Q1: How to reduce the incidence of porosity in die casting product design?

A1: The use of die-casting to manufacture parts can indeed produce excellent surface quality and close tolerances, but there is still the risk of holes or voids in the casting; therefore, every product designer and engineer needs to understand the formation of holes or voids and what measures can be taken.

Porosity refers to any holes or voids in the casting. The causes of defects may be slightly different depending on the materials selected for aluminum, zinc, magnesium, etc. Porosity may be caused by impurities in the cast metal, environmental pollution, or oil and moisture in the mold, which can only be controlled by using the correct materials and quality control procedures.

Another common reason is caused by gas. Air may be trapped in the mold and must be discharged through vents in the mold. When the air escapes, the molten metal is pressurized to fill the cavity; however, it is possible that some air molecules are suspended inside the metal.

In addition, on the surface near the tool wall, the metal quickly cools and solidifies to have a fine texture, while away from the colder tool wall, the molten metal takes longer to solidify. During this longer cooling cycle, the metal shrinks slowly. The process will produce tiny voids, in these voids, hydrogen molecules in aluminum migrate into the voids and become gaseous to form holes.

So, how do we control the porosity in product design can be roughly divided into several major items:

• Thin wall：The first thing to understand is that the part of the molten metal first solidifies on the surface, and the cooling extends inward to the thicker part. The thinner outer layer, up to about 0.5 mm, is fine-grained, has a small porosity, and can be stronger than a thicker core. From a designer's point of view, this means that many areas that require greater strength can achieve this goal without the need to add more materials.

• Permissible porosity in areas with less mechanical stress：Porosity is not always detrimental to some functions. Parts and molds can be designed so that larger porosity areas are concentrated in areas with less mechanical stress or areas that do not impair functionality. In many cases, it is better not to leave these areas alone instead of using complex mold configurations that are expensive and time-consuming.

• Consistent wall thickness：At present, the most common cause for porosity is the uneven cooling of the components in the cavity, which is caused by different wall thicknesses; therefore, the simplest and most convenient way to prevent this is to keep the wall thickness as consistent as possible.

• Angle rounded：Avoid acute angles and 90° angles as much as possible. The angle rounded will fill faster in the mold and will avoid hot and cold spots without affecting strength or function.

Without expensive professional processing equipment, including circulating cooling or the use of conformal cooling channels, or the vacuum die-casting process commonly used in the industry to effectively degas the molten metal to reduce porosity, it is almost impossible to prevent certain porosity.

Compared with the above mentioned remedial measures, it is wiser to evaluate the location of the holes during product design and plan the design, accordingly, control the porosity of die castings to improve the yield of the product, and reduce unnecessary additional processing time and costs.

This article is excerpted by Wang Yujie, a graduate student of the Department of Mechanical Engineering, National Taiwan Ocean University, from: Porosity in Pressure Die Casting and How To Control It, from Star Rapid.