Analysis and Experiment of Machining Process for TC4 Plane Based on Abrasive Flow Technology

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Abstract

In order to analyze the influence of abrasive flow technology on TC4 plane and the characteristics of abrasive flow machining technology, the experimental method is used to analyze the process of abrasive flow. The results show that the process of abrasive particle flow can improve the surface quality of TC4 plane by means of abrasive flow.

Keywords

Abrasive flow; TC4 plane; experiment.

1. Introduction

With the rapid development of science and technology, equipment parts are becoming more complex and sophisticated, which makes the process requirements of the parts more and more high, greatly improving the processing cost of parts, precision machining in the total manufacturing costs accounted for as high as 15%[1]. Therefore, as a new concept of automatic finishing technology - abrasive grain processing technology came into being.

In this paper, the characteristics and principle of abrasive flow machining technology are analyzed, and the difference between abrasive flow machining technology and traditional machining technology is described. At the same time, in order to verify the effect of abrasive flow machining method on the improvement of TC4 plane quality, the paper uses a self-developed abrasive particle flow test bench for processing experiments.

2. Abrasive particle flow technique

2.1 Principle of abrasive flow machining technology

Abrasive Flow Machining technology refers to the fluid as a carrier, in which mixed with a certain amount of a cutting abrasive, a fluid abrasives, abrasive rely on with respect to the processing of the flow energy of the machined surface of the processing techniques[2-3], shown in Figure 1 as shown by a narrow solid space, liquid two-phase mixing abrasive scouring action on the part of the machined surface of the part surface polishing, finishing, to improve the quality of parts machined surface.

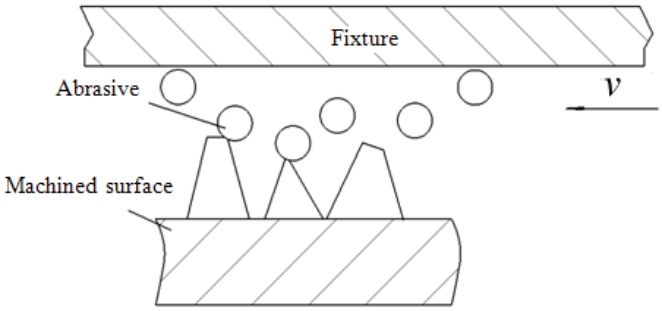

Fig.1 Principle of abrasive flow machining technology

2.2 Characteristics of abrasive flow machining

Abrasive flow is a kind of internal surface, internal cross surface and cannot touch the area of burr removal and polishing process, without the work piece geometry, compared with the traditional

mechanical processing technology, has the uniformity and controllability, machining precision and production efficiency, can realize automatic production and so on.

3. Experimental design of abrasive particle flow

3.1 Processing equipment

In this research, we have designed the abrasive particle flow test rig, which is composed of a hydraulic cylinder, a grinding agent, a hydraulic station, a clamp and a connecting line. Hydraulic cylinder diameter 100mm, the piston stroke is 250mm, abrasive cylinder diameter 100mm, piston stroke 250mm, small hydraulic station provide the biggest boost pressure 16MPa. The hydraulic cylinder is connected with the hydraulic station through the high pressure pipe, and the hydraulic pressure station is conveyed to the hydraulic cylinder by the electric control reversing valve and the hydraulic oil is recovered. The grinding cylinder is driven by a hydraulic cylinder to drive the reciprocating movement, and the surface of the grinding agent is pushed on the surface of the experimental part.

3.2 Abrasive agent

An abrasive composed of silicon carbide (800#), silicone oil, silicone and triethanolamine. 1:1:1 the proportion of preparation. First, the speed of the 150rpm is 3 minutes, 2 minutes after the interval of 3 minutes to 100rpm speed of mixing. Observation of silicon carbide, silica gel, triethanolamine is thoroughly mixed by 10% of the total volume of adding silica gel after again with a speed of 100 RPM stirring 3 minutes to form can be abrasive.

3.3 Fixture and equipment

The work piece is TC4 material of the rectangular body, as shown in figure 2. The machining plane size is 40mmx20mm, which is fixed with the fixture. The experimental part is divided into three kinds of milling surface, milling surface and grinding surface of the milling cutter.

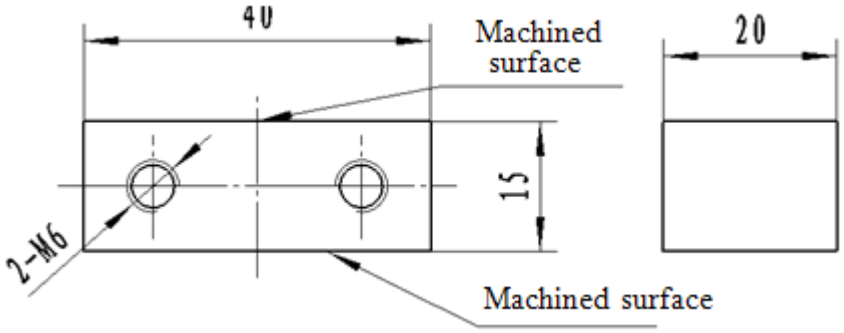

Fig.2 Work piece structure

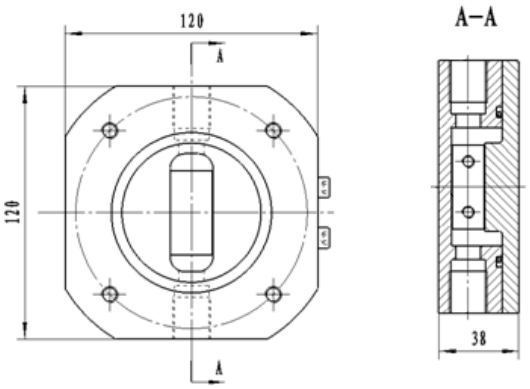

Fig.3 Fixture structure sketch map

The fixture used is shown in Figure 3, and the fixture is composed of concrete and fixture cover. The experimental parts in the clip concrete and the jig cover is composed of space, there is a very small gap, used for abrasive through. Clip in the connection with the screw connection, seal with sealing

ring. The concrete upper and lower connecting holes are used to connect with the grinding agent cylinder.

3.4 Processing parameters

Experiments are carried out on the work piece, and the parameters are shown in Table 1.

Tab.1 Processing parameters

Supply pressure	Processing time	Cycle time	Trip	Abrasive grain strength	Abrasive concentration
5MPa	3 Hour	30s	130mm	800#	30%

4. Processing experiment

In order to verify the abrasive flow processing method to improve the quality of surface of TC4, abrasive flow machining equipment, using the same experimental parameters (see chart 1), respectively of disc cutter milling surface, rod milling processing surface and the grinding surface of the sample in abrasive flow machining experiment.

4.1 Abrasive flow machining of disc milling cutter

Because of the factors such as cutting tool vibration in the process of disc cutter, the surface of the experimental part is a circular arc, and the surface roughness is detected by using a hand-held roughness tester, and the detection results are recorded as shown in Figure 4. After the experiment, the surface roughness of the test piece was measured again, and the specific values are shown in Table 2.

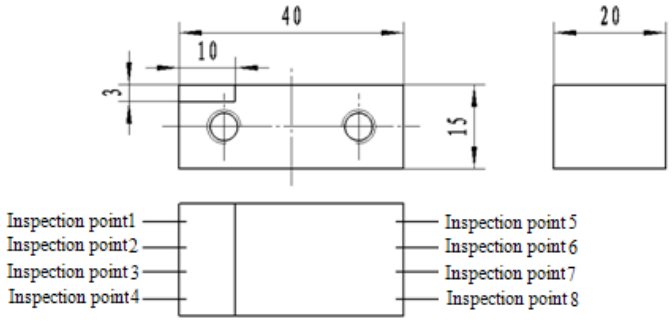

Fig.3 Detection part

Tab.2 Comparison of pre process and post roughness

	Pre process (μm)	After processing (μm)		Pre process (μm)	After processing (μm)
Detection point 1	1.187	0.593	Detection point 5	1.702	1.019
Detection point 2	1.132	0.479	Detection point 6	1.391	0.959
Detection point 3	1.225	0.561	Detection point 7	1.375	0.990
Detection point 4	1.076	0.490	Detection point 8	1.434	0.937
Mean value	1.1550	0.5308	Mean value	1.4755	0.9763
Increase value	0.6242		Increase value	0.4992	
Percentage increase	54.05%		Percentage increase	33.84%	

Through table 2 it can be seen that the abrasive flow machining method has obvious removal effect on the machining of the TC4 plane. The surface roughness of the two sides of the experiment is increased by 54.02% and 33.84% respectively.

4.2 Abrasive flow machining of rod mill

In order to show the effect of the abrasive flow on the TC4 plane of different surface quality, the feed of the two bar milling cutter is different, so the difference of the surface roughness of the same plane is large. The test results of the surface roughness of the test pieces are shown in Table 3.

Tab.3 Comparison of pre process and post roughness

	Pre process (μm)	After processing (μm)		Pre process (μm)	After processing (μm)
Detection point 1	0.622	0.459	Detection point 5	0.706	0.564
Detection point 2	1.079	0.891	Detection point 6	1.644	1.344
Detection point 3	1.197	1.007	Detection point 7	2.192	1.87
Detection point 4	1.661	1.475	Detection point 8	1.608	1.371
Mean value	1.1398	0.9580	Mean value	1.5375	1.2873
Increase value	0.1818		Increase value	0.2502	
Percentage increase	15.95%		Percentage increase	16.28%	

By means of Table 3, it can be seen that the abrasive flow machining method has the removal effect on the TC4 plane of the rod mill, but the removal of the TC4 plane is not big, and the surface roughness of the two sides of the experiment is increased by 15.95% and 16.28% respectively.

5. Conclusion

Abrasive flow machining a special finishing method, which can well polished parts of the complex surface and the area, is gradually applied in the precision machining process. This paper analyzes the principle and characteristics of abrasive flow machining technology. In order to verify the characteristics of abrasive flow machining, this research designs the abrasive flow machining test bench, and carries on the experiment to the TC4 surface. The results show that the process of abrasive particle flow can improve the surface quality of TC4 plane by means of abrasive flow.

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