Performance Analysis of New Material Wheels for High Speed EMUs

Wang Jinhua

Wuhan Railway Vocational College of Technology, Wuhan, Hubei, 430205, China

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Abstract: With the rapid development of economy, high-speed railway trains have become the most convenient means of transportation for people's life and travel. In order to ensure people's life and work efficiency, the practical application efficiency of high-speed railway trains is improved. The effect is what is urgently needed. In the high-speed railway EMU, the strength and hardness of the wheel of the train need to be constantly changed. It is particularly important to complete the preparation and composition analysis of the new material wheel. The main purpose of this paper is to use the wheel of the new material as the main research object, and analyze the actual use effect and performance to ensure that the wheel of the new material can be used for the actual use of the high-speed EMU in the actual engineering process. Make a contribution and meet the requirements of current people.

1. Introduction

As one of the most important accessories in high-speed EMUs, the practical application effect of the wheels is related to the quality and service life of high-speed EMUs. Whether it is strength, hardness or toughness in the process of using high-speed EMUs, etc. The indicators will directly affect the use of the entire high-speed EMU. In recent years, China has been pursuing the improvement of the quality of the wheels and making breakthroughs in the overall quality improvement of high-speed EMUs. At present, researchers in China have made great achievements in the research of high-speed EMU wheels, but there are still many, especially In the material technology of the wheel, there are rapid development speeds of high-speed EMUs in China. If the quality of the wheels is not improved quickly, the development of high-speed EMUs will be delayed, and the overall economy will be hindered. Therefore, careful research on wheel materials is needed.

2. Physical and chemical properties of new material wheels

For the chemical composition analysis of the new material wheel and the ER8 wheel used in the past, the specific results are shown in Table 1. The analysis of the chemical composition of the wheel of two different materials can effectively and effectively help to complete other performance tests and analysis.

Table 1 Test results of chemical composition of new material wheel and ER8 wheel sample (mass score)

wheel	C	Si	Mn	P	S	V	Cr	Ni	Mo
New material wheel	0.53%	0.72%	0.72%	0.004%	0.001%	0.12%	0.04%	0.06%	0.01%
ER8 wheel	0.53%	0.37%	0.76%	0.007%	0.002%	0.01%	0.03%	0.12%	0.03%

Compared with the ER8 wheels used in the past, the yield strength and tensile strength of the new material wheels are significantly improved, which is a technical advancement for the new material wheel, in order to ensure the service life of the high-speed EMU The improvement of these aspects is very important. In the new material wheel, the tensile strength is increased by 9% compared with the ER8 wheel, and the yield strength is increased by 12% compared with the ER8

wheel. More obvious improvements, these are very important for new material wheels. From the data analysis, in the past, the tensile strength of the ER8 wheel was about 68 MPa, while the new material wheel became 23 MPa, and the ER8 wheel had a difference of 39 MPa in yield strength, while the new material wheel was 29MPa, the new material wheel and ER8 wheel have a more obvious difference in the hardness difference. The hardness of the ER8 wheel is 20HBW and only 6HBW in the new material wheel. This fully illustrates the ER8 wheel. The difference between the new material wheel and the new material wheel can also be found by selecting the new material wheel in the manufacturing process of the high-speed EMU. Compared with the ER8 wheel, the fluctuation of the new material wheel is smaller than the hardness and strength. The performance of itself is more sTable, and it is easier to be controlled in different processes such as forging and rolling of wheel materials, and the overall quality and completion effect of the high-speed EMU can be ensured.

2.1 Toughness test results

The toughness of the wheel material in the high-speed EMU is also directly related to the overall quality of the high-speed EMU. For this reason, it is particularly important to test the toughness of the new material wheel in the material analysis of the new material wheel. Comparing and analyzing the ER8 wheel with the new material wheel, it can be found that the rim toughness test result is shown in Figure 2, and the new material wheel is increased by 10% from the data. The new material wheel and ER8 wheel are simultaneously analyzed for impact performance of +20 degrees Celsius and -20 degrees Celsius, and the test results of the elongation after fracture can be found to be basically the same, that is to say, in the past high-speed EMU Compared with the new material wheel, the ER8 wheel has a drop in the toughness index. The toughness of the new material wheel meets the actual demand of the high-speed EMU in China, and the shape of the fracture of the fracture toughness sample of the ER8 wheel and the new material wheel is completed. Analysis, in the process of observing the fracture type of the new material wheel and the ER8 wheel, the observation mode that can be selected is SEM. It can be clearly observed through observation that the fracture type of the new material wheel and the ER8 wheel has a very large initial. In the new material wheel, the fracture mode shows the intergranular fracture, while the ER8 wheel exhibits the fracture condition as the dissociation fracture. According to the analysis and measurement of these two completely different wheel fracture characteristics, it can be found that the fracture toughness has a certain relationship with the fracture mode. The fracture of the new material wheel is analyzed and the width of the crack tip ligament on the fracture is found. It is 47.69μm, which is very different from the ER8 wheel. In the ER8 wheel, the width of the fracture ligament is smaller than the new material wheel. Comparing the rupture width of the new material wheel with the ligament of the ER8 wheel, it can be found that the test results of the fracture toughness of the wheel have a very obvious correspondence.

2.2 Hardenability test results

After the hardening test analysis of the new material wheel and the ER8 wheel is completed, the result is shown in Fig. 3. The actual analysis of the ER8 wheel and the new material wheel is completed by Fig. 3, when the wheels of the two different materials are respectively at the quenching end face. From the position of 9mm, the hardness value is 40HRC for the new material wheel and 36HRC for the ER8 wheel. Through this data, it is basically determined that the ER8 wheel and the new material wheel have the same effect from the hardenability, but when the ER8 wheel and the new material are used. Another problem arises when the wheels are within the 9mm range of the quenched end face. As the distance between the wheel and the quenched end face is increased, the hardness of the steel itself will gradually decrease and the speed will decrease. Very fast, compared with the wheel quenching end face of 9mm, it can be found that the hardness of steel is directly reduced by 30% compared with before, but when the distance between the wheel and the quenching end surface exceeds 9mm, the hardness of the steel decreases more and more slowly. Many experiments have confirmed that in the hardenability analysis of the new material wheel and ER8 wheel, the most important when the distance between the wheel and the hardened end face is

9mm. Folding point, the right can be inferred bainite and martensite phase transition critical position. The metallographic structure in the wheel is mainly composed of pro-eutectoid ferrite and pearlite. Through the analysis of two different materials, it is found that the overall hardness of the ER8 wheel is slightly lower than that of the new material wheel, and When the quenching end face distance is less than 9mm, the hardness of the steel decreases more rapidly, but compared with the new material wheel, the two different quality wheels have little difference from the overall analysis. It can be said that the hardening of these two wheels is basically quite.

2.3 Metallographic organization

Metallographic organization is also an important part of the quality of high-speed EMU wheels. For this reason, the same area comparison analysis is needed for the new material wheel and ER8 wheel. The metallographic analysis of the two different materials is completed. The result is as follows. As shown in Fig. 4, the overall analysis is completed according to Fig. 4. Both the new material wheel and the ER8 wheel are themselves made of metallurgical structure by quenching the medium carbon steel and then tempering, and the composition is fine pearl light. Body and ferrite distributed along the grain boundary. However, there is a very obvious difference between the new material wheel and the ER8 wheel. The difference between the new material wheel and the ER8 wheel in the metallographic structure is also very obvious, because the metallographic structure of the new material wheel has a significantly larger pearlite mass. Small, and from the grain boundary analysis of the new material wheel, it is found that the pro-eutectoid ferrite structure in the new material wheel is more evenly distributed, but the analysis of the ER8 wheel can be very clearly found in the ER8 wheel. This does not happen, and the uniform distribution of the pro-eutectoid ferrite structure can also promote the increase in the pearlite volume fraction in the new material wheel. The grain refinement effect of the new material wheel is more obvious and meets the actual needs of the current high-speed EMUs in China.

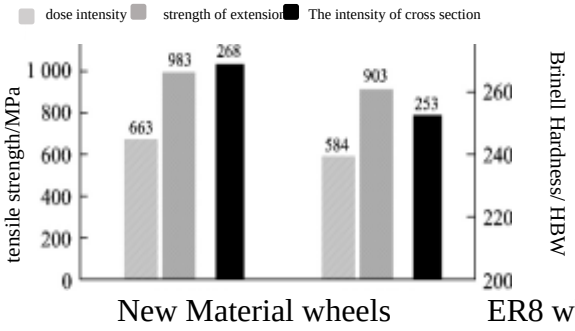
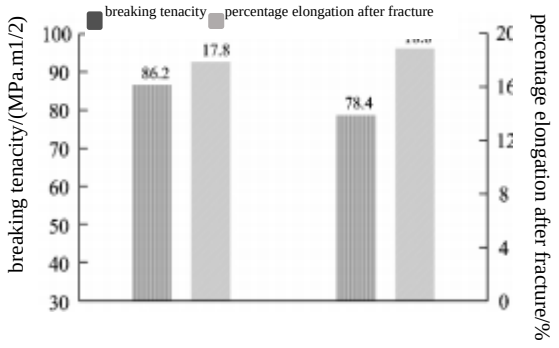
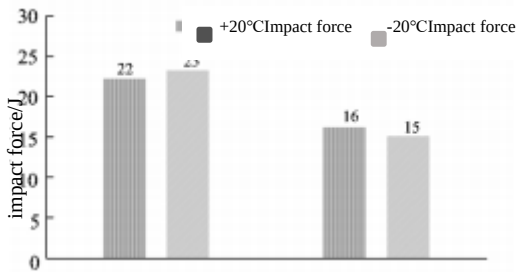


Figure 1 Rim strength and hardness test results of new material wheels and ER8 wheels



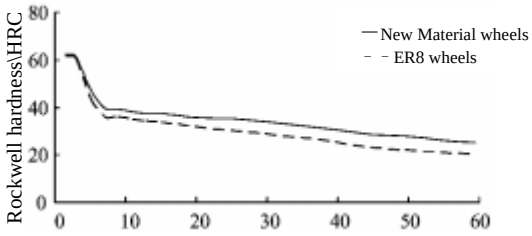
(a) breaking tenacity and percentage elongation after fracture



New Material wheels ER8 wheels

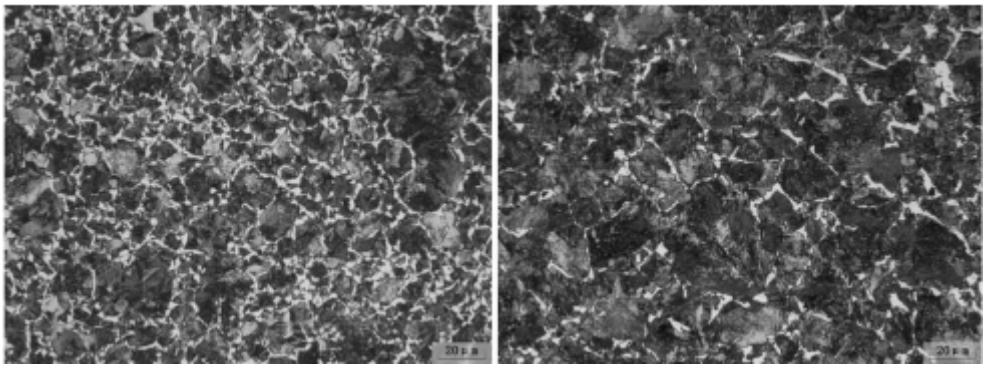
(b) impact property at 20 degrees and minus 20 degrees

Figure 2 Rim toughness test results of new material wheels and ER8 wheels



Distance from the Quenching end

Figure 4 End hardenability curve of new material wheel steel and ER8 wheel steel



(a)New material wheel (b)ER8 wheel

Figure 5 Metallographic organization at a depth of 10 mm from different treads

3. Analysis and discussion

The following analysis can be carried out for the performance index between the above-mentioned new material wheel and the new material wheel and the analysis and comparison of chemical elements. Since the wheel used in the high-speed EMU has a certain microstructure and the strength and hardness of the wheel as a whole. The linear relationship requires gradually refining the pearlite mass in the wheel and gradually reducing the pitch of the pearlite layer, effectively improving the wheel strength and hardness, and ensuring the overall effect and application state of the wheel in actual use. In the new material wheel, the mass fraction of Si is relatively larger and higher than that of the new material wheel, which promotes the gap between the pearlites of the new material wheel to be reduced in the direction of reduction. Development, but need to be aware of a problem in the use of new material wheels, because Si is a non-carbide-forming element, and in the transformation of austenite to pearlite, due to the cementite inside the new material wheel The region will discharge the Si atoms contained in it to the ferrite region, which is why the new material wheels used in the past have a large distance between their own pearlites. However, due to the obvious improvement of the Si mass fraction in the new material wheel, this makes the area formed by the cementite in the new material wheel extremely difficult in completing the Si rearrangement process, and the thickness in the new material wheel will be It

becomes smaller and can directly and effectively reduce the spacing between the pearlite sheets, and adds V to the new material wheel. This material does not enter the cementite but does not exist in the form of V carbonitride.

In the process of completing the wheel forging in the high-speed EMU, whether the heating or the soaking of the wheel is completed before starting the rolling. The pitch of the pearlite layer contained in the process of wheel manufacturing mainly depends on the temperature change during the completion of the production process. If the temperature is too low during the completion of the production process, the supercooled austenite is stabilized. Reduced sex. The purpose of hardenability in the process of completing the new material wheel is to ensure that the new material wheel can obtain the most uniform fine pearlite structure. In the actual production process, the process is tread quenching, the purpose is to form a layer of horse in the new material wheel. The structure of the body gradually completes the transformation to pearlite + ferrite structure. Since the martensite structure is not allowed on the surface of the new material wheel, it needs to be hardened, and the hardenability of the new material wheel is higher. The greater the depth of the non-equilibrium structure appearing on the surface, the more metal it needs to process in the actual work, and the more uncontrollable factors encountered, the need to ensure the completion of the hardening process of the new material wheel Its quality and nature meet the actual needs of high-speed EMUs for the wheels. After the above analysis and discussion, the most important point of the application of the new material wheel in the high-speed EMU is to change the mass fraction of Si in the ER8 wheel used in the past, although the change in the mass fraction of Si does not change the wheel itself. Basic metallographic organization, but the parameters of the refined pearlite spacing, strength and hardness in the wheel have changed significantly, and the toughness in the new material wheel has been improved, in line with the actual needs of the current high-speed EMUs in China.

4. Conclusion

In summary, through the study of the wheel material of the high-speed EMU, the following two conclusions can be obtained: First, in the new material wheel, due to the adjustment of the mass fraction of Si and the addition of V alloy elements to the new material wheel, Compared with the ER8 wheel used before, it is refined from the pearlite and promotes the dispersion of granular vanadium carbonitride in the new material wheel. Second, the new material wheel is resistant to its tensile strength. The strength or the yield strength and hardness are significantly improved compared with the ER8 wheel, and the hardenability and the elongation after break and the impact toughness of the new material wheel are the same as those of the ER8 wheel.

References

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