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Rerserach on Microstructure and Properties of Cr12MoV after Heat Treatment

Abstract: After spheroidizing annealing / quenching and tempering treatment as preheat treatment and the same vacuum heat treatment as final heat treatment, the microstructure, hardness, impact toughness, bending strength and wear resistance of Cr12MoV steel were studied. The results indicate that the quenching and tempering treatment as preheat treatment, instead of spheroidizing annealing, has more benefits for the variation of carbide morphology, size and distribution, and can effectively improve properties of Cr12MoV, like hardness, impact toughness, bending strength and wear resistance. After vacuum heat treatment, the impact toughness and bending strength of the samples reach 8.654 J • cm^{-2} and 2201.4 Mpa, respectively, In comparison to the samples with spheroidizing annealing, They increase 13.5% and 39.3%, Respectively.

Cr12MoV steel is a kind of ledeburite cold work tool steel which developed from Cr12 steel, as the added content of Mo, V and decrease of C, Cr12MoV have the advantage of Higher hardenability, hardness, wear resistance and small heat treatment distortion. It's regularly be used in manufacturing cold mold with heavy load, bulk production and complex shape. Due to Cr12MoV is ledeburite steel, so its toughness is greatly influenced by the carbide morphology and distribution.

The spheroidized annealing and quenching and tempering treatment were used as the preliminary heat treatment of Cr12MoV steel, and then the materials were subjected to vacuum heat treatment under the same process parameters to study the effect of heat treatment on the microstructure and properties of steel.

1. Test Materials and Methods

1.1 Test materials

The chemical composition of Cr12MoV steel for inspection as the following table 1

Table 1 - Cr12MoV chemical composition

C	Si	Mn	Cr	Mo	V	P	S
1.45-1.70	≤0.35	≤0.40	11.0-12.5	0.40-0.60	0.15-0.30	≤0.030	≤0.030

Samples was cut into Unnotched impact test piece (10mm x 10mm x 55mm, 3 pcs / group), bending test piece (5mm x 5mm x 35mm, 3 pcs / group), wear resistance piece (10mm x 10mm x 10mm)

1.2 Test methods

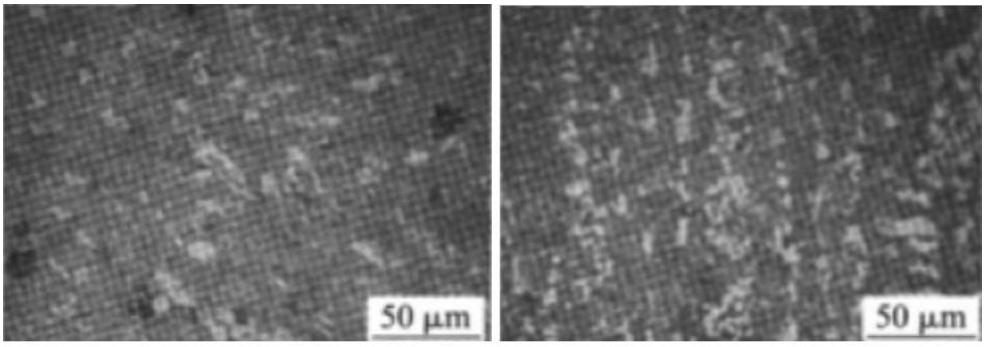
First put the samples into two groups, ones pre heat treatment is spheroidizing annealing, another is quenching and tempering (Q+T). And then put these two groups of samples into final heat treatment in the same vacuum quenching + tempering condition. Its details is as the following table 2.

Table 2 - Hteat treatment process of Cr12MoV steel		
	Preocess I	Process II
Pre heat treatment	Spheroidizing annealing : 860℃ x 2h furnace cooling to 750℃ Isothermal for two hours and then furnace cooling to 500 - 550 ℃, remove out and air cooling	Quenched + Tempered : 1100℃ x 20min Step quenching + 700 ℃ x 1h tempering, remove out and air cooling
Final heat treatment	Quenching: 1030 ℃ x 40min oil quenching (800 ℃ preheating, vacuum 2.5 Pa). Tempering: 250 ℃ x 1h	

XJP-6 metallographic microscope measure the instruction, hardness is checked by HR-150A Rockwell Hardness Tester. The impact toughness was measured By a JB-W300 impact tester. The WDW-50 microcomputer controls the electronic universal Test machine to measure the bending strength, M-2000 friction and wear tester to measure wear resistance.

2. Results and Discussion

Figure 1 - Different metallographic structure after heat treatment. it can be seen that the microstructure of the two heat treatment is mainly shown in the size and distribution of the carbides in structure. Due to the quenching temperature can reach 1100 ℃ and above during QT treatment, IT completely dissolved the smaller carbides, meanwhile promoting the partial dissolution of large carbide corners, and the carbides which incorporated into the matrix are precipitated in a small, diffusible manner during the subsequent high temperature tempering. Thus the shape, size and distribution of carbides get improved. After the same vacuum heat treatment, the organization of carbides by pre-heat treatment is significantly smaller and more even than by spheroidizing annealing.



Preocess I Process II

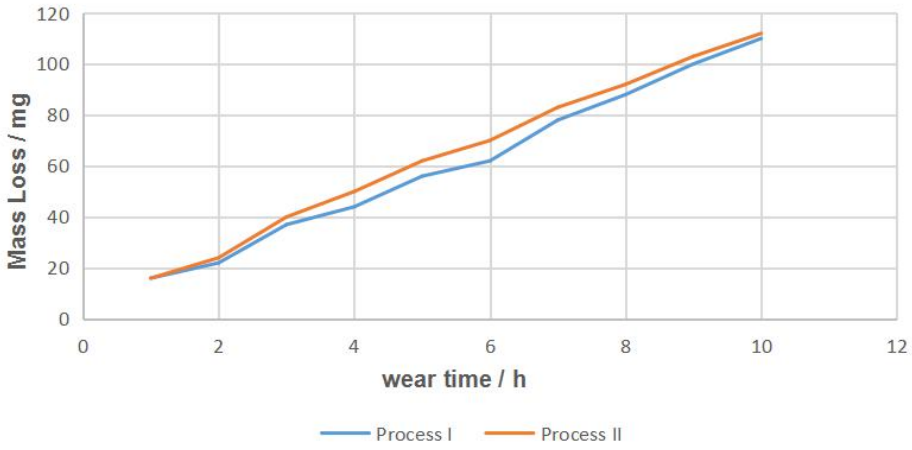
Figure 1. Microstructure of Cr12MoV steel by different heat treatment

Table 3 shows the test results of mechanical properties of the materials after different heat treatment. It can be seen that the hardness, impact toughness and bending strength are 59HRC, 8.654 J·cm-2 and 2201.4 Mpa respectively after treated by process II. In comparison of process I, increased by 3.5%, 13.5% and 39.3% respectively. The improvement of material properties is directly related to the refinement and uniform distribution of carbides in the organization.

Table 3 - Mechanical properties of Cr12MoV sample by different heat treatment			
	Hardness (HRC)	Impact toughness (J·cm-2)	Bending strength (Mpa)
Process I	57.5	7.624	1580.5
process II	59.0	8.652	2201.4

Figure 2 shows the wear curves of the material after different heat treatment. It can be seen that the ware resistance of Cr12MoV sample treated by Process II is better than Process I. This is because of the wear resistance is closely related to the material's hardness and the shape, Size, distribution of Hard phase (carbide). From the above analysis we can see that the material hardness which treated by Process II is higher, and the carbides in the organization are more finer and evenly distributed. Thus lead to a higher wear resistance.

Figure 2 - Wear curves of Cr12MoV sample under different heat treatment



Conclusion

It will improve the shape, size and distribution of carbides by take the quenched and tempered as Pre heat treatment, which will improve the materials performance. After the final heat treatment, the impact toughness, bending strength reach 8.654 J • cm-2 and 2201.4 Mpa respectively after the final heat treatment. In comparison of Spheroidized annealing, increased by 13.5% and 39.3% respectively.

ALTA is good at manufacturing and supplying Cr12MoV steel, which cover rolled and forged bars, with the following size range.

Diameter : 8mm to 450mm (0.3” to 17.7”)

Thickness : 2mm to 350mm (0.0787” to 13.77”), width max up to 860mm (33.86”)

Any requires on the steel materials, please contact ALTA, we are professional and timely deal your issues.

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