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Comparison study for finished accuracy of WEDM process

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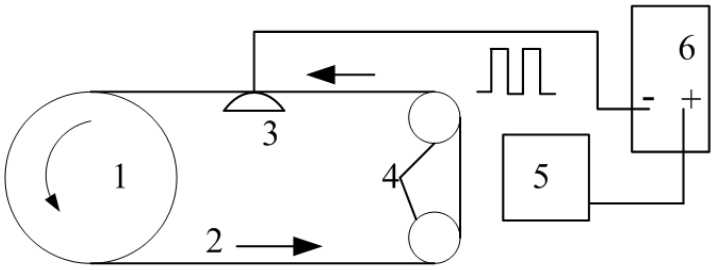
Abstract. WEDM wire-cutting processing is a special machining method using pulse discharge happenns between electrodes and workpieces. This paper have analyzed and compared the two working modes of high-speed wire-EDM machine and low-speed wire-EDM machine. For the holes or slots distributed in mould device should be machined by WEDM method and could meet technical regulation. If all the holes or slots with higher accuracy requirement are machined in one process, the form accuracy and positional accuracy mighty be achieved. The paper compared two machining methods for the special holes with experiment. The result indicates that the improved process can greatly improve the machining accuracy and this method can be used in WEDM-HS and WEDM-LS process.

Introduction

WEDM wire-cutting processing is a special machining method using pulse discharge happenns between electrodes and workpieces[1.2], which is shown in Fig.1. The processing principle is same as EDM forming, but the electrode used in machining is a mobile metal wire (molybdenum wire or copper wire), during which the workpiece connect with positive electrode of pulse power, the electrode silk connects with power negative.



1. Wire barrel 2. Electrode wire 3. Power feed contact 4. Guide roller

5. Workpiece 6. Pulse power

Fig.1 A simplified scheme of WEDM

In the process of machining, the system take molybdenum wire as cutting tool electrode, the wire cylinder instruct molybdenum wire move along positive and alternate direction and the pulse power supply processing energy[3]. Pouring liquid medium into the space of wire electrode and workpiece, at the same time, the workbench moves in two coordinate directions of horizontal plane according to control procedures. In according to the spark gap, the two servo consequently drive the platform movement, the various curve guide the workpiece cutting path. The WEDM can be classified as high-speed wire-EDM machine mode and low-speed wire-EDM machine mode[4]. Both the two machine modes are shown in Fig.2 and Fig.3. The main technical items of two working modes are compared in Table.1. The common machining steps and requirements of WEDM is shown in Fig.4.

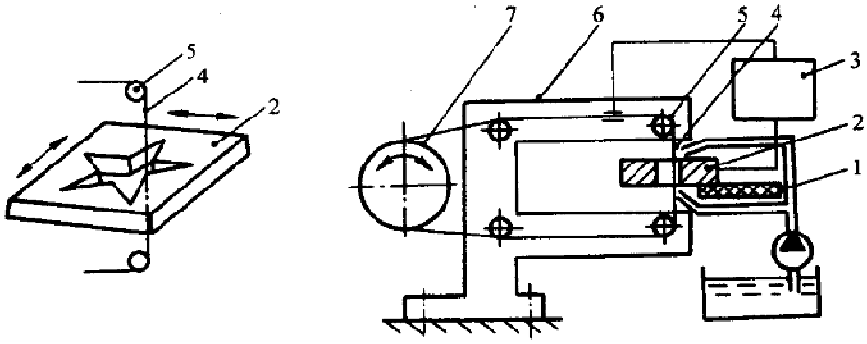


Fig.2 High-speed wire-EDM machine mode

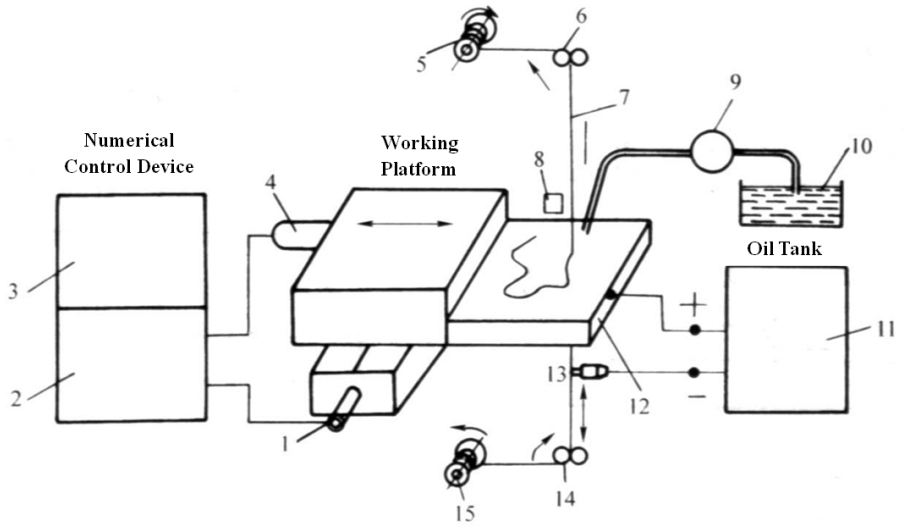


Fig.3 Low-speed wire-EDM machine mode

Table.1 Comparison of two cutting machine processing

Main technical items	High-speed wire-EDM machine mode	Low-speed wire-EDM machine mode
Wire feeding speed (m/mm)	360~660	1~15
Wire feeding direction	Alternate motion	Directed movement
Wire electrode	Molybdenum wire	Copper wire, tungsten wire
Operating fluid	Emulsified liquid	Deionized water
Discharging gape (mm)	0.01	0.02~0.05
Cutting speed (m^2/mm)	20~160	20~240
Finished roughness (Ra)	3.2~1.0	1.6~0.2
Repeatability precision (mm)	±0.01	±0.002
Wire electrode loss	0.01	Ignore

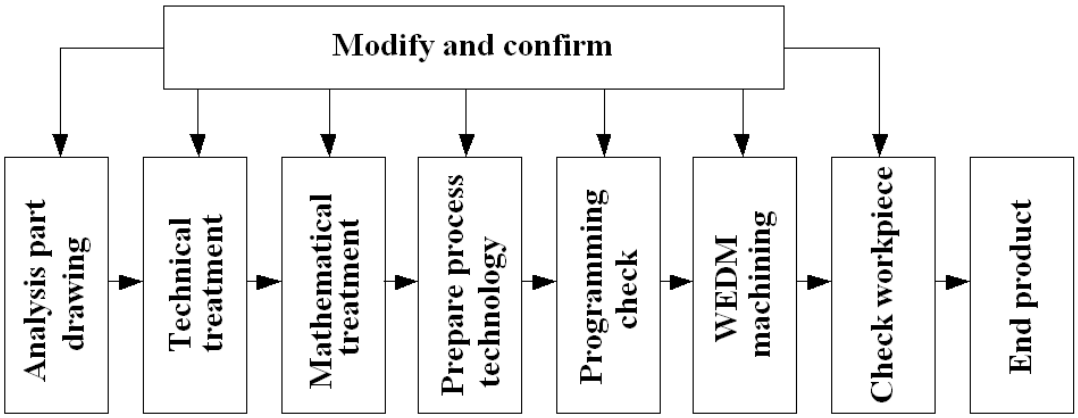


Fig.4 Machining steps and requirements of WEDM

An example is provide to demonstrate, which is shown in Fig.5. The example is a punch concave die with special holes. The material of workpiece is Cr12MoV steel with the thickness of 30 mm and hardness of 58~62HRC. In additional, the diameter of guide sleeve mounting holes are Φ20 and Φ22, the middle of the irregular hole is concave die shape hole. According to technical regulation, the primary task of machine concave die is to ensure the positional precision of Φ20, Φ22 and irregular holes.

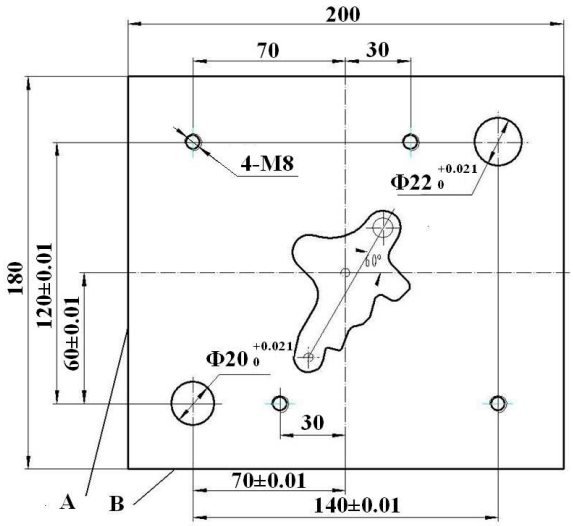


Fig.5 Drawing of Concave die part

General process of machine holes

For the traditional cutting hole process, the hole for molybdenum silk is often employed in order to locate electrode wire, therefore, the form and position accuracy of hole for molybdenum silk should be assured firstly. The hole for molybdenum silk need finish machining. If the material is treated by quenched process, the round holes should be machined by drilling or jig grinding. The rectangular holes and irregular holes should be fabricated by WEDM. The hole for molybdenum silks are manufactured by jig grinding finish machining will be useful for locating the electrode wire during cutting.

The machine process steps of workpiece is listed as:

01 Preparation dimension. 200X180X35

02 Milling end surface

03 Grinding flat surface with the thickness of 31.5

04 CNC milling. Milling base surface process and drilling hole from Φ20 to Φ19.5, drilling hole from Φ22 to Φ21.5. Drilling the irregular hole for molybdenum silk to Φ3.5. Machining four M8 holes with center drill

05 clamping. drilling and tapping

06 Quenching with the requirement temperature

07 Grinding surface with the thickness of 30

08 Jig grinding. Grinding the hole of Φ20 and Φ22 to the requirement. make hole for molybdenum silks shining

09 Machining the shape hole with WEDM

The improved technology process

The technology process. The traditional process is improved which can be described as follow.

01 Preparation dimension 200×180×35

02 Milling end surface

03 Grinding flat surface with the thickness of 31.5

04 NC milling, milling the datum surface, drilling the hole of Φ20,Φ22,4－M8

05 Benching and drilling the thread hole, drilling Φ20,Φ22 and Φ4 pylome

06 Quenching with the requirement temperature
07 Grinding flat surface with the heights of 30
08 process shape hole with WEDM

From the view of process content, the improved process 04 is less, and just need to drill a few center holes, reducing the boring time. The improved process 08 is to cut out all holes in one time, although the processing time increases, the efficiency is certainly higher than the process of boring and grinding. When aligning, just align a work-piece side (as the front), while the electrode wire locates the hole center only by eyeballing and saves more alignment time. Which completely avoids the alignment error, the location accuracy after processing only relate to the precision of the device.

Cutting routes and procedures. Assuming the cutting route as: Φ20 → irregularly-shape hole → Φ22. The first is to locate electrode wire in the approximate center of Φ20 wire hole, cut and pause. and then undo the wire, use the hop-step function and move the electrode wire to the center of irregularly-shape hole through the process controlling, cut. after that repeat the previous action.

At the formulation of cutting routes, it must adopt the principle of proximity, in that which could minimize air-travel and improve efficiency. Compilation of image-like cutting procedures is to generally adopt linear cutting software, such as CAXA linear cutting, YH software. HS-WEDM use 3B procedures, WEDM-LS with ISO procedures.

Such as using HS-WEDM to process the graphic above, the 3B procedure generated by CAXA cutting software is as follows.

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**************************************
N  1. B  9900 B     0 B  9900 GX  L1 .  -217.326 ,    58.689
N  2. B  9900 B     0 B 39600 GY  NR1 .  -217.326 ,    58.689
N  3. B  9900 B     0 B  9900 GX  L3 .  -227.226 ,    58.689
N  4. D
N  5. B 70000 B 60000 B 70000 GX  L1 .  -157.226 ,   118.689
N  6. D
N  7. B  3005 B 16249 B 16249 GY  L2 .  -160.231 ,   134.938
…
N 34. B  3005 B 16248 B 16248 GY  L4 .  -157.225 ,   118.689
N 35. D
N 36. B 70000 B 60000 B 70000 GX  L1 .   -87.225 ,   178.689
N 37. D
N 38. B 10902 B     0 B 10902 GX  L1 .   -76.323 ,   178.689
N 39. B 10902 B     0 B 43608 GY  NR1 .   -76.323 ,   178.689
N 40. B 10902 B     0 B 10902 GX  L3 .   -87.225 ,   178.689
N 41. DD
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N1~N3 is the cutting process for Φ20 hole, N2 is for cutting round, N1 and N3 are feed and return, respectively, which are necessary for each part of the graphics. N4 is the pause, suggesting the operator undo the wire. N5 is the Hop-stop procedure, the position of table moves from Φ20 center to the center of irregularly-shape hole. N6 is the pause. N7~N34 is for the procedure of irregularly-shape holes. N38~N40 is for the processing of Φ22 hole. N41 is the end. N35 and the N4, N36 and N5, N37 and N6 have the same meaning.

Conclusion

WEDM wire-cutting processing is a special machining method using pulse discharge happenns between electrodes and workpieces. This paper have analyzed and compared the two working modes of high-speed wire-EDM machine and low-speed wire-EDM machine. For the holes or slots distributed in mould device should be machined by WEDM method and could meet technical regulation. If all the holes or slots with higher accuracy requirement are machined in one process, the form accuracy and positional accuracy mighty be achieved. The paper compared two machining

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