

Dummy Report for Materials & Introduction to Manufacturing Technology 2019



JANNERY 2019

MODULE NAME: MATERIALS & INTRODUCTION TO MANUFACTURING

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1. Introduction

This mission is to provide a company with better production processes for bushes and sleeves. After comparing various casting methods, the paper decided to recommend the company to use pressure die casting or investment casting to meet the production needs of the company. Reduce large-scale production costs, improve product surface quality, and reduce material loss.

2. Sand-casting and secondary machining processes

2.1. Introduction of sand casting and secondary machining processes

Sand casting is the most popular and simplest type of casting. The castings it produces have been used for centuries. Sand casting is used to make large parts such as grey cast iron, ductile iron, stainless steel and other types of steel. (Campbell, 1993) The main steps include painting, mold, core making, molding, melting and pouring, cleaning, etc. Sand mould is generally cast by gravity, and when it has special requirements, it can also be used in low pressure casting and centrifugal casting. (Degarmo, et al., 2003) Sand casting has a wide adaptability, and small pieces, large pieces, simple pieces, complicated parts and single pieces can be used. The mold used for sand casting was previously made of wood and is commonly known as wood mold. (Todd, et al., 1994) The disadvantage of the wood mold is that it is easily deformed and easily damaged; in addition to the sand casting produced by a single piece, an aluminum alloy mold or a resin mold having a high dimensional accuracy and a long service life can be used. Although the price has increased, it is still much cheaper than the mold for metal casting, and the price advantage is particularly prominent in small batches and large parts. The basic raw materials for sand casting are foundry sand and sand binder. The most commonly used foundry sand is siliceous sand. When the high temperature performance of silica sand can not meet the requirements of use, special sand such as zircon sand, chromite ore, corundum sand is used. (Gutowski, 2004)

Since the dimensional accuracy of sand castings is generally poor, it is necessary to use the secondary machining process after the completion of the casting blanks. The secondary machining generally has machining processes such as turning, grinding, milling, etc., and the machining accuracy is generally determined by the requirements of the parts, about IT6-IT8 level in common. For a size length of 100 mm, the error is about 22 μ m - 54 μ m. The surface roughness of ordinary grinding is generally Ra1.25~0.16 μ m. (Li, 2014)

2.2. Advantages and disadvantages of Sand casting

Advantages:

Lower raw material costs: due to the rich resources and low prices of clay. When the company adopts the sand casting process, most of the used clay wet sand can be recycled after proper sand treatment; (Guharaja, 2006)

The cycle for manufacturing the mold is short and the work efficiency is high: since the sand mold is convenient to manufacture and the manufacturing cost is relatively low, the single piece or the large piece is relatively easy to produce, the time for manufacturing a single mold is short, and the work efficiency is high.

The mixed molding sand can be used for a long time: due to the fact that the molding sand is not easy to deteriorate and easy to store, the service life of the

molding sand is generally long. (S.Sulaiman, 2004)

Disadvantages:

High-scale production costs: Because each sand mold can only be poured once, the mold is damaged after the casting is obtained, and must be reshaped, so the sand casting is less efficient, when the company uses sand casting to produce bushes and sleeves. When the product needs large-scale production, when each product in the production process needs to be reshaped, it will undoubtedly increase the production cost of the product.

The rigidity of the mold is not high, and the dimensional accuracy of the casting is poor: due to the inherent defects of the sand casting, the workpieces produced by the casting are often only casting blanks, the dimensional accuracy is low, and the surface roughness is poor. It requires secondary processing to form the required parts, so the process is relatively large and the mass production cost is high.

Castings are prone to defects such as sand washing, sand inclusion, and porosity. (SSulaiman, 2001)

3. Pressure die casting

3.1. Introduction of Pressure die casting

Pressure die casting is a kind of special casting method with less cutting and less development in modern metal processing technology. It is a process of filling a molten metal at a high pressure and high speed and crystallizing it under high pressure to form a casting. (X.P.Niu, 2000) High pressure and high speed are the main features of pressure die casting. The commonly used pressure is tens of megapascals, the filling speed (inner gate speed) is about 16 to 80 m/sec, and the time for the molten metal to fill the mold cavity is extremely short, about 0.01 to 0.2 seconds. (M.Regev, 1997) Therefore, high pressure and high speed are fundamental differences between pressure die casting and other casting methods, and are also important features. In 1838, the first time Americans used the pressure die casting method to produce printed letters, and the next year there was a pressure die casting patent. After the 1860s, the pressure die casting method has been greatly developed. It can not only produce tin-lead alloy die-casting parts, zinc alloy die-casting parts, but also aluminum alloy, copper alloy and magnesium alloy die-casting parts. After the 1930s, the steel pressure die casting method was tested. (MASKREY, 1978)

The principle of pressure die casting is mainly the principle of injection molding of molten metal. Usually, the casting conditions are set by the speed, pressure, and speed switching positions on the die casting machine, and others are selected in the die casting type. (RaimoHelenius, 2005)

3.2. Advantages and disadvantages of Pressure die casting

Advantages:

Good product quality: In this case, if the company adopts pressure die casting, then the casting has high dimensional accuracy, generally equivalent to 6~7, even up to 4; good surface finish, generally equivalent to 5~8; strength and The hardness is higher, the strength is generally 25~30% higher than that of sand casting, but the elongation is reduced by about 70%; the size is stable and the interchangeability is good; the thin-walled complex casting can be die-cast.

High production efficiency: high machine productivity. For example, the JIII3 horizontal cold air die casting machine produced in China can die-cast 600-700 times on average, and the small hot chamber die-casting machine can die-cast 3000~7000 times every eight hours. The die-cast mold has a long service life. , a die-casting mold, die-casting alloy, life expectancy of hundreds of thousands of times, or even millions of times; easy to the company's current mechanization and automation of bushes and sleeves; (K.Domkin, 2009)

Excellent economic results: due to the precise size of the die-casting parts, the surface is bright and clean. Die-casting workpieces generally do not require secondary machining and can be used directly, or the castings require a small amount of further processing, so the die-casting process not only improves the metal utilization rate, but also reduces a large amount of processing equipment and man-hours;

Castings are cheap: company can use combination die-casting with other metal or non-metal materials. Saves assembly time and saves metal.

Disadvantages:

Some inherent defects: During die casting, due to the high velocity of the liquid metal filling cavity and the unstable flow state, when the general pressure die casting method is used, the bushes and sleeves are prone to generate pores and cannot be heat treated; (K.D.V.Yarlagadda, 1999)

Material limit: When bushes or sleeves are produced from high melting point alloys such as copper and ferrous metals, the life of the die casting mold is low.

It is not suitable for small batch production: The main reason is that the die casting mold has high manufacturing cost, the large-scale production efficiency of the die casting machine is high, and the small batch production is uneconomical.

4. Investment casting

4.1. Introduction of Investment casting

The investment casting process, simply by making a fusible model (for example, a melt mold or a mold) with a fusible material (such as a wax or plastic), is coated with several layers of special refractory paint, dried and hardened. After forming a monolithic shell, the model is melted from the shell by steam or hot water, and then the shell is placed in a flask, filled with dry sand molding around it, and finally the mold is placed in a roaster at a high temperature. Calcination (for example, when a high-strength type shell is used, the demolded shell can be directly fired without styling), and the mold or shell is fired, and molten metal is poured therein to obtain a cast piece. (SJones, 2003)

Investment castings have high dimensional accuracy, generally up to IT4-6 (sand casting is IT10~13, die casting is IT5~7). Of course, due to the complicated process of investment casting, there are many factors affecting the dimensional accuracy of castings, such as mold. The shrinkage of the material, the deformation of the investment mold, the change in the amount of the shell during heating and cooling, the shrinkage of the alloy, and the deformation of the casting during solidification, etc., so the dimensional accuracy of the ordinary investment casting is high, but Consistency still needs to be improved (the dimensional uniformity of castings using medium and high temperature waxes is much higher). (Lopes, 2003)

When the investment mold is pressed, the molding having a high surface finish of the cavity is used, and therefore, the surface finish of the investment mold is also relatively high. In addition, the shell is made of a refractory paint made of a special binder with high temperature resistance and a refractory material, and is coated on the investment mold, and the inner surface of the cavity which is in direct contact with the molten metal has a high surface finish. Therefore, the surface finish of investment castings is higher than that of general castings, generally up to Ra.1.6~3.2 μ m.

The biggest advantage of investment casting is that because of the high dimensional accuracy and surface finish of the investment casting, it can reduce the machining work, but only a small amount of machining allowance is required on the parts, even some castings only Leave the grinding and polishing allowance and use it without machining. It can be seen that the investment casting method can save a lot of machine tool equipment and processing man-hours, and greatly save metal raw materials. (JulioAguilar, 2011)

Another advantage of the investment casting process is that it can cast complex castings of various alloys, particularly casting high temperature alloy castings. For example, the blade of a jet engine, its streamlined profile and cooling cavity, can hardly be formed by machining. The production by the investment casting process can not only achieve mass production, but also ensure the consistency of the castings, and avoid the stress concentration of the residual knives after machining.

4.2. Advantages and disadvantages of Investment casting

Advantages

High dimensional accuracy: Investment casting casting dimensional accuracy is generally up to IT4-6 (sand casting is IT10~13, die casting is IT5~7), for 100mm size, the accuracy error is only between 15-22 μ m. The surface roughness is only Ra.1.6~3.2 μ m.

Can improve the utilization of metal materials: the use of investment casting can significantly reduce the processing of the forming surface and mating surface of the product, saving processing time and the consumption of cutting tool materials;

It can maximize the similarity between the blank and the part, which brings great convenience to the structural design of the part: Casting casting with complex casting shape can cast castings with very complicated shapes, and can also cast a wall thickness of 0.5mm. For castings with a weight as small as 1g, it is also possible to cast a combined, integral casting; (Yuan, 2003)

Not limited by alloy materials: Investment casting can cast carbon steel, alloy steel, ductile iron, copper alloy and aluminum alloy castings, as well as castings of high-temperature alloys, magnesium alloys, titanium alloys and precious metals. For alloy materials that are difficult to forge, weld and machine, it is particularly suitable for casting by precision casting;

Disadvantages

The single piece production price is higher: investment casting is the most complicated in all the blank forming methods, and the casting cost is also high. However, if the product is properly selected, the part design is reasonable, and the high casting cost reduces the cutting, assembly and metal saving. If the material is

compensated, the investment casting has good economy. (Jean-ChristopheGebelin, 2003)

5. Conclusion

Based on the above discussion, ordinary sand casting produces a single piece of castings at a low price, but the dimensional accuracy is low, requiring secondary processing to assist, and if the company uses a pressure casting process, high dimensional accuracy and surface quality can be obtained. However, since the manufacturing cost of the mold is higher than that of the sand type, it is more suitable for mass production, while the investment mold can obtain higher dimensional accuracy and surface quality, but the process is relatively complicated and the cost is relatively high, which requires the company to use rationally to reduce production costs.

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