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EFFECT OF QUENCHING TEMPERATURE ON MICROSTRUCTURE AND MECHANICAL PROPERTIES OF 50CrVA SPRING STEEL FOR MOUNTAIN BIKE SHOCK ABSORBER

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In order to improve the quality of people 's cycling and improve the safety performance of mountain bikes. The effects of quenching temperature on the microstructure and mechanical properties of 50 CrVA spring steel for mountain bike shock absorber were studied by means of microstructure observation, tensile test and impact test. The results show that the microstructure of 50CrVA steel is tempered troostite after quenching at 860-940 °C and tempering at 450 °C. In the quenching temperature range of 860 ~ 940 °C, with the increase of quenching temperature, the yield strength, tensile strength and elongation of 50CrVA steel increase first and then decrease, and reach the maximum at 920 °C, while the impact energy shows the opposite trend. When the quenching temperature is 920 °C and the tempering temperature is 450 °C, the comprehensive mechanical properties of 50CrVA steel are the best. At this time, the yield strength is 1 419MPa, the tensile strength is 1 538MPa, the elongation is 12 %, and the impact energy is 20,2J.

Keywords: 50CrVA spring steel, quenching temperature, mountain bike shock absorber, microstructure, mechanical properties

INTRODUCTION

As one of the Olympic Games events, the bike mountain race stipulates that the gentle section shall not exceed 15 %, and the other sections are uneven. The track usually consists of a high-speed downhill section, a climbing section, a rural section, a gravel section, a forest section, and a short asphalt section. Due to the diversity of its race road conditions, it is very important to make an efficient, safe and reliable mountain bike. The mountain bike shock absorber greatly reduces the impact of potholes and bumps through compression and expansion. By reducing the vibration between the body and the rider, the shock absorber can reduce the rider 's fatigue and discomfort, so that the rider is now driving more comfortable and safe. As a kind of spring steel, 50CrVA spring steel not only takes into account the advantages of spring steel, but also increases toughness and fatigue strength. It is a relatively successful mountain bike shock absorber material.

50CrVA steel is a kind of high strength medium carbon alloy spring steel, which has high tensile strength and elastic limit, good hardenability and fatigue performance. It is often used to manufacture bicycle shock absorber, automobile clutch diaphragm, stabilizer bar, torsion bar and leaf spring. The main process of manufacturing mountain bike shock absorber by 50 CrVA spring steel is as follows : blanking → heating → hot rolling → earing → quenching (arcing) → medium temperature tempering → shot peening → assembly. The microstructure of 50 CrVA spring steel after quenching and medium temperature tempering is tempered troostite. The quenching temperature and tempering temperature significantly affect the mechanical properties of spring steel, and the research on this aspect is rare at present. In this paper, the effect of quenching temperature on the microstructure and mechanical properties of 50CrVA steel was studied. The experimental results can provide reference for the application of 50CrVA spring steel in mountain bike shock absorber.

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Materials and methods

The 50CrVA spring steel samples were prepared by medium frequency melting furnace, sand casting and experiment. Its chemical composition (mass fraction) : C : 0,49 %, Si : 0,28 %, Mn : 0,72 %, S : 0,015 %, P : 0,011 %, Cr : 0,98 %, V : 0,12 %, Fe : remainder. The experimental steel was quenched by box-type resistance furnace. The quenching temperature was 860,880,900,920,930 and 940 °C, respectively, and the holding time was 0,5 h. The quenched test steel was then put into a heating furnace at 450°C for 2h and then cooled to room temperature. The microstructure of the experimental steel was observed on the metallographic microscope, and the corrosive agent was 3 % nitric acid alcohol solution. The mechanical properties of experimental steels in different states were tested on 5105 microcomputer controlled electronic universal testing machine.

Experimental results and discussion

Figure 1 is the microstructure of 50CrVA steel quenched at different temperatures and tempered at 450 °C. It can be seen from the diagram that these structures are tempered troostite. Tempered troostite refers to the metal phase with specific structure and properties formed during tempering. Its main characteristics are fine grains, uniform distribution, high strength and good toughness. With the increase of quenching temperature, the lath characteristics of tempered troostite become more obvious. With the increase of quenching temperature, the volume fraction of lath martensite increases after quenching. Because the spring steel is tempered at medium temperature, the morphology of martensite cannot be eliminated after tempering, so the lath characteristics of tempered troostite are obvious at high quenching temperature.

During the quenching process, the quenching time and temperature affect the properties of the material. In general, the best ratio can be obtained by controlling the parameters. The mechanical properties of the experimental steel at different quenching temperatures and 450 °C tempering temperatures are as shown in Table 1.

The hardness of the alloy was evaluated by Rockwell hardness method. The hardness change curve of the alloy at different quenching temperatures is shown in Figure 2. In order to avoid the experimental error, the hardness measurement was carried out at different quadrants of the plane of the sample block. It can be seen from Figure 2 that the hardness of the experimental steel did not change much.

Figure 3 show the relationship between quenching temperature and tensile strength and yield strength. The basic law is that when the quenching temperature is 860 ~ 920 °C, the yield strength and tensile strength increase with the increase of quenching temperature. When the quenching temperature increases from 920 °C to 940 °C, the yield strength and tensile strength decrease. When the quenching temperature is 920 °C, the yield strength and tensile strength are the largest, and the maximum yield strength and tensile strength are 1 419 MPa and 1 538 MPa.

The impact energy reflects the ability of the material to resist deformation and failure under impact load, and its size reflects the impact toughness of the material. As shown in Figure 5, when the quenching temperature increases from 860 °C to 940 °C, the impact toughness decreases with the increase of quenching temperature. When the quenching temperature increases from 920 °C

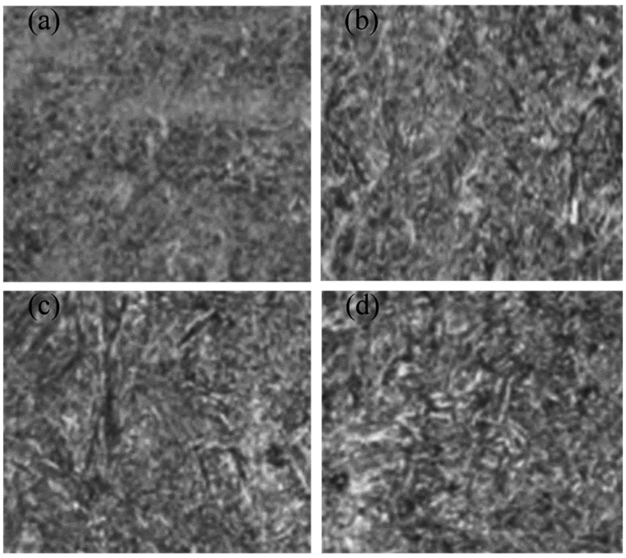

Figure 1 Microstructure of experimental steel at different quenching temperatures

Table 1 **Mechanical properties of experimental steel at different quenching temperatures**

Number	Tempering temperature/°C	Hardness/ HRC	R_m/ MPa	R_v/ MPa	Elongation/%	impact work
1	860	62	1 350	1 255	10,2	31,1
2	880	57	1 483	1 387	11,1	28,2
3	900	55	1 524	1 415	11,4	22,3
4	920	56	1 538	1 419	12,1	20,2
5	930	61	1 483	1 378	11,8	22,3
6	940	62	1 472	1 362	11,7	23,4

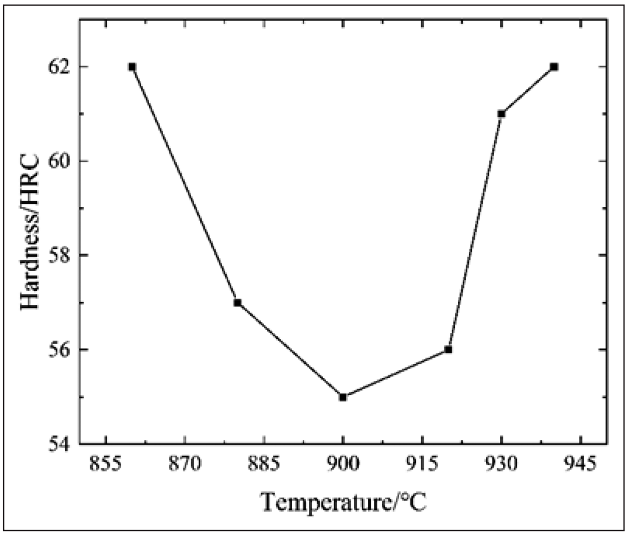

Figure 2 Effect of tempering temperature on hardness of experimental steel

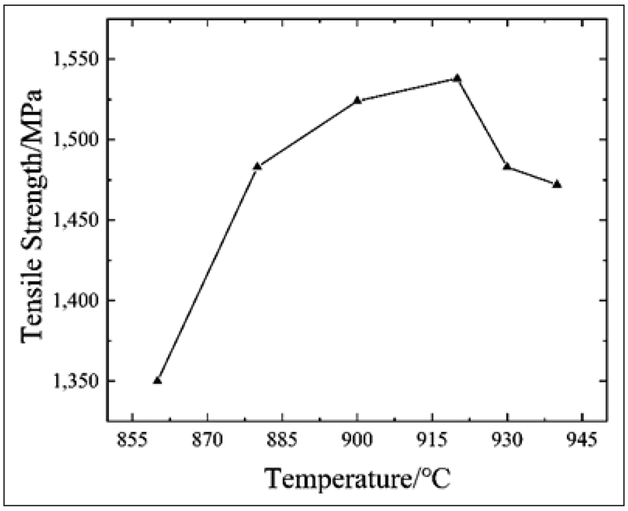

Figure 3 Effect of tempering temperature on tensile strength of experimental steel

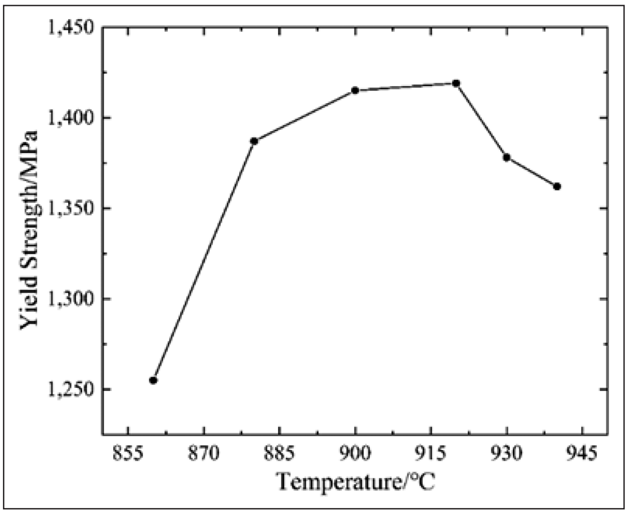

Figure 4 Effect of tempering temperature on yield strength of experimental steel

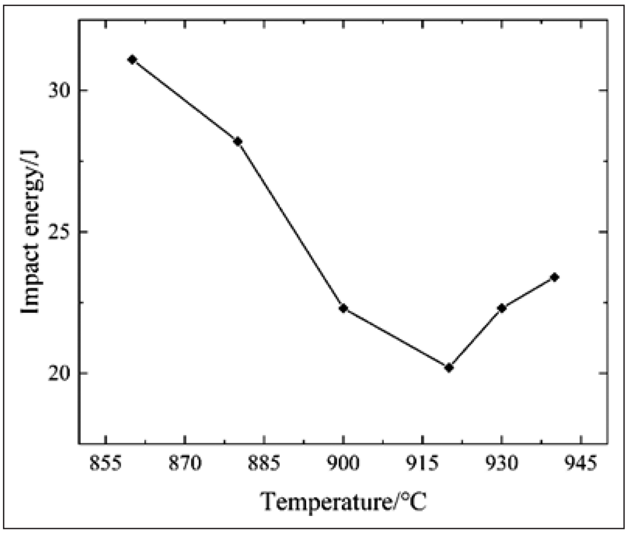

Figure 5 Effect of tempering temperature on impact toughness of experimental steel

to 940 °C, the impact energy increases. When the quenching temperature is 920 °C, the impact energy is the lowest, which is 20,2 J.

Elongation is an index to describe the plastic properties of materials. It refers to the percentage of the ratio of the total deformation of the gauge section to the original gauge length after the tensile fracture of the specimen. Figure 6 is the effect of quenching temperature on elongation. When the quenching temperature increases from 920 °C to 940 °C, the elongation increases with the increase of quenching temperature. When the quenching temperature increases from 920 °C to 940 °C, the elongation decreases. When the quenching temperature is 920 °C, the elongation is the highest, which is 12,1 %.

CONCLUSION

The microstructure of 50CrVA steel quenched at 860-940 °C and tempered at 450 °C is tempered troostite. With the increase of quenching temperature, the lath characteristics of tempered troostite become obvious.

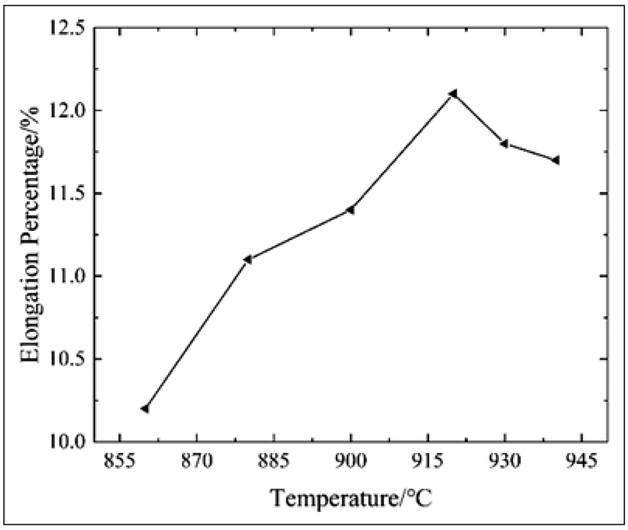

Figure 6 Effect of tempering temperature on elongation of experimental steel

In the quenching temperature range of 860-940 °C, with the increase of quenching temperature, the yield strength, tensile strength and elongation of 50CrVA steel after tempering at 450 °C increase first and then decrease, and all reach the maximum at 920 °C, while the impact energy shows the opposite trend. When the quenching temperature is 920 °C and the tempering temperature is 450 °C, the comprehensive mechanical properties of 50CrVA steel are the best. At this time, the yield strength of the steel is 1 417MPa, the tensile strength is 1 535MPa, the elongation is 12,2 %, and the impact energy is 21J. This study has a certain guiding role in the development of mountain bike shock absorber materials.

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Note: The responsible translator for English language is Y. Q. Gui – Jiangsu vocational college of electronics and information, China.