

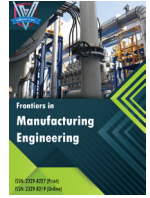


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DISCUSSION ON EXPENDABLE PATTERN CASTING TECHNOLOGY

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ABSTRACT

In this paper, through the discussion of the principle of expendable pattern production process, the analysis and discussion of the process of expendable pattern white area and black area and the importance of refractory coatings to expendable pattern casting, the advantages and defects of expendable pattern in the casting process are summarized. It provides a practical basis for the production and use of daily expendable pattern casting.

KEYWORDS

Expendable pattern, Casting process, Discussion.

1. THE WORKING PRINCIPLE OF EXPENDABLE PATTERN TECHNOLOGY IN CASTING PRODUCTION

Expendable pattern casting is commonly referred to as EPC. In the industry, EPC is also called gasified mold casting or solid mold casting. The basic principle of the process is to bond paraffin or foam models that are similar in size and shape to the pre-molded casting into clusters. The outer surface of the model cluster is coated with refractory paint and heated and dried, then buried in dry quartz sand to vibrate and form. The casting is carried out under the action of negative pressure to make the preset model quickly vaporized. The high temperature liquid metal occupies the prefabricated model position. The casting is formed after the hot liquid solidifies and cools. This is a new casting method.

Expendable pattern casting is a new casting method with high forming rate, small processing allowance and accurate forming of blank. The advantage of this new casting method is that it does not need to remove the pre-made sample mold from the mold cavity. At the same time, the parting line can not be seen in the appearance of the product. It is also not necessary to use sand cores in the lost die casting process. Therefore, there are no casting defects such as burrs and draft angles on the formed product. At the same time, problems such as dimensional deviation caused by the combination of cores and boxes can be reduced.

After the casting is completed, the machining allowance can be reduced to 1.5mm to 2mm. Due to the reduction of the machining allowance, the costs related to the subsequent processing consumption of mechanical manufacturing can be reduced. Compared with the traditional sand casting method, the use of the expendable pattern casting process reduces the amount of machining. It can be greatly reduced, and the amount of machining can be reduced by 40% to 50%. This technology was first invented and created by H.F. Shroyer of the United States in 1958, and then it was continuously improved by the scientific research of relevant technical researchers from Germany, Japan, Italy and other countries.

In the 1980s, China also introduced expendable pattern casting production technology. In recent years, the expendable pattern casting process has developed rapidly in China, and the development results are very optimistic. A foundry machinery factory in Kunming, Yunnan, China has done a good job in the field of expendable pattern research and development. Its products have been exported to Malaysia and other neighboring countries. In addition, Tsinghua University, Huazhong University of Science and Technology and other colleges and universities have made valuable contributions to the research and development of expendable pattern technology.

2. PROCESS FLOW OF EXPENDABLE PATTERN TECHNOLOGY

The process flow of expendable pattern casting is divided into two parts: white area and black area.

Process flow of the expendable pattern white area: The white area is mainly a procedure for making foam models. The foam molding process should first consider the wall thickness and material of the casting, and select a suitable foaming agent (original foaming beads). After finding suitable foaming beads, put the original beads into the batch pre-expander for foaming. Process requirements should be considered when foaming, such as: density, strength and other indicators. After drying on the vulcanized bed of the preconditioner, it is transported to the curing bin for curing. Then in the molding workshop, the matured beads are injected into the preform mold, and then heated and humidified by steam to expand and melt the beads, and finally fill the mold cavity to form a casting shape. Then, the temperature is lowered through the water cooling process, and the foamed white mold has a certain strength. Then it is dried in the drying room, and the white mold is completed.

Process flow of expendable pattern black area: The foundry places a special interlayer sand box on the vibrating equipment table, and then lays dry quartz sand with a thickness of about 100MM at the bottom of the box (the particle size of quartz sand is about 20-40 mesh). Then, the

quartz sand in the box is vibrated by the vibration equipment, and the top of the box is also scraped flat. Then the yellow model made in the white area is pre-placed on the bottom sand surface of the sand box. The position of the yellow mold in the sand box is arranged according to the pre-design. The reserved model of the runner used in casting is well connected with the pouring riser. The sandbox is filled with dry sand. The sand box is re-vibrated according to the process requirements. After the sand in the sand box is vibrated, the dry quartz sand at the mouth of the box is scraped again. After scraping, the box is covered with plastic film. The pouring cup is placed at the gate. At the same time, the plastic film on the edge of the box is fixed with quartz sand. The vacuum system hose is connected to the line at the bottom of the box. The equipment of the vacuum system performs the vacuuming operation. After the specified time and process requirements are reached, the dry sand in the box is tightened. In this way, the mold process of the black mold area is completed. The metal solution enters the mold cavity of the mold box through the pouring cup. The white mold evaporated and disappeared. The high-temperature metal solution quickly replaces the cavity of the white mold and overflows the gate, and the pouring procedure is completed. After the pouring is completed, the box should be pressure-maintained and cooled. After cooling, the vacuum equipment should be reset and the vacuuming process of the box should be cancelled. Finally, after the casting is cooled, the box is turned over and the casting is taken out.

3. THE IMPORTANCE OF REFRACTORY COATINGS IN EXPENDABLE PATTERN CASTING

A layer of refractory paint hanging on the outer surface of the foam model is one of the three key process factors for the success of the expendable pattern casting process. Overcoating is a key factor in reducing surface defects in castings and preventing other defects.

3.1 Working principle of external refractory coating

The finished Styrofoam model is buried in the sandbox.

The molding material in the sandbox can be tightly wrapped around the foam model. However, since the shapes of the moldings are almost spherical, the contact between the moldings is actually point contact, not surface contact. This results in many small gaps between the moldings. In addition to the effect of vacuuming, the molten metal can easily enter the gap between the mold materials, resulting in a succulent product, resulting in casting failure. Therefore, a layer of refractory paint is usually applied to the outer surface of the foam model before the expendable pattern is cast. The effect of this is:

- ① At room temperature, the strength and stiffness of the plastic model can be effectively improved. This can prevent the model from being deformed or damaged by dry sand during transportation and sand filling vibration between processes, thus ensuring the stability of the cavity.
- ② When the molten metal is poured, the refractory coating can effectively separate the molten metal from the molding sand. Therefore, it can effectively prevent the molten metal from infiltrating into the molding sand and causing unnecessary chemical reactions with it, so as to effectively prevent the castings from sticking to the sand and the castings from producing blisters and other defects. At the same time, the phenomenon of mold collapse is greatly reduced.
- ③ The external coating can absorb or penetrate the decomposition residues of the foam plastic mold, so that the foam plastic decomposition products and residues can be effectively discharged during the casting and molding process. This prevents defects such as carbon defects, porosity, etc. in metal castings.

3.2 Composition of refractory coatings for lost mold casting

The expendable pattern casting refractory coating includes refractory aggregate, carrier (solvent), suspending agent, binder and other additives.

Refractory aggregate. It is the main component of the expendable pattern casting coating. It has the functions of heat insulation, isolation, anti-sticking sand and reducing the roughness of the casting surface. In the expendable pattern coating, its mass fraction is usually more than half. It

mainly includes refractory materials such as zircon powder, bauxite, talc powder, brown corundum powder, quartz powder, stone powder and mica powder. Under normal circumstances, different refractory mineral materials are selected according to the different materials of the castings. In addition, it is necessary to take into account the prevention of sand sticking and high air permeability. The particle shape determines that it is more conducive to improving air permeability. Therefore, a certain number of spherical particles are usually selected in actual production. This is more conducive to the discharge of gas after the sample model is vaporized by the high-temperature molten metal solution.

Carrier (solvent). The main components of the carrier of foundry coatings are ethanol and water. For expendable pattern casting refractory coatings, it is necessary to consider hanging coating, gas generation, drying, price, etc., and use water as its carrier, commonly known as water-based coatings. At the same time, the suspension and thixotropy of water-based coatings are better, and it is more convenient to adjust.

Binder. The binder in the expendable pattern casting refractory coating plays a very important role in the strength and adhesion of the expendable pattern coating. This improves the strength and hangability of the refractory coating. Suspension is improved. Die coating has better adhesion.

4. ADVANTAGES AND DEFECTS OF EXPENDABLE PATTERN IN CASTING PROCESS

4.1 Advantages of using expendable pattern

Styrofoam is used when making the white mold. Its density is small. The labor intensity of the operators during the operation is low. The foam material will not pollute the environment at normal temperature, and has little harm to the human body, and it is easy to achieve clean production.

Compared with the traditional casting process, the expendable pattern casting process does not require the production of cores. The moulding procedure is greatly simplified. The post-treatment process of sand used in casting is also simple. White molds and yellow molds also have a small amount of handling between processes. The labor intensity is greatly reduced. In the process of white mold processing and transportation, it is easy to realize mechanized and automated production.

Dry sand modeling has good fluidity. This eliminates the need for sand mixing procedures and equipment. Noise and dust generation are greatly reduced. In this way, the old sand recovery equipment and processes are also saved.

The expendable pattern casting method does not use the making of the core. The rough castings produced by this method have relatively high precision. The refractory coating on the outer surface of the blank is easy to fall off. In this way, the cleaning in the later stage of blank production is simple. The labor intensity of operators can be reduced.

The waste gas such as carbon monoxide and carbon dioxide produced in the production process of the expendable pattern casting process is relatively small. During casting, the white mold material is thermally decomposed and gasified under the action of the high temperature of the molten metal, resulting in a small amount of waste gas such as carbon monoxide and dioxide. And these exhaust gases can be effectively treated during the vacuuming process.

4.2 Defects in the casting process of expendable pattern technology

Because the pre-production preparation work is not in place, the theoretical negative pressure value of the system is designed to be relatively low. This can cause sand sticking defects in castings.

Due to the low temperature of the molten metal, the casting of the workpiece is not fully poured. Cracks or fractures occur when the cast product is subjected to external force. There are oxide inclusions at the fracture and they are not fused together. This is the reason for the defect of the cold barrier.

The shape of the slag holes formed on the castings by the metal oxides of

the casting materials and the slag and slag of the refractory materials is irregular. From the appearance color, the slag hole caused by the molten slag is black. The charge slag holes do appear white. At the same time, the hot melt of refractory material is used in the ladle, and black slag is displayed on the surface of the casting. This is the reason for the defect of slag inclusion.

5. CONCLUSION

The expendable pattern casting technology is a major trend in the development of the foundry industry in the future. It is in line with the concept of sustainable development advocated by our country. The development prospects of this process are very broad. It has unparalleled advantages over traditional casting techniques. At the same time, it also meets the requirements of energy conservation and environmental protection now advocated. Its use greatly reduces the pollution of noise, dust and smoke. This also greatly improves the working environment of operators and reduces the labor intensity of operators. It is believed that

the development prospect of expendable pattern is very broad.

REFERENCES

- [1] Tao, J. and Liu, Z. 2007. The Status Quo and Development Trend of Lost Foam Casting Technology in Europe and the United States - A Side Note of the 4th. (2006) Paderborn lost foam seminar. Special casting and non-ferrous alloys, (2), 37-44.
- [2] Zhang, Z. and Xiao, Y. 2010. Three-dimensional Numerical Simulation of Lost Foam Casting of in-line Six-cylinder Engine. Special casting and non-ferrous alloys, (8), 49-57.
- [3] Liang, G. and Li, Z. 2008. The Current Situation and Prospect of Chinese Solid (lost foam) Casting. Foundry Technology, (8),112-119.
- [4] Liu, L., Zhou, J., Xu, Q., Fang, S., Wu, Y. and Chen, Z. 2001. Development of Lost Foam Casting Coatings. Foundry Technology, (5), 87-95.

