Cost control of mold enterprises under the trend of intelligence

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Abstract. The intelligentization of molds is an important development direction and frontier of molds at present, and the intelligentization of molds will have a huge impact on the development of the mold industry. Based on this, this paper first expounds the development background and cost structure of the mold manufacturing enterprise, then systematically analyzes the cost composition of the mold manufacturing industry, and finally proposes effective measures for the cost control of the mold manufacturing industry under the intelligent background.

1. Introduction

In recent years, China's mold market has grown more and more, and its proportion in the global mold market is also increasing. With the development of information technology and digital technology, the intelligentization of molds is gradually emerging. Injection molds and die-casting molds that can control temperature and pressure are becoming popular, new mold structures are emerging, and precision forming control and technology are also receiving more and more attention from mold companies, showing the initial characteristics of many molds. However, in order to achieve effective cost control, the mold manufacturing industry must carry out professional cost analysis in combination with the characteristics of the production mode to achieve the requirements of reducing costs and improving efficiency.

2. Classification of mold materials

Commonly used metal molds can be divided into three categories according to the processing technology, namely cold work molds, hot work molds and plastic molds. The use of different molds is different, and the working conditions are different, and the requirements for mold materials are not same.

The chemical composition and heat treatment process of commonly used cold work die steel are listed below. T7 belongs to carbon tool steel, which is characterized by high hardness and toughness and poor cutting performance. Its chemical composition is shown in Table 1, and the heat treatment process is shown in Table 2.

| Element | C    | Si | Mn | P    | S    |
|---------|------|----|----|------|------|
| Quality score /% | 0.620~0.730 | ≤0.360 | ≤0.400 | ≤0.037 | ≤0.025 |
Table 2. T7 heat treatment process.

| Project          | Heating temperature / °C | Open forging temperature / °C | Final forging temperature / °C | Cool down   |
|------------------|--------------------------|-------------------------------|-------------------------------|-------------|
| Steel ingot      | 1 100~1 140              | 1 070~1 110                   | 750~650                       | Air cooling |
| Steel billet     | 1 030~1 100              | 1 050~1 080                   | 800~750                       | Air cooling |

Hot work dies are divided into die-cast die steel, hot forging dies steel and hot extrusion die steel. The chemical composition and heat treatment process of commonly used hot work die steel are listed below. 2344 die steel is suitable for die casting molds with ductility requirements. The chemical composition is shown in Table 3. The heat treatment process is shown in Table 4.

Table 3. Chemical composition of 2344 mold steel.

| Element | C          | Si         | Mn          | S          | P           | Cr          | V           | Mo         |
|---------|------------|------------|-------------|------------|-------------|-------------|-------------|------------|
| Quality score /% | 0.30~0.45 | 0.70~1.20 | 0.30~0.50  | 0.026 max  | 0.006 max   | 4.55~6.00  | 0.70~1.30  | 1.15~1.65 |

Table 4. Heat treatment process of 2344 mold steel.

| Isothermal annealing | Annealing temperature 830~860 °C, heat preservation 2 h, furnace cooling + air cooling |
|----------------------|---------------------------------------------------------------------------------------------|
| High temperature tempering | The tempering temperature is 700~720 °C, the temperature is kept for 2 h, and the furnace is cooled + air cooled. |

Plastic mold materials are divided into thermoplastic mold materials and thermosetting plastic mold materials. The chemical composition and heat treatment process of common plastic mold steels are listed below. P20 is a common pre-hardened plastic mold material, which can be directly used only after cold working. The chemical composition is shown in Table 5.

Table 5. Chemical composition of P20.

| Element | C          | Si         | Mn          | P          | S           | Cr          | Mo         |
|---------|------------|------------|-------------|------------|-------------|-------------|------------|
| Quality score /% | 0.25~0.4  | 0.50~0.80  | 0.70~1.00  | ≤0.030     | ≤0.030      | 1.50~2.00  | 0.35~0.50 |

2.1. Application status of mold materials
With the increasing use of mold steel in China, the mold steel series has gradually formed. However, the market of mold steel in China needs further development, and it is necessary to develop more advanced production technology and improve the quality of mold steel. There are two ways to improve the quality of die steel: first, improve the production process and heat treatment technology of die steel; second, improve the technical management system to ensure product quality. At present, China has developed special mold steel with excellent performance in some fields, but the promotion of special mold steel is limited and the application is not extensive. Therefore, the development of advanced steel should be selective and cannot follow the trend blindly.

3. Mold manufacturing cost composition analysis

3.1. Design and development cost
The design and development stage is the key of mold production, and it is the process of designing the plan according to user need. The design and development stage mainly refers to the scheme design and process design. The scheme design section refers to the overall planning and overall control of the mold manufacturing enterprise according to the user's need, and the process is the presentation of the scheme design link, which is the mold production. The overall plan is broken down. The scheme design is the basis for ensuring the quality of mold production. The process design is the concrete realization form of the scheme design. The process design implements the design scheme of the mold, which results in material cost, processing cost and other costs. The relevant data shows that the proportion of design and development costs to the total cost of molds is more than 60%, which puts new demand on the cost control of the mold manufacturing enterprise design and development stage.
3.2. Raw materials and production process costs
Raw material and production process costs are mainly determined based on design and development results. Raw material costs will include certain floating costs. These floating raw material costs will not change due to changes in mold production and manufacturing models. It is worth noting that once the design of the mold is determined, the cost of the raw materials is relatively fixed, and unless the price changes occur by the supplier, the price difference will not be formed. As long as the production process is based on the design and process design of the mold processing and processing, the resulting costs include labor costs, depreciation of fixed assets and site occupancy fees, in addition, machine tool work status, process flow, design and development is reasonable. Factors such as sex can also significantly affect the cost of the manufacturing process in mold manufacturing companies.

3.3. After-sales service cost
The non-repetitive nature of mold manufacturing determines the individuality and uniqueness of mold production. Taking the stamping die as an example, in order to further improve the production qualification rate of the mold and meet the individual requirements of the customer, the enterprise should carry out debugging, inspection and acceptance of the stamping die produced for a long time, and the safety and control of the mold. For the mold manufacturing industry, the delivery of the product does not mean the completion of the sales process. The cost incurred in the half year or one year after the mold is delivered and used should also be included in the cost of the stamping die.

4. Mold intelligence
The future smart mold consists of mold, sensor, network and control system, and forming process intelligent control software. In the process of forming the part, the mold transmits the real-time information acquired by the sensor to the mold forming control system, and analyzes and makes decisions by the intelligent software in the control system, and issues control commands to realize the intelligent control of the whole process of the mold forming process. Intelligent and networked is the future development direction of molds. Intelligent molds and networking will completely change the structure, form, design and working mode of molds. Therefore, mold intelligence will bring changes to the mold industry in the following aspects.

The intelligent design of the mold. There are two main aspects to the intelligent design of the mold. First, the use of intelligent design software is more extensive; second, the design and implementation of intelligent molds. The biggest difference from the current mold structure is that a large number of sensors are added to the mold, and the network of the mold makes it possible to link and integrate with other equipment and manufacturing modules.

The intelligence of the mold manufacturing system. There are also two aspects to the intelligence of the mold manufacturing system. The first is the intelligentization of the mold and its components by the manufacturing system; the second is the intelligent structural design of the mold.

The intelligence of the mold market. The intelligentization of the mold market makes the market more transparent and competitive. In addition to the technology, management and price advantages of the mold enterprises, the advantages of the company in the intelligentization of the mold will become an important bargaining chip in the market, which can further reduce the after-sales of the enterprise cost.

5. Analysis of cost control measures in mold manufacturing
Achieve a range of economies to achieve higher profits. At present, mold manufacturers design and produce mold products with diversity, and these molds have an intrinsic connection. When a mold manufacturer produces more than one product produced by a number of mold manufacturers, the scope economy will be generated. In order to achieve economies of scope, mold manufacturing enterprises must make full use of the production equipment inside the company; second, they must pay attention to improving the efficiency of stamping, numerical control and other processing equipment, in order to reduce the amortization cost of fixed assets, and obtain excess through effective equipment to achieve a range of economies. In addition, mold manufacturing companies rely on a single product to obtain a
competitive position with a strong risk, while adopting a range-based production and operation model, which can rely on product diversification to spread risk and avoid the cost increase caused by uneven market distribution. High problems, at the same time, internal business risks and external environmental risks are effectively controlled.

Mold enterprise management should be intelligent and networked, and standardize the production process. In the case of the characteristics of single-piece small-volume production of molds and the development of unmanned workshops, the intelligent and networked management of mold enterprises is very important. The existing management software will be replaced by more advanced intelligent management software. Database and cloud computing will become an important means for enterprises to reduce costs. In order to achieve effective control of logistics costs, the internal logistics department of the mold manufacturing enterprise should carry out active logistics management, minimize the inventory quantity of mold products, accelerate the inventory turnover rate and improve the after-sales service level.

Improve the practical experience and theoretical basis of designers. The practical experience and theoretical basis of the designer are important factors influencing the design of the solution and the design of the process. At present, designers lack practical work experience, and can not combine theoretical learning with real work, resulting in a disconnect between theory and practice. Therefore, designers must work hard to accumulate experience, enhance their understanding of mold products, and closely link product design theory, user needs and cost control objectives. At the same time, designers must strengthen the study of theoretical knowledge such as network and digital. Due to the rapid development of mold manufacturing technology and the continuous improvement of product design requirements, the theoretical basis of many designers cannot meet the actual work needs. To this end, designers can achieve rich and improved theoretical foundation through training, lectures and other means, and provide conditions for achieving high-level program design and process design.

6. Conclusion
The emerging technology and the demand for diversified manufacturing will bring huge impact to the mold industry, and the intelligentization of the mold will bring unlimited expansion space and possibilities for manufacturing. Of course, the road to intelligentization of molds still needs long time. The manufacturing model based on the combination of network and intelligence of the Internet of Things is the future direction of the manufacturing industry and the development of mold intelligence. This new situation will also reduce the production cost of the mold industry and improve the production efficiency of the industry.

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