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Effect of Post Carburizing Treatment on Hardness of Low Carbon Steel

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Abstract

Low carbon steel containing 0. 15% to 0. 3% of carbon does not respond to hardening heat treatment processes like quenching and tempering and hardly any martensitic transformation takes place on quenching. Thus, to improve the surface hardness carburizing treatment is done in which the surface composition of the low carbon steel changes by diffusion of carbon and results in to hard outer case with good wear resistance. The low carbon steel was carburized a temperature of 900^0C for 5 hours. After carburizing, annealing, normalizing, hardening and tempering treatments were done. The resultant hardness values under all the processes have been measured and reported in this investigation.

Keywords: carburizing, Post carburizing treatment, Hardness

Introduction

In some engineering applications, requirement needs to have a hard outer surface but a ductile and tougher inner core such as in cams, gears and shafts etc where the hard surface resist the wear to give long life and the tough interior resist the shock or breakage. Such combination can be achieved by carburizing technique. Carburizing is the most commonly used diffusion treatment in which carbon is diffused into the surface of low carbon steel by heating it in contact with a carbonaceous material. Carburizing process provides a deeper case depth in case of plain carbon steel [2] and improves surface hardness. After carburizing, in most of the cases, the steel requires specific treatment to improve hardness.

Methodology

Plain carbon steel was collected from the local market and the chemical composition was tested by spectroscopic analysis according to ASTM E 415-99a which is shown in table 1.

Table 1 Composition of steel

C	Si	Mn	Cr	Mo	Ni	Cu	Al	P	S	V	Fe
0. 139	0. 103	0. 425	0. 455	0. 0113	0. 0910	0. 122	0. 00363	0. 0623	0. 0815	0. 0005	98. 90

The test specimens for hardness measurement were prepared from the steel collected by different machining processes as per ASTM standard whose dimensions are given as Length= 25 mm, Width = 10 mm and Thickness = 10 mm. Then the test specimens were carburized at 900^0C for 5 hours. After carburizing, the steel often becomes harder than the required value. It becomes too brittle for most practical uses. But in our case, the steel samples became softer than original when they were kept within the packing of charcoal for 24 hours. Thus, to improve the hardness, the carburized samples were again given different treatments. The carburized steel samples were heated for 30 minutes at 800^0C. Some samples were kept inside the furnace to be annealed and some were quenched in water. Due to the rapid cooling, severe internal stresses were developed. To relieve the internal stresses induced and to reduce brittleness, tempering process was done on hardened carburized steel samples at 150^0C for 30 minutes, and then cooled in air. The hardness was measured at each stage to know the difference in hardness values.

In the present work, Rockwell hardness value was measured for carburized steel samples in which steel ball indenter was used and a major load of 100 kg was applied. It gave the Rockwell hardness value in B scale i. e. RHB. For each of the sample, test was conducted for 5 times and the average of all the tests was taken as the observed values in each case.

Results and Discussion

The hardness value of the steel after carburizing decreases. It is because of release of internal stress during cooling after carburizing treatment where samples got annealed after keeping in the carbon packing for 24 hours (slow cooling). When different heat treatment processes are performed on the carburized steel it gives a variation in hardness values as shown in table 2 and the variation graph is shown in fig 1.

Table 2 Effect of post carburizing treatments on hardness of steel

Initial Hardness (RHB)	Hardness after carburizing (RHB)	Hardness after carburizing & Quenching (RHB)	Hardness after carburizing, Quenching & Tempering at 150^0C and soaking for 30 min (RHB)	Hardness after carburizing & Annealing (RHB)	Hardness after carburizing & Normalizing (RHB)
76	69	104	82	52	74

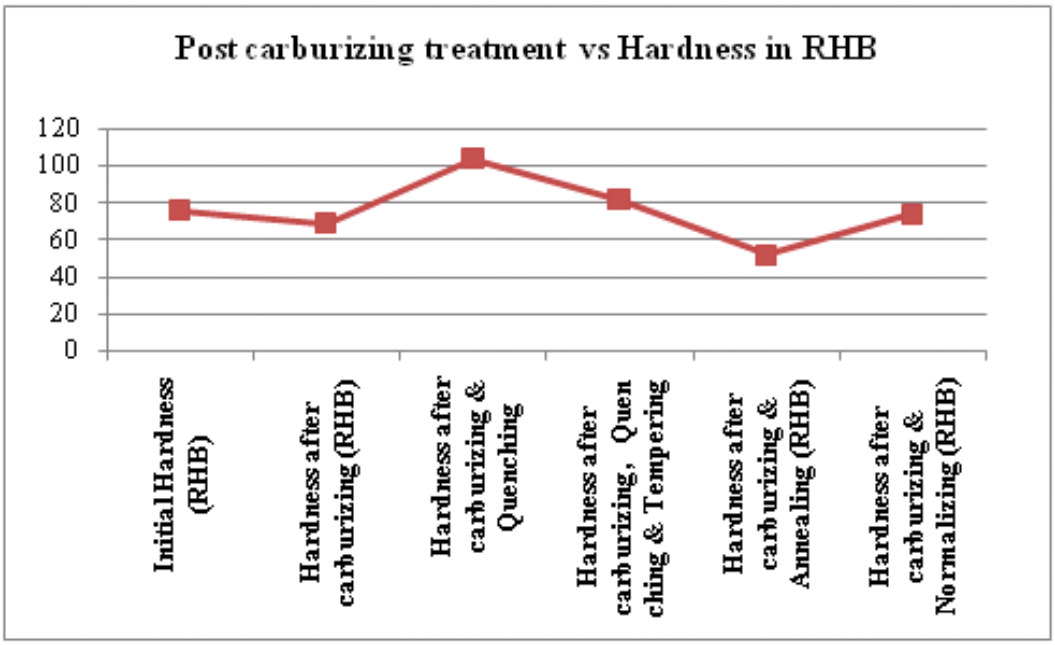

Figure 1 Graph of Hardness values after post carburizing treatments

Conclusion

Based on the results obtained the following conclusions have been drawn:-

1. The surface hardness is strongly influenced by carburizing process.
2. The value of hardness decreases with retention of sample in the furnace for longer period due to release of internal stresses.
3. Post carburizing heat treatment processes strongly influenced the hardness of carburized steel.
4. The highest value of hardness is obtained on quenching and the lowest value of hardness is obtained on annealing of carburized steel.

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