

PROLONG THE SERVICE LIFE OF SWITCH RAIL BY IMPROVED INDUCTION HEAT TREATMENT

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Abstract: Switch rail is a very important part on the railway track, which not only accounts for the safety of the passing trains but also greatly influences the speed of the train. The higher the speed and the loads of the train the more it demands on the properties of the switch rail. Research shows that the higher mechanical properties of switch rail the longer the service life.

Induction heat treatment is a good way of improving the mechanical properties of metallic materials. But the switch rail's section area changes gradually across the lengthways, which is difficult for induction heating especially for the small section. And the mechanical property of small section of the switch rail is the most important for its service life. The induction heat treatment used past always brings the low hardness on small section which can cause low service life of switch for wearing, or too high hardness because of martensite microstructure which can cause the shelling or even breaking of the switch rail.

To prolong the service life of switch rail by higher mechanical properties, we researched the improved induction heat treatment for switch rail by adjusting speed of heating, and adopting compressed air cooling. The results showed that switch rail obtain almost the same high hardness across the length way after the improved induction heat treatment, which is very helpful to extend the service life of switch rail.

Key Words: switch rail; induction heating; heat treatment; slack quenching

1 INTRODUCTION

Switch rail is a very important component of the railway track, which not only accounts for the safety of the passing trains but also influences the speed of the train. Continuous improvement on the speed and loads of the passing trains places more and more demands on the performance of the switch rail.

Wear is the main damage mechanisms for the switch rail, on some busy main line of China some switch rails even has the service life of lower than 3 months. It is important and necessary to improve the wear resistance of the switch rail, especially on the small section area. It is important to prolong the service life of switch rail by improving the mechanical properties of small section area of switch rail by improved heat treatment technique.

The past induction heat treatment technique for switch rail cannot ensure the reliable and high

mechanical properties of switch rail especially on the small section area. The small section area always has very low hardness or sometimes some baleful martensite microstructures are existed there.

In this paper we introduce some improvements on the heat treatment for switch rail, which can greatly improve the mechanical properties on small section, which is very helpful to prolong the service life of switch rail on the railway track. The new improved heat treatment technique and devices for switch rails has been successfully used in many switch rail making factories in China

2 THE IMPROVEMENT ON THE HEAT TREATMENT FOR SWITCH RAIL

To prolong the service life of switch rails, we must ensure the high mechanical properties mainly high hardness on the whole switch rail, especially on the small section area. And we also must ensure the reliability and safety of the heat treated switch rail when they are served on the railway track. So we also must ensure the microstructure of the switch rail after heat treatment is pearlite, and martensite is forbidden.

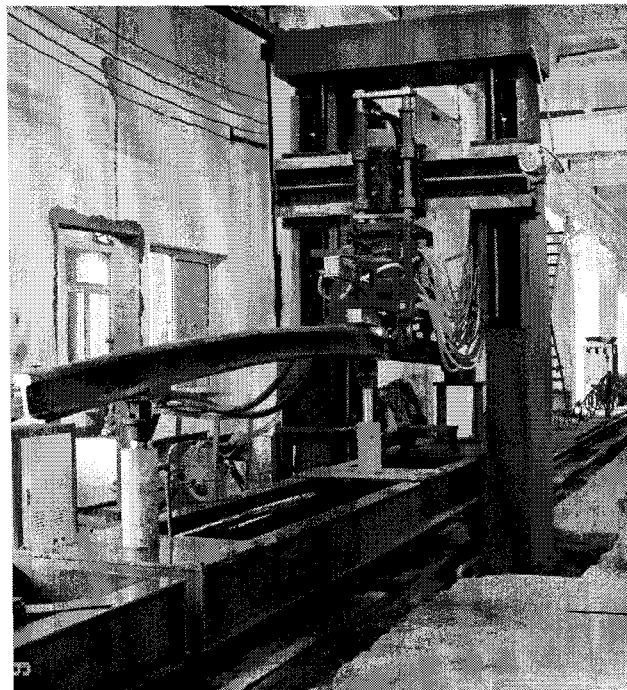


Figure 1. The Induction Heat Treatment Devices for Switch Rails

To get the high mechanical properties and obtain the right microstructure, we made some improvement for the heat treatment technique shown as below. Figure 1.is the device we produced to heat treating switch rail.

2.1 Compressed air as a new coolant is adopted

The past coolant for switch rail is mist which is produced by mixing the compressed air and

water. But the mist can bring the martensite microstructure, which can cause the breaking of switch rail on the small section area.

The new coolant is compressed air. It can ensure the uniform cooling speed of switch rail between surface and deeper, which ensure the pearlite microstructure and the safe serving of switch rail.

2.2 Changing the speed of heating according the section area

The temperature is very important for the heat treatment. But the switch rail has different size along the lengthways (From fig.3 we can see the difference on the size and area of the switch rail along the lengthways). But it is difficult to obtain high temperature on small sections when induction heating. On the past we heat switch rail with same speed along the lengthways, the small section areas will has lower temperature than big area, which will cause the lower hardness on small section after heat treatment.

To ensure the uniform hardness after heat treatment, the changing speed of heating according section size is very helpful.

3 THE PROPERTIES OF SWITCH RAIL AFTER HEAT TREATMENT

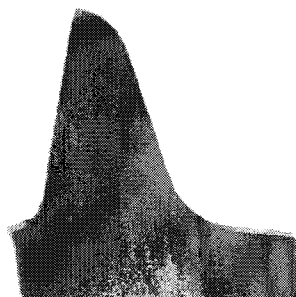
3.1 The shape of hardened layer

The switch rail chosen as experiment has the chemical composition shown on table 1. The shape of hardened layer is shown on Figure 2.

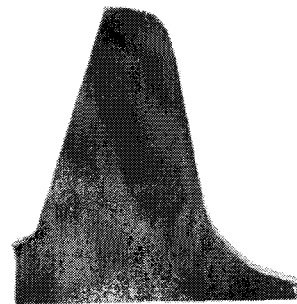
Table 1. Chemical Composition of Switch rail for experiment (wt.%)

C	Si	Mn	S	P
0.73	0.26	1.35	0.030	0.031

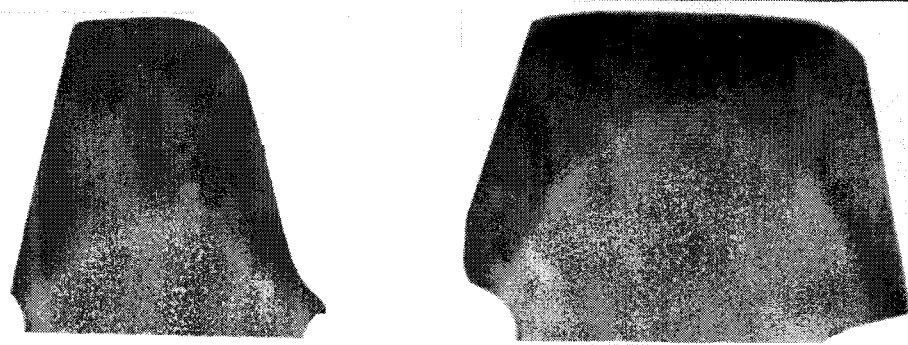
From these figures we can see that the small section area has deeper hardened layer and big section area has lower hardened layer because of different heating speed. But this is very helpful for the service of switch rail. Because the small section area always endure more forces when the train passing the switch especially the forces on the side face. For the big section area the forces on the side is less and it also has harden layer on the side.



5-millimeter section



10-millimeter section



30-millimeter section 50-millimeter section
Figure 2. The Shape of switch head's hardened layer on different section

3.2 The hardness of hardened layer

The main mechanical property of switch rail is hardness. The service of switch rail shows that the higher hardness on the head hardened layer the longer service life if the microstructure is pearlite.

The hardness of different section area after heat treatment is shown on table 2. The distance between 2 testing points and the distance between first point and surface are all 2.5 millimeters. From Table 2 we can see that the hardness of hardened layer along are almost the same although the different section area. The most important is that the hardness of small section area as 5-millimeter section and 10-millimeter section is very high, which is very helpful to prolong the service life of switch rail.

Table 2. The Hardness of Hardened Layer

Section Size	The hardness tested from surface to deeper (HRC)				
5 millimeter	36.5	37.0	35.0	34.0	
10 millimeter	37.5	36.4	36.4	36.0	
20 millimeter	37.0	35.5	34.5	35.0	
30 millimeter	35.0	36.0	36.0	35.5	
50 millimeter	36.8	37.0	35.0	34.5	(center)
	36.0	35.5	35.5	34.5	(corner)
70 millimeter	35.0	34.5	33.5	32.5	(corner)
	33.5	33.0	32.0	30.0	(center)
	37.0	34.5	33.0	32.0	(corner)

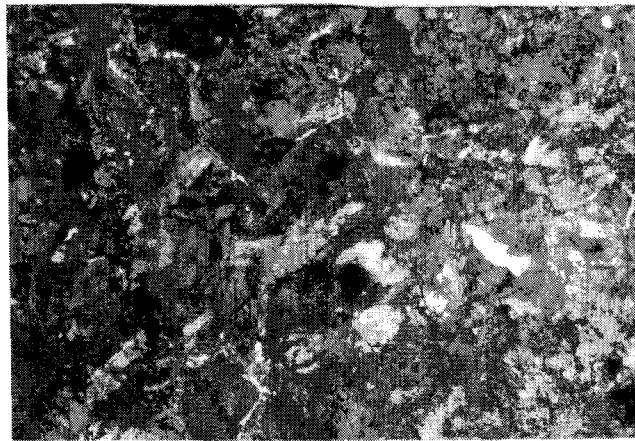
3.3 The microstructure of hardened area

The good switch rail not only requires high hardness but also pearlite microstructure. The martensite microstructure is absolutely forbidden on the heat treated switch rails.

The microstructures of different section of switch rail are shown on Figure.3. The microstructures are all pearlite and some little ferrite but no martensite. With the compressed air adopted as the coolant, the martensite can be prevented.



10-millimeter section



50-millimeter section

Figure 3. Microstructure of Harden Layer on different Section(400×)

4 CONCLUSITON

Because of the adoption of the compressed air as coolant and changing the heating speed according section size when heat treatment. The switch rail not only obtains higher hardness on the small section area but also prevents the bringing of martensite microstructure, which ensures the safe service of switch rail.

With the higher hardness on the switch rail's hardened layer and reliable pearlite microstructure, the service life of switch rail can been greatly prolonged.

Now this improved heat treatment technique and devices are successfully used on many switch making factories in China.

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