EVALUATION OF EN8 STEEL IN DIFFERENT QUENCHING MEDIUM

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Abstract

The heat treatment and quenching process offer enormous advantages to the steels by changing the mechanical properties, phase changes in structure of the steel in the present scenario. So, we undergo this heat treatment process for the evaluation of the En8 steels in different quenching medium. Samples of EN8 medium carbon steel were examined after heating between 900ºC-930ºC in the Gas Carburizing Furnace and quenched in different quenching medium. The different quenching mediums used like Oil, Water, and Air. The mechanical properties such as hardness are determined using the Rockwell hardness equipment and the hardness of the quenched material is higher than the parent material. The hardness of the water quenched material is higher than the other quenched materials. The heat treated materials are cut into the required specification using wire cutting machine. And the microstructure of the quenched samples was taken using optical microscope. The water quenched material has more hardness, suggesting improved mechanical properties.

Keywords: Heat treatment, quenching process, EN8 steel, Hardness, Microstructure

1. Introduction

1.1 Material Selection

We are selecting the EN8 steel because it's a harden steel. EN8 also known as 080M40. EN means Europe norm**.** Unalloyed medium carbon steel. EN8 is a medium strength steel, good tensile strength. It is easily available and cost of the steel is low. Suitable for shafts, stressed pins, studs, keys etc.EN8 steel is supplied as round drawn/turned, round hot rolled, hexagon, square, flat and plats.

We are taken five flat EN8 steel plate in 200mm×100mm×10mm dimensions. In that plate four are heat treated and one is not treated.

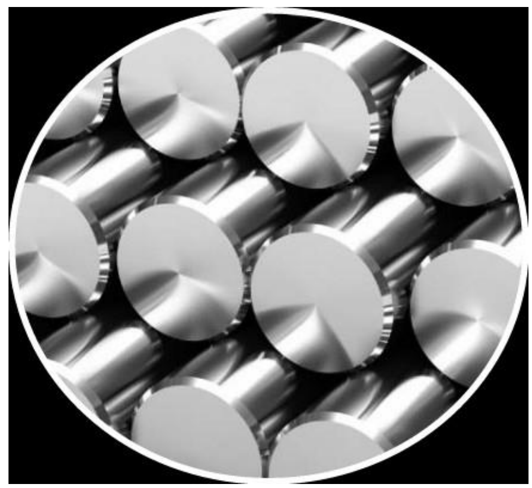

Fig.1 Flat EN8 steel plates

Carbon	0.36-0.44%
Silicon	0.10-0.40%
Manganese	0.60-1.00%
Sulphur	0.050 Max
Phosphorus	0.050 Max
Chromium	–
Molybdenum	–
Nickel	–

Table .1 EN8 (080M40) Specification

Chemical composition

1.2 Composition Of En8 Steel

C	Si	Mn	Ni	Cr	Mo	S	P
%	%	%	%	%	%	%	%
0.35/0.45	0.05/0.35	0.60/1.00	-	-	-	0.06 max	0.06 Max

Table .2 Composition of EN8 steel

EN8 (080M40) – Mechanical Properties in "R" condition

Max Stress	700-850 n/mm^2	
Yield Stress	465 n/mm^2 Min	(up to 19mm LRS)
0.2% Proof Stress	450 n/mm^2 Min	(up to 19mm LRS)
Elongation	16% Min	(12% if cold drawn)
Impact KCV	28 Joules Min	(up to 19mm LRS
Hardness	201-255 Brinell	

Table .3 Mechanical Properties

1.3 Applications Of En8 Steel

1. Bolt
2. Gears
3. Keys
4. Shafts
5. Stressed pins
6. Studs etc.,

2. Heat Treatment

EN8 or 080m40 can be tempered at a heat of between 550°C to 660°C (1022°F-1220°F), heating for about 1 hour for every inch of thickness, then cool in oil or water.Normalising of EN8 bright Mild Steel takes place at 830-860°C (1526°F-1580°F) then it is cooled in air.

2.1 Heat Treatment Process Cycle

1. Heating the material of 3 quantity up to 930°C for 3 hours in the Gas Carburizing Furnace (GCF)

2. Temperature drop at 840°C for 30min is done in the furnace

3. One quantity is heated up to 930°C for 3 hours in Special Quenching Furnace (SQF) and quenched in oil within the furnace itself

Here we are using two types of furnaces.

a.Gas carburising furnace

b.Special quenching furnace

In Gas carburising furnace we are treated 3 materials only. In this furnace the quenching process is done in outside of the furnace. Other one material is treated in special quenching. In this furnace the quenching process is done in inside the furnace.

2.2 Our Quenching Medium During The Heat Treatment Process

1. Water quenching
2. Air quenching
3. Oil quenching
   1. Open oil quenching (outside the furnace)
   2. Closed oil quenching (inside the furnace)

2.3 OUR QUENCHED MATERIALS

Fig.2 Oil (Closed)

Fig.3 Oil (open)

Fig.4 Water

Fig.5 Air

2.3.1 Annealing

Heat slowly to 680-710°C, soak well. Cool slowly in the furnace.

2.3.2 Hardening

Heat the component slowly to 820-860°C and allow it to be heated through. Quench in oil or water.

2.3.3 Tempering

Temper the EN8 component immediately after quenching whilst tools are still hand warm. Re-heat the EN8 component to the tempering temperature then soak for one hour per 25 millimeter of total thickness (2 hours minimum) Cool in air. For most applications tempering of EN8 will be between 550-660°C

2.4 HARDNESS TEST

We are taken indentation hardness in Rockwell hardness machine. After heat treatment we have determined the hardness of the treated materials as well as parent material in Rockwell hardness. The "c scale" is taken to find hardness. The 120^0 diamond cone is used an indenter. The load of 150Kg is applied for the penetration.

The Rockwell hardness number for the different quenched materials.

From Rockwell hardness test, all heat treated materials hardness is higher than the raw material (as received). Here, the hardness of the water quenched material is higher than the other quenched materials.

2.5 MICROSTRUCTURE

The microstructure of the quenched materials as well as the parent material using the optical microscope. From the microstructure of the

materials the effect of heat treatment is involved in the changes of the mechanical properties and the structure.

3. RESULTS AND DISCUSSION

As described the EN8 steel samples were subjected to heat treatment up to 930°c and subjected to the four types of quenching process: air quench, water quench, oil quench (open), oil quench (closed). Variation of mechanical properties of EN8 steel after the heat treatment and these quenching sequences is shown below in a graphic format. All mechanical testing was performed at room temperature.

3.1 EFFECT OF HEAT TREATMENT ON HARDNESS

Variation of hardness against hardening temperature for each quenching medium is shown in Fig. 6. As hardening temperature increases, the stresses in the steel get relived and the material becomes soft and the phase changes to martensite. Hardness of the material gradually decreases. The different quenching made for the EN8 steels shows the hardness increased in each materials than the raw material as received.

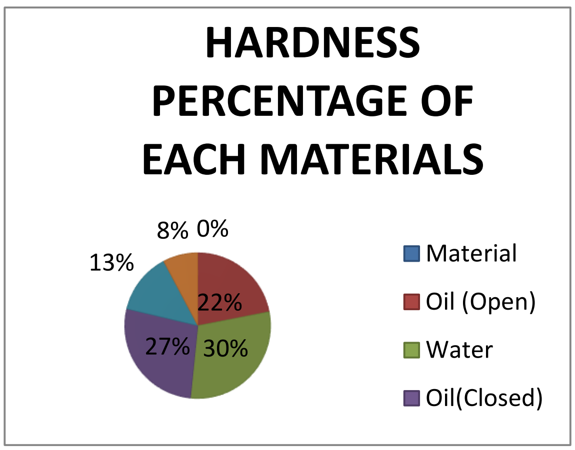

Fig.6 Hardness comparison chart

From the all quenched materials the water quench has more effect on heat treatment where the maximum hardness is obtained. The hardness for water quench and oil (closed) quench are very close to each other, indicating the water quench has the maximum hardness. It is a general observation for normal steels that hardness decreases with higher temperatures, and with a sudden cooling of the steels with lowering temperatures the hardness increases. However, the increasing in the hardness seen, in water quench the high hardness is obtained.

3.2 EFFECT OF HEAT TREATMENT ON MICROSTRUCTURE

Effect of heat treatment on microstructure in EN8 steel for different quenching medium as well as received material are given below and these microstructures are taken in 100x magnification using optical microscope.

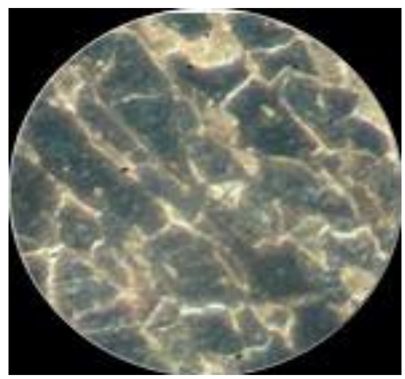

Fig.7 Microstructure of As Received Material'

This was the microstructure of 'as received material'. The pearlite and ferrite have been seen clearly in the image. The composition of pearlite and ferrite was found to be equal. This microstructure is the result of 100x magnification using optical microscope.

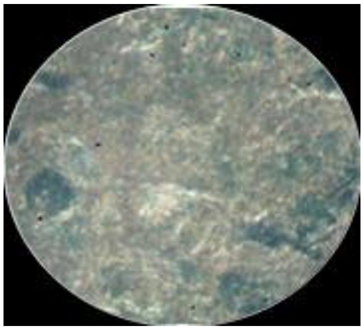

Fig.8 Microstructure of Air Quenched Material

This was the microstructure of ‘air quenched material’. The composition of pearlite and ferrite was found almost equal but compared to the ‘as received material’ here ferrite dispersed in pearlite matrix.

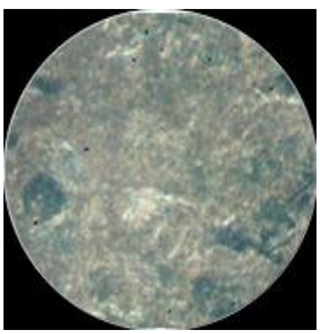

Fig.9 Microstructure of Oil (Open) Quenched Material’

This is the microstructure of ‘oil (open) quenched material’. The composition of pearlite and fearlite matrix was found to be equal. Needle like structures are formed slightly.

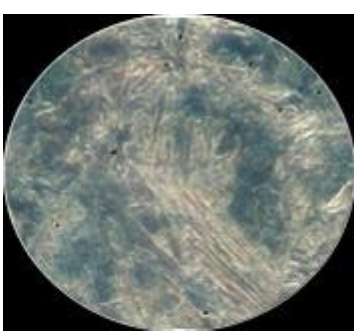.

Fig.10 Microstructure of Oil (Closed) Quenched Material’

This was the microstructure of ‘oil (closed) quenched material’. The composition of pearlite and ferrite almost equal here black was pearlite matrix and white was ferrite. It showed that needle like structure.

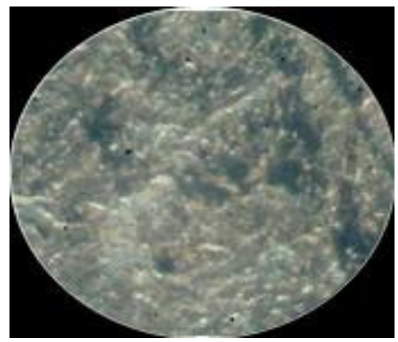

Fig.11 Microstructure of water quenched material

This was the microstructure of ‘water quenched material’. The structure clearly showed needle like structures.

From these microstructures we can see the clear needle structures in water quenched material. The hardness of the water quenched material had been more compared to other.

CONCLUSION

1. The Hardness of the quenched materials was increased over the raw material.

2. The water quenched material has the best mechanical properties in Hardness when compared to the other quenched materials.

4. This improved EN8 steel can be used in the automobile brake drums due to its high hardness.

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