9. dissolved gases from the molten metal, such as dross containing gas porosity. Professional die casting companies continuously remove or otherwise control dross prior to metal ladling,
10. improper ladling or metal pouring procedure,
11. improper fast shot speeds,
12. low injection pressures caused by worn shot pistons, hydraulic fluid pressure loss or pre-fill accumulator tank pressure loss,

POROSITY AND PERFORMANCE

Many part designers create effective designs that meet customer specifications for fit, form and function, yet do not always consider designing a part for die casting, inherent porosity or overall cost effectiveness. Part quality or performance testing can be done, such as non-destructive penetrant or x-ray inspections. But these methods are not always accurate, and in some cases are subjective rather than objective, do not guarantee quality or performance, and can be costly.

KENWALT SIMULATION SOFTWARE, THIN-WALL GATING AND VACUUM-ASSIST

At KenWalt Die Casting Company we use advanced systems to produce the highest quality die castings possible. 3D Flow Modeling or Metal Flow Simulation Software is used to analyze and determine optimum gating designs. Thin-wall gating techniques are used which allow us to optimize metal flow to obtain the most dense castings. And we use Vacuum-Assist Die Casting Systems that normally allow us to remove or draw out 10X more air from dies than the normal casting process. Over 40 years of die casting experience producing high quality aerospace parts along with the use of state-of-the-art systems allows us to obtain optimum conditions for dense castings and high quality finished products.

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