

Research and application of electrochemical abrasive belt polishing technology in compressor crankshaft

Hongwei Qu^{1, a}, Shisuo Li^{1, b}, Qiang Wang^{1, c}, Qingjin Zhang^{1, d} and Zhihui Xu^{1, e}

¹Quality management department Dalian SANYO compressor co., Ltd. Dalian, China

^aquhw@sanyocomp.com, ^bssli@sanyocomp.com, ^cwq@sanyocomp.com, ^dzhangqj@sanyocomp.com, ^exuzh@sanyocomp.com

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Abstract. On the analysis of the electrochemical abrasive belt polishing technology, the main process parameters and equipments for the compressor crankshaft are selected; a set of finishing experiment plan is designed. The results show that the polishing process can reduce the surface roughness obviously, and reach a certain machining precision requirement.

Introduction

Electrochemical abrasive belt grinding is a composite surface processing technology of electrochemical dissolution and abrasive belt grinding combination [1]. It is a kind of electrochemical-mechanical composite processing technology. The processing principle is based on the electrochemical anodic dissolution; the passive film formed during electrochemical machining process can be removed by the grinding belt, so as to achieve the purpose of processing [2-3].

In the electrochemical abrasive belt grinding process, the influencing parameters on the grinding results are not independent; they are related to each other, experiment of single factor cannot completely reflect the effect on the machining results; Therefore, various influence factors must be simultaneously considered to carry out integrated experiments, and find a practical and feasible electrochemical abrasive belt polishing processing technology. The influencing parameters include: electrolyte composition, electrolyte concentration, solution temperature, current density, machining parts, original surface roughness, processing time, and so on.

Principle and main equipments of electrochemical abrasive belt polishing

Principle of electrochemical abrasive belt polishing. Principle of electrochemical abrasive belt polishing is shown as Fig.1, current path is formed by workpiece, electrolyte, electrode and power. The workpiece is connected to the positive electrode of the power; the tool cathode is connected with the negative electrode of the power. Workpiece is as anode, tool electrode is as cathode, a certain gap between them is to be maintained. Being soaked in electrolyte with certain pressure and flow, anode dissolution would take place in the workpiece, a layer of thin film on the surface can be generated, which with a certain hardness, but softer than that of the metal. Because of the resistance for this film, anodic dissolution reaction would be hampered. When the passive film is grinding away by abrasive belt, the workpiece surface can be re activated, Re electrolysis, and grinding away, and so forth, until the desired processing required [4].

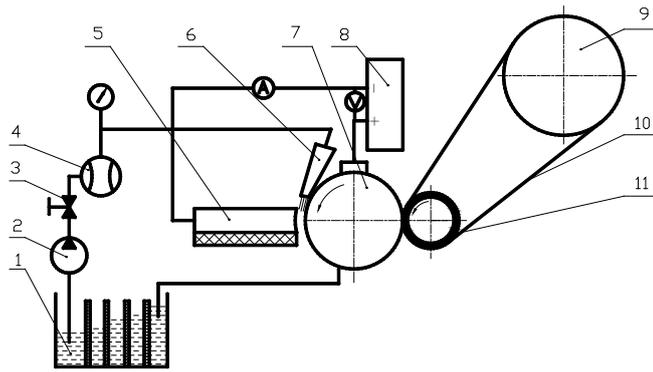


Fig. 1 The principle diagram of electrochemical abrasive belt grinding processing

1-Electrolyte filter system; 2-centrifugal pump; 3-Throttle; 4-flow meter; 5-Tool cathode
6-spray nozzle; 7—workpiece; 8-DC Power; 9-tension wheel; 10-abrasive belt; 11-contact wheel

Machine tool selection. In the process of electrochemical abrasive belt polishing, machine tool mainly plays the following roles: providing different rotary speed; ensure the workpiece in stable working condition, convenient operation.

Based on the above requirements, CDL6136 high-speed horizontal lathe is selected, which can provide 12 spindle speeds, respectively: 32, 62, 140, 160, 230, 270, 320, 450, 720, 1000, 1400, and 2000 (RPM).

Power selection. According to the expected machining efficiency and size of the workpiece, SMD-300D numerical control pulse electroplating power is selected. the output waveform parameters as follows: rectangular wave, 5-5000Hz output frequency, 0-100% duty ratio, 300A maximum output current peak value, 100A average current value, 220V input voltage.

Belt device selection. Structure of belt machine: abrasive belt device mainly consists of six parts: frame, pneumatic motor, tensioning mechanism, driving wheel, driven wheel and guide wheel.

Belt type selection: the belt is fabric based with oxide accumulation abrasive to be adhesive joint.
Abrasive belt granularity selection: particle size of 1200.

Electrode structure selection. Electrode structure is shown in Fig.2. This electrode structure can ensure the symmetrical electrolyte flow in finishing zone to form right back flow pressure region. This structure can also fully supply the electrolyte in the process to ensure the generated heat be taken away by the electrochemical reaction timely. The electrode tip arc with high machining accuracy, which can be able to closely fit with the crankshaft polishing parts, so as to realize the purpose of convenient adjustment to the inter electrode gap. On the other hand, the adjustment precision of electrode gap is very high and can reach 0.01mm, which can fully guarantee the accuracy requirements of the inter electrode gap.



Fig. 2 Structure of the electrode head

Experiment planning and results analysis for compressor crankshaft

Measurement position of surface roughness. In this experiment, the test piece is compressor crankshaft made of 45 # steel; the sliding bearing is polished, specific measurement position as shown in Fig.3.

The evaluation length $ln=4mm$, sampling length $Lr=40mm$, the longitudinal magnification ratio is 2000, transverse magnification ratio is 50. 12 locations are selected as detection object.

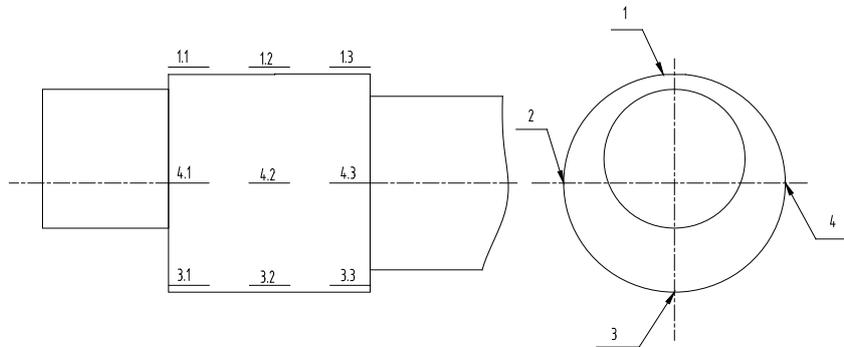


Fig. 3 Measurement location of test piece

Main process parameters. Table.1 lists the main process parameters of electrochemical abrasive belt polishing. Among which, the current density and workpiece rotating speed is most important to polishing quality and need to be strictly controlled.

Table 1 main technology parameters of electrochemical abrasive belt polishing

Technology parameters	Spec value	Experimental value
Electrolyte types	$\text{NaNO}_3, \text{NaCl}, \text{NaClO}_3, \text{Na}_2\text{Gr}_2\text{O}_7$	NaNO_3
Electrolyte concentration (%)	5-30	20
Electrolyte temperature ($^{\circ}\text{C}$)	10-30	20
Current density (A/cm^2)	30-50	40
Electrode gap (mm)	0.3-0.5	0.3
Abrasive belt granularity	≥ 1200	1200
Work speed (turn/min)	32,62,140,160,230,270,320,450	270

The polishing effect. In the following conditions: crankshaft speed $n=160r/\text{min}$, current density $I=18.75\text{A}/\text{cm}^2$. Under the electrochemical action for 60s, then DC power is closed, the abrasive belt continue to grinding for 60s in the same speed with crankshaft belt machine. Comparison of surface roughness for polishing is as shown in Fig.4.a, Fig.4.b. and Table. 2

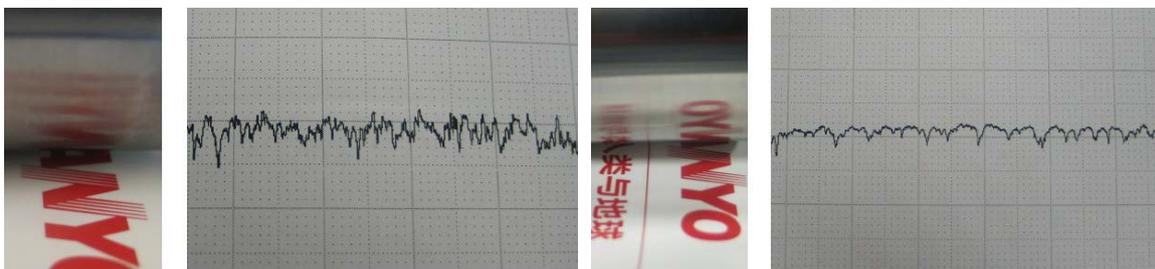


Fig.4.a Roughness curve before polishing

Fig.4.b Roughness curve after polishing

Table 2 Comparison of surface roughness before and after polishing

surface roughness (μm)					
Position number	Before finishing	After finishing	Position number	Before finishing	After finishing
1.1	4.498	2.090	2.1	3.433	2.144
1.2	4.240	2.167	2.2	4.400	1.665
1.3	5.248	1.784	2.3	4.865	2.006
3.1	4.212	2.525	4.1	4.448	2.267
3.2	4.780	2.268	4.2	4.562	2.831
3.3	5.228	1.800	4.3	5.042	2.375

Conclusion

In this study, the selection of main equipment, process parameter and processing condition for the electrochemical abrasive belt finishing is discussed, and a set of finishing plan is set up. Utilizing the existing production equipment, through repeated testing, a feasible crankshaft electrochemical finishing process is found, which can make the surface roughness be steady increased, the maximum can reach $0.5\mu\text{m}$.

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