Contemporary Engineering Sciences, Vol. 2, 2009, no. 8, 355 - 359

Effect of Heat Treatment on the Microstructure and Hardness of Chromium – Nickel steel

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Abstract

This research is the effect of heat treatment of chromium-nickel steel was studied. For this purpose of chromium-nickel steal were carburized, normalized, annealed, hardened and tempered. It was shown that the hardness of the material increased. The effect of temperature and holding time and cooling media (Furnace) of annealing on hardens. It was found that; the hardness will increase while the annealing temperature is rising to 740°C then decreases after that till it reach the temperature of 760°C. Sixty minutes was the best time.

Keywords: Hardness; Furnace; Microstructure; Holding time; Spheroidal annealing

1. Introduction

The characteristics and importance of the chromium nickel steel in industry: Low alloy steels constitute a category of ferrous materials that exhibit mechanical properties superior to plain carbon steels as the result of additions of such alloying elements as nickel, chromium, and molybdenum. The process of intermediate annealing was added to disperse uniformly the carbides in the steel.. The temperatures were chosen in the range of spheroidal annealing [1]. The general purpose of annealing processes is to soften iron or steel materials and refine it's grains [2] due to ferrite-pearlite microstructure [3]. Spheroidal annealing gives maximum softness because of the transformation of cementite lamellae to spheroids. Many works concern of heat treatments as they change holding time and temperature, which affect the properties of these metals. Also rapid annealing

can be used to study the nucleation step in a number of transformations and to control the scale and spatial distribution of a variety of reaction products [4]. so that chromium-nickel stainless steels are now the most widely- used materials in a wide range of corrosive environments both at room and elevated temperatures [5]. Intermediate annealing heat treatment at different temperatures and period of annealing was used in an attempt to improve strength and impact toughness resistance, high martensite dual phase steel [6].

2. Experimental

Materials and heat treatment processes

All specimens of Chromium-Nickel (table 1) steel DIN×19 Nicro MO4 (W.Nr 1.2764) with a diameter of 8 and 12 mm and 100 mm length were carburized in a Liquid carburizing. The remaining specimens were carburized, normalized, annealed, hardened and tempered. The annealing temperatures 740, 760, and 780 °C were selected in holding time intervals of 45, 60, and 75 min.

Microstructure

Microstructure examination of finish surface is an important analysis to be carried out. It is very useful, since it can provide important information about the material properties and reliability. It can show the surface cracks or other machining damage, improper machining cause transformation of the microstructure. A cylinder part (test piece) with 12mm diameter and 10 mm length was cut off from each specimen. After grinding, the test pieces using a rotary polishing machine type Roto Force-4 with the aid of diamond paste of 1μm were treated until achieving a mirror like surface. After that, the polished surfaces were etched by the nitric acid (2%) and alcohol (98%) for 10 second.

Microhardness

Hardness is one of the most important properties, which is commonly used to give a general indication of the strength, and scratching of a material. The hardness can be defined as the ability of a material to resist deformation when it is in contact with an indenter under load.

3. Results and discussion

Microstructure

On the surface of all annealed samples (including the standard samples) the martinsite microstructure well seen due to heat treatment processes which give an indication of no change due to normalization and annealing (see fig 1).

Microhardness

Table 2 shows The microhardness of specimens annealed at 740 and 780 °C, gives the best results at 60 min and 45 min where the microhardness for these specimens are 50.4, 48 HRC respectively. The annealing samples at 760 °C gave the minimum results for all investigated times. In general the best result of microhardness test was for the annealed samples at 740 °C for a period of 60 min (50.4 HRC).

4. Conclusion

Samples of chromium-nickel steal were carburized, normalized, annealed, hardened and tempered to study the effect of holding time and temperature on hardness. The hardness of the material increased that indicates a uniform dispersion of carbides in the metal with some reservations. The temperature for the metal spheroidal annealing process expected to be 740˚C for chromium nickel steel, the best holding time 60 min. The regularity of carbides distribution based on the regularity of heat charge ,we see after fast heating an aggregation of the carbides and when lower the speed of heating and equalizing the temperature ,the carbides aggregation will be hidden and get carbides distribution regularity by replacing the slow heating by hold the temperature without Ac_1 line range 40-50ºC .

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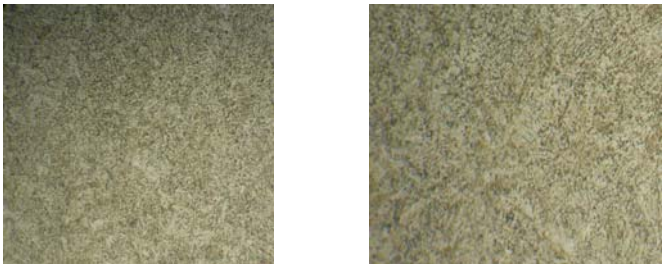
Table 1. Chemical composition in weight percent of Cr-Ni steel DIN×19 NicrMo4

Element	C	Ni	Cr	Mo
Wt %	0.19	3.7	1.3	0.2

Figure 1. Micrographs (1000X) of: (B) annealed at 740 °C, 60 min and (C) at 780 °C, 45 min.



A B

Table (2):- Conditions and results

Specimen No.	Spheroidal annealing temp.(˚C)	Holding time (min)	Cooling media	Hardness (HRC)
1	740	45	Furnace	34
2		60		50.4
3		75		38.6
4	760	45		33.5
5		60		33.9
6		75		30.9
7	780	45		48
8		60		45.6
9		75		35.3

Received: January, 2009