Application of EDM Technology in Mold Manufacturing

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Abstract. After exploring the academic research of machinery, we may know that mold is the mother of industry. It is an important indispensable tool for mass production of products and rapid development of new products in the important basic equipment of the manufacturing industry. Its high efficiency, low consumption and high production consistency are not comparable to other mechanical manufacturing methods. It is precisely for this reason that the production of some high-tech industries must rely on the mold manufacturing industry as an industrial chain that complements each other. Some scientists have said frankly that the quality of the current mold industry has been able to measure the level of manufacturing at the national level. In the exploration of mold manufacturing, people have not stopped their steps. The adoption of EDM technology has promoted the improvement of mold manufacturing level and created a new stage for the application of molds in machinery manufacturing.

Keywords: Electric Spark, Mold, Manufacturing

1. Introduction

In today's fast-paced world of life and work, the international exchanges of all walks of life make the development of every high-tech very fast. This is normal. It is precisely because of the rapid progress of the mold industry that in order to meet some specific technical requirements of the machinery industry, materials with special properties have been introduced one after another. This is a good phenomenon in the development of high-tech machinery. For metal cutting technology in the machinery industry, this is a failure. It is precisely because of the production of new mold materials that the old metal cutting process will encounter more difficulties and related technical problems that are difficult to solve.

In this context, EDM technology has been widely used in the process of mold processing. The proposal of EDM is also an innovative step that people take to make up for the shortcomings of traditional metal cutting technology. But after it was put forward, many questions were also unfolded in academia. Fortunately, EDM technology has resisted these doubts, and it has now been widely used in the process of mold processing. However, recently scholars have discovered that its use may also affect the service life of the mold. In modern manufacturing, the surface treatment of the mold and the treatment of the surface quality of the mold using the EDM process can be the most effective way to increase the service life.
2. Analysis of the main factors affecting mold life during mold manufacturing

2.1. Mold life problems caused by mechanical parts
In the mold production process, the choice of materials is the most important part. If the choice of material is not appropriate, it will greatly affect the life and quality of the mold\(^2\). In addition, for example, in the process of some common injection mold experiments, we will find that the setting of the gate and the position of the runner may affect the quality of mold manufacturing. Therefore, we attribute them to the related quality problems of mold manufacturing and molding caused by improper mechanical design (see Fig 1).

![Figure 1. Die manufacturing based on EDM](image)

2.2. Mold life problems caused by unclear electrical wiring
In the process of mold production and manufacturing, its temperature control is also very necessary. The difference in temperature at different positions of different mold shapes results in differences in the mechanical capabilities of mold materials. In addition, during operation, the contact between the thermal plastic and the source of the wire will find a chemical type of carbonization reaction, which may cause a short circuit of the circuit. When the injection molding machine is energized, the frequent occurrence of power failure will also affect the insufficient melting of the hot instant material. This can also lead to the short life of the mold.

2.3. Inappropriate production management factors limit mold life
After the technical staff of the enterprise has set the production plan, the workers must carefully consider the actual operation and maintenance process\(^3\). If the equipment is unable to carry out perfect production and the mold usage specification is not clear, this will cause very serious product quality problems. For example, the solidification of the gate, the blockage of the gate and the pollution of plastic materials are the consequences of different types of improper production management. This will affect the service life of the mold.

3. Display of the characteristics of EDM technology in the mold manufacturing process

3.1. It can deal with difficult-to-process materials and odd-shaped workpieces
For the difficult-to-process high-hardness and high-strength mold materials, the traditional metal
cutting process has no way to process the mold. In contrast, EDM technology can cut high-toughness materials and process complex workpieces. This is because of the unique characteristics of electric sparks, people use it as the inheritance technology of metal cutting process.

| Mold processing skills          | Features                      |
|--------------------------------|-------------------------------|
| General machinery manufacturing | Low cost and low technology   |
| EDM                            | Medium cost and good quality  |
| CNC machining skills           | High cost and good quality    |

3.2. Processing integrity of fragile workpieces
In the process of working with EDM technology, the electrodes and workpieces working in the whole process cannot be in close contact. On the contrary, in traditional metal cutting, the cutter head must make close contact with the workpiece. For some thin-walled and weak-strength workpieces, the metal cutting process is difficult to ensure the integrity of the workpiece. In contrast, the supportability of EDM technology is more pleasing (see Table 1).

3.3. Unmanned operation is easier
EDM processing technology mainly relies on the sequential cutting of the two-dimensional drawings of the computer network to complete various shapes of workpieces. It can only perform step-by-step work in accordance with computer processing procedures. Therefore, it does not require workers to be guarded by the side throughout the entire work process. Unmanned operation only requires people to wait for the passage of time to complete various operations.

4. The main advanced application of EDM technology in mold manufacturing

4.1. Application of mirror processing technology
The high-performance mirror-finished circuit can effectively overcome the negative influence of the parasitic coefficients generated by distributed capacitance and inductance\(^4\). On this basis, it can also form a layer of carbon black film on the surface of the working electrode to effectively protect the surface of the electrode from any factors. Even on the surface of relatively weak electronic products such as mobile phones and tablets, electric sparks can also be used as the final finishing mold manufacturing process.

4.2. Application of EDM on the surface of the workpiece
In fact, the strengthening layer of the electric spark of the electric spark is a very effective way for the surface treatment of the mold. It is an alloyed film formed by the material of the electrode and the workpiece under specific conditions at the moment of discharge. This film is different from a simple oxide film, it has all the characteristics of the mold material. Moreover, it can withstand high-intensity shocks and clicks.

4.3. The application of mixed powder EDM mirror processing
The addition of conductive materials in the working fluid can change the state of electric spark discharge. It can significantly reduce the surface roughness of a large area of EDM processing under the condition that the surface properties of the mold material will not change. It makes it possible to manufacture large-area precision and complex profiles of mold materials.

5. Analysis of the main technical problems in the application of EDM in mold manufacturing

5.1. The relationship between electrode loss and machining accuracy
During the pulse discharge, the corrosiveness of the electrode will accelerate the wear of the electrode. According to the analysis of scholars, the loss of a large number of electrodes will reduce the
machining accuracy of EDM technology to a certain extent. Therefore, how to reduce the degree of electrode wear is a problem that needs to be solved in the current optimization process of EDM.

5.2. The impact of the accuracy of electric spark discharge on machining accuracy
In the process of using EDM to process the mold, it must be ensured that the pulse discharge between the electrode of the tool and the workpiece needs to maintain a certain discharge gap\(^5\). The width of the discharge gap can determine the stability of processing. Generally speaking, increasing the gap of pulse discharge can improve the accuracy of EDM.

5.3. The relationship between surface change layer and mold surface quality
The surface change layer formed by the combination of the solidified layer and the heat-affected layer has a very strong ability to resist corrosion. The appearance of this characteristic layer is due to the changes in the metallographic structure under the influence of high temperature. This is also an advantage of the workpiece material after EDM. Therefore, the surface characteristics of the mold after EDM are much better than those after ordinary processing.

6. Conclusion
The traditional form of metal cutting has been unable to find its specific advantages in the rapid development of today's manufacturing industry\(^6\). In order to meet the requirements of the times, research on the application of EDM technology in mold manufacturing is a step that must be carried out. It will also become the inevitable leading advanced technology for the development of the machinery manufacturing industry in the future.

References
[1] Jian-Yan Z. . The Application of EDM Technology in Mold Manufacturing[J]. Equipment Manufacturing Technology, 2012.
[2] Di W. . Application and Research of EDM Technology in Mould Manufacturing[J]. Modern Manufacturing Technology and Equipment, 2018.
[3] Nie, Dong, Suo, et al. Application of orthogonal experiment in EDM using the suspended powder fluid[J]. Journal of Wuhan University of Technology Materials Science Edition, 2002.
[4] Suolai-Chun N. . Application of Orthogonal Experiment in EDM Using the Suspended Powder Fluid[J]. Journal of Wuhan University of Technology-Mater Sci Ed, 2002, 17(4):92-93.
[5] Suolai-Chun N. . Application of Orthogonal Experiment in EDM Using the Suspended Powder Fluid[J]. Journal of Wuhan University of Technology-Mater Sci Ed, 2002, 17(4):92-93.
[6] ZHOU,Libo, YAGUCHI,Yuta, SHIMIZU,Jun. Development of Meso-Micro Mechanical Manufacturing (M^4) Technology[C]// The Japan Society of Mechanical Engineers, 2002.