

Fe-Mn Alloy Cold Plating Repairing Technology and Practice

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Abstract: This paper introduces the electroplating repairing technology. This technology can be widely applied to repair the worn failure surface of machine parts in metallurgy, machinery, mining, building material, and so on.

Key words: Fe-Mn Alloy Plating Solution, Repairing Technology.

1 Introduction

When the work surface of various shafts, rods, inner holes of parts are overly worn to failure, however, their geometry structure and mechanical property are in good conditions. We often apply the way of changing spare parts and abandoning the parts to repair them. Sometimes, we also apply painting, plating, bead welding, as well as other technologies to repair the parts. But the current repairing methods have a lot of disadvantages, some of them will cause over deformation of parts, some of them can not meet the technology requirements, and some of them will severely pollute the environment. Some parts can not be repaired with the current methods due to their complex geometry shape and high quality requirement. This will cause a huge waste. However, the low temperature Fe-Mn alloy electroplating repairing technology recommended in this paper can receive good results.

Table 1 shows various indexes of different repairing methods.

Table 1

Repairing Method	Fe-Mn Alloy Cold Plating	Iron Plating without Etching	Iron Plating with Anodic Etching	Painting	Spray Welding	Cr Plating
Bonding Strength kg/mm ²	40	35	20-30	3-5	35-50	35-50
Max Coating Thickness	3-4	2-3	2-3	0.5-2.5	0.3-0.1	0.2-0.3
Plating Temperature	30-50	30-50	30-50	200-250	1050	50-60

Temperature (°C)						
Deformation Degree	NO	NO	NO	Little	Easy	NO
Environment Pollution	Very Little	Very Little	Acid Mist	Dust and Noise	Noise	Severe Pollution
Microstructure of Coating	Compact	Compact	Compact	Compact	Compact	Compact
Production Efficiency	High	High	High	High	Low	High

From the above table, we can know that the various indexes of Fe-Mn alloy cold plating are not worse than other repairing methods.

2 Plating Technology

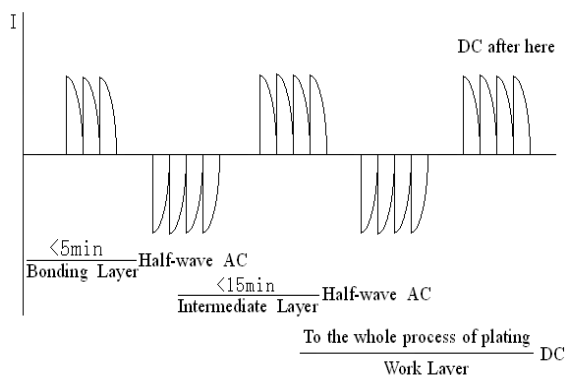
2.1 Electroplating Power and Current Density

This technology applies non-symmetric alternating current—DC power. Current density can be adjusted according to material, size, coating thickness and plating time of parts.

The specific process as following:

Initial plating lasts 3 to 5 minutes, applies non-symmetric alternating current, non-symmetric ratio is $1 < \beta < 1.3$, current density is 1.5 to 3 A/dm². During 10 to 15 minutes, applying non-symmetric alternating current, non-symmetric ratio is $6 < \beta < 8$, current density is 10 to 25 A/dm². Then, applying DC power until plating is completed, current density is 30 to 50 A/dm².

Its time control and wave figure as following:



Non-symmetric alternating current has the peaking effect, it can make the coating produce core on the basic surface and growing speed of grain be uniform, and improve bonding strength.

To get the results, when selecting power equipment, we should do as following. Firstly, positive and negative half-wave can be adjusted respectively. Secondly, the conversion between AC and DC must be convenient under the condition of not cutting the power. Thirdly, the power equipment must have pulse frequency and the current can be adjusted smoothly.

2.2 Electroplating Solution

The conventional Fe plating solution made from the reaction of industrial HCl and scrap iron is FeCl. The plating complex ion is Fe^{+2} . The technology in this paper adds Mn^{+2} on this basis and the content of Mn^{+2} is 1.5-8 g/l, so we call this technology as Fe-Mn alloy electroplating. Due to adding Mn^{+2} , the dispersibility of plating solution is high and coating thickness can be increased by 0.5 to 1.0 mm, up to 3 to 4 mm. Due to the polarization of Mn^{+2} , grain size of coating is fine, the hardness and wearability of coating are obviously improved. By indirect testing, HV can reach 450 to 630 kgf/mm^2 .

2.3 Electroplating Temperature

The control range of electroplating solution temperature is 30 to 50 $^{\circ}\text{C}$, so we call this technology as cold plating. The growing speed of grain is low, and grain size is fine, the wearability of coating is good when cold plating is used.

2.4 Process Flow

Check before plating → Machining before Plating → Cleaning and Removing Oil → Insulating and Loading → Treatment before Plating → Plating → Treatment after Plating → Measurement and

Inspection → Machining after Plating → Measurement and Inspection → Oil Immersion and Storage.

3 Compare of Example, Wearability and Economic Benefit

3.1 Compare of Wearability

We take the repairing of Balas 540 crank shaft as an example, its material is 18CrNiWA, part of the shaft neck is plated with this technology, part of the shaft neck is not plated. After assembling and commission, we test the wearability of each shaft neck and the results as following.

Table 2

Shaft No.	Recovering Condition	Neck No.	Before Commission $\Phi(\text{mm})$	After Commission $\Phi(\text{mm})$	Wear Rate $\Delta\Phi$	Average $\Delta\Phi$	Distance of Commission (km)
73622	Cold Plating	3	94.470	94.465	0.005	0.005	9893
		4	94.680	94.675	0.005		
	Non-plating	2	94.085	94.070	0.015	0.015	
70307	Cold Plating	4	94.360	94.360	0.000	0.006	6600
		5	94.345	94.330	0.012		
	Non-plating	3	94.383	94.345	0.048	0.048	

3.2 Analysis of Economic Benefit

Repairing fee can be saved by 20% to 40% compared with changing spare parts. Typical examples see Table 3.

Table 3

Parts Name	Material	New Parts Fee	Repairing Fee	Saving Rate
Secondary Drive Shaft of Reducer of 1700 Mill	30CrMn Mo _A	700,000 RMB per part	60,000 RMB per part	-91%
Inner Hole of Hydraulic Piston Cylinder	38CrMn Al _A	100,000 RMB per part	25,000 RMB per part	-75%

4 Conclusion

This technology is developed and improved on the basis of conventional iron plating technology. It has been used to repair thousands of parts in Anshan STEEL and Benxi STEEL. From the aspect of material, there are alloy structure steel , carbon structure steel, cast iron. From the aspect of plating surface, there are inner hole of outer circle and complex surface, whose coating mechanical property are not less than original parts, and working life are longer than original parts. By extrapolating, if it can be applied and disseminated in the whole country, it will create benefits of tens of billions RMB annually.

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