Study of effect of Heat Treatment Processes on the Hardness of Different Grades of Mild Steels

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Abstract— Study of effect on the hardness of three sample grades of mild steel are studied. In this paper, we are going to determine the change hardness number of mild steel grade due to different heat treatment processes i.e. annealing, normalizing and case hardening. By going through research paper we came to know that after heat treatment mechanical properties of material changes. After heat treatment material is tested for hardness and we get readings. By comparing graphs of readings we can understand changes in hardness of material. Heat treatments are normalizing, annealing, case hardening etc. This heat treatment processes causes change in mechanical properties like hardness. This change in hardness for mild steel material is studied.

Key words: Mild steel, heat treatment, hardness

I. INTRODUCTION

As we know there is a little bit of steel in everybody life. Steel has many practical applications in every aspects of life. Steel with favorable properties are the best among the goods. The steel is being divided as mild steel, medium carbon steel, high carbon steel on the basis of carbon content. Mild steel has carbon content of 0.15% to 0.45%. Mild steel is the most common form of steel as it's provides material properties that are acceptable for many applications. It is neither externally brittle nor ductile due to its lower carbon content. It has lower tensile strength and malleable.

Steel with low carbon steel has properties similar to iron. As the carbon content increases, the metal becomes harder and stronger but less ductile and more difficult to weld. The process heat treatment is carried out first by heating the metal and then cooling it in water, oil and brine water. The purpose of heat treatment is to soften the metal, to change the grain size, to modify the structure of the material and relive the stress set up in the material. The various heat treatment process are annealing, normalizing, hardening, austempering, martempering, tempering and Case hardening. We are going to study effect various heat treatments on material.

II. LITERATURE REVIEW

Ashish Bhateja studied the Effect on the hardness of Sample grades of tool steel after heat treatment processes. They found that for tool steel hardness of material increases. After annealing specimen machine-ability properties increased. Devnath khunte researched on an effect of heat treatment on steel. In this work they conclude that the mechanical properties vary depending upon the various heat treatment processes. The tempered samples gave an increase in tensile strength and hardness than untreated samples. Nadum Ibrahim Nasir Studied about the effect of heat treatment on the mechanical properties of stainless steel type 304. In this research work they found that, after doing heat treatment on steel capability of tensile strength has been improved due reducing the size of the granules Amit Kumar Tanwer Studied on effect of various heat treatment processes on mechanical properties of mild steel and stainless steel. In this research they conclude that Tensile strength, yield strength and elongation have best results in normalized heat treated mild steel specimen.

Sanjeev Kumar Jaiswal Studied on the effect of heat treatment processes on the hardness and the microstructure of medium carbon steel. In this paper they state that the value of hardness decreases with retention of samples in the furnace for a longer period. D. A. Fadare Studied about the effect of heat treatment on mechanical properties and microstructure of NST 37-2 Steel. In this research they conclude that Hardened sample had the highest tensile strength and hardness with lowest ductility and impact strength when compared to other heat treated samples. L.O. Mudashiru Studied on effects of heat treatment on the hardness and microstructure of welded low carbon steel pipes. In this paper they conclude that ductility and toughness in the annealed weld was found to be higher than the without annealed weld specimen.

III. METHODOLOGY

The experimental procedure for the project work can be listed as –

1) Material selection
2) Material Purchase
3) Specimen preparation
4) Heat treatment
5) Testing - Hardness measurement

A. Material selection:

From literature review we find out the materials which are used for research in this area. For our project we select mild steel grades i.e. EN-19, EN-8, MS-POLISH etc. Mild steel have wide application in engineering field. It is mostly used in different machine parts. So we select mild steel for project work.

B. Material Purchase:

For doing this project material selection and material availability is very important.

C. Specimen Preparation:

The first and foremost job for the experiment is the specimen preparation. The specimen size should be compatible to the machine specifications:

We got the sample from mild steel trader. First we cut the pieces of mild steel bars by using auto hacksaw machine. We got bars of 50 cm length from supplier. Then we cut this in 50mm pieces for project work. For testing of

material after heat treatment we required smooth finish on the job. Therefore on each piece we done the facing operations for smooth appearance on both side of material which is necessary to determine accurate penetration depth while testing the material hardness. For more surface finish cylindrical grinding is on the pieces.

D. Heat Treatment:

Main aim of this project is to study the effect of heat treatment on mild steel hardness. Therefore selecting suitable heat treatment processes is very important. We select annealing, normalizing and case hardening and carried out the specimen for heat treatment

E. Testing:

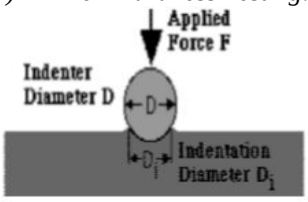
As the objective of the project is to compare the hardness of various heat treated mild steel specimens, now the specimens were sent to hardness testing. We test the hardness of mild steel in our Sanjay Ghodawat Polytechnic SOM lab. By using hardness testing machine we measure the hardness of mild steel. In this we use various pointers and load as specified in lab manual or standards.

1) Rockwell hardness testing:

The heat treated specimens hardness were measured by means of Rockwell hardness tester. The procedure adopted can be listed as follows:

- First the brale indenter was inserted in the machine; the load is adjusted to100 kg.
- The minor load of a 10 kg was first applied to seat of the specimen.
- Now the major load applied and the depth of indentation is automatically recorded on a dial gage in terms of arbitrary hardness numbers. The dial contains 100 divisions. Each division corresponds to a penetration of .002 mm.The dial is reversed so that a high hardness, which results in small penetration, results in a high hardness number. The hardness value thus obtained was converted into C scale by using the standard converter chart.

2) Brinell Hardness Testing:



$$BHN = \frac{F}{\frac{\pi}{2} D \left(D - \sqrt{D^2 - D_i^2}\right)}$$

Fig. 1:

By using this formula we can find out the Brinell hardness number. The diameter of the indentation left in the test material is measured. The Brinell harness number is calculated by dividing the load applied by the surface area of the indentation.

In this,

D = Diameter of pointer.

Di = Diameter of indentation.

Fig. 1.1: Experimental Set up

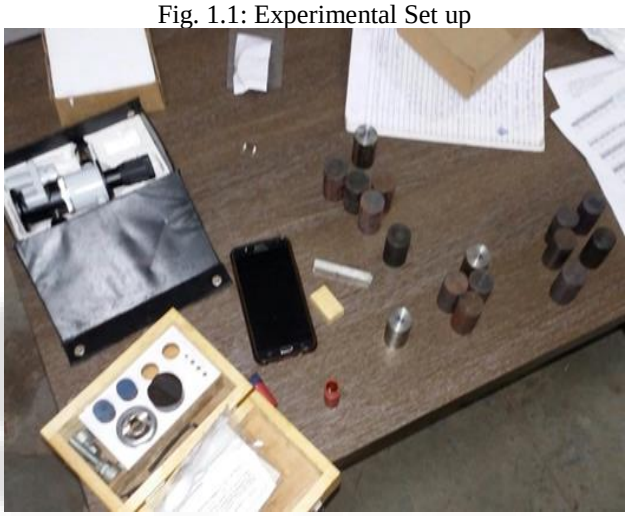


Fig. 1.2: heat treated jobs and instruments.

IV. Results & Discussion

A. Hardness testing of untreated and treated mild steel i.e. EN-8, EN-19, MS Polished:

1) Hardness test readings for untreated mild steel EN-19, EN-8 and MS-polish:

Untreated material	Rockwell C-HRC	Rockwell B-HRB	Brunel Hardness BHN
EN-8	9	88	175
EN-19	11	90	183
MS Polished	9	88	175

Table 6: Hardness of untreated mild steel material EN-8, EN-19, MS Polished

Material	Sample mark	HRC	HRB	BHN
EN-8	A	7	87	170
	N	1	82	154
	C.H.	6	86	167

Table 7: Hardness of heat treated mild steel EN-8.

Material	Sample mark	HRC	HRB	BHN
EN-19	A	7	87	170
	N	4	85	163
	C.H.	0	76	137

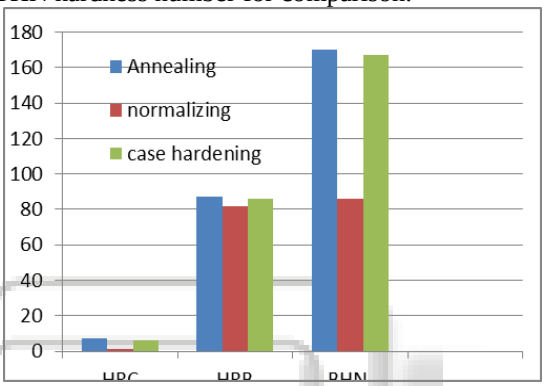
Table 8: Hardness of treated Mild steel EN-19.

Material	Sample mark	HRC	HRB	BHN
MS Polished	A	9	88	175
	N	7	87	170
	C.H.	4	85	163

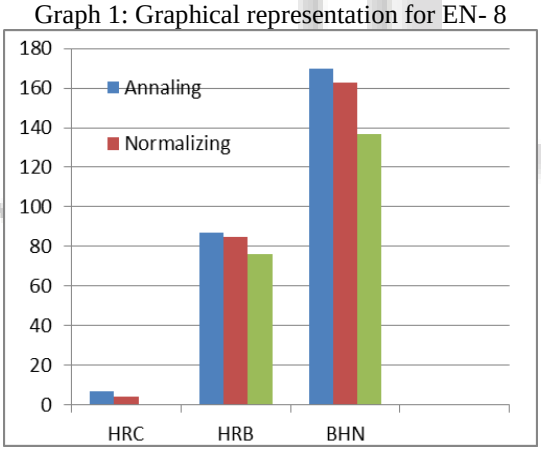
Table 9: Hardness of treated mild steel MS Polished.

B. Graphical representation of observations:

This graphical representation gives direct comparison between hardness of different heat treatment processes. In this heat treatment processes are plotted on x-axis and hardness number on y-axis. In this graph we use HRC, HRB and BHN hardness number for comparison.

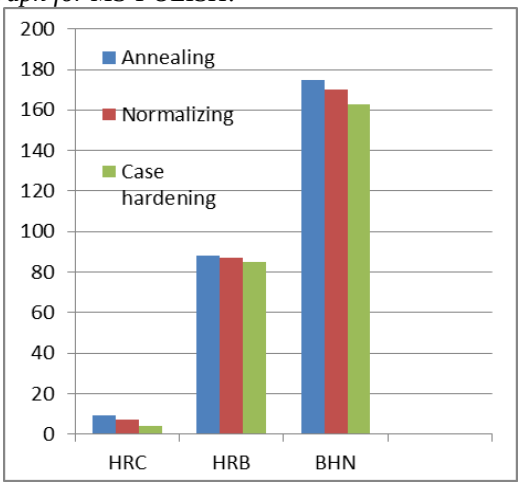


Graph 1: Graphical representation for EN- 8



Graph 2: Graphical representation for EN- 19

1) Graph for MS-POLISH:



Graph 3: Graphical representation for MS- polished

V. Conclusion

Literature gap analysis & industrial survey conduction are found to be very useful approach for selection of mild steel grade which will more beneficial for industrial point of view. From this project, it is obseverd that less research work has been seen for mild Steel i.e. EN-19, EN-8, and MS polish after Heat Treatment All these aspects will be addressed in research work. After heat treatment hardness of material change. Due heat treatment of annealing material becomes softer. Material compositions also changes due to heat treatment.

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