Journal of Engineering Research and Application www.ijera.com
ISSN : 2248-9622, PP 52-58

RESEARCH ARTICLE OPEN ACCESS

Experimental Analysis of E250 Quality Br Under Diverse Quenching Media.

Nehal Ahmad#1, Dr.Muzzamil Ahamed.S*2, Younus Pasha#3, Harish.H#4, Manjunath.N#5, Prashanth.D#6

 # Asst.Profe ssor,HKBK College of Engineering, visvesvarya Technological university,India
**Professor,HKBK College of Engineering, visvesvarya Technological University,India*

ABSTRACT- *This research was conducted in order to improve the mechanical properties of mild steel (E250) materials used as bolts, studs, welding plate and building construction application, following their frequent failure in service. Heat treatment at 900°C for three hours was done and then quenched with different media used as the major source of strength enhancement. The results of the tests showed positive changes in the strength properties of the mild steel material, in terms of high tensile strength, toughness, ductility and hardness. These desirable qualities are needed for durability in service, especially for many application. Oil proved to be the best quenchant for achieving these desirable qualities among the quenching media used.*

Keywords: *Quenching media , microstructure , METSCOPE, Metaquench , martensite.*

I. INTRODUCTION

Heat treatment is a combination of timed heating and cooling applied to a particular metal or alloy in the solid-state in such ways as to produce desired mechanical properties (yield strength, ultimate tensile strength and percentage elongation). Quenching are the most important heat treatment often used to modify the mechanical properties of engineering materials particularly steels.

1.1 Literature review

Dual-Phase steels (DP) are constituted by a ferrite matrix with a martensite fraction, giving a good combination of strength, ductility, capacity of energy absorption and strain hardening. It was observed that for DP steels with low carbon content (0.08 and 0.11%C), the volume fraction of martensite had a higher influence in elongation to fracture, due the decreasing carbon content of the martensite with the increase in its fraction. The opposite occurred for DP with 0.2%C. The best combination of mechanical properties in the analyzed DP can be obtained with carbon content between 0.1 and 0.15% and 50% martensite.

1.2 Aim

To investigate the mechanical properties on heat treated mild steel such as hardness, strength as well
as microstructure analysis of Mild steel E250 under different quenching media.

II. EXPERIMENTATION

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

1) Specimen preparation
2) Heat treatment
3) Harden measurement
4) Mechanical property study
5) Microstructure study

2.1 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. The sample that we got was Mild steel. IS : 2062/2011 Gr. E250 Quality “BR”:It is one of the Indian standard specifications of the mild steel having the martensite structure. And so it has high hardness with moderate ductility and high strength as specified below. So we can also say that it is basically a martensite structure.

2.2 Heat treatment:

Mild Steel are primarily heat treated to create matrix microstructures and associated mechanical properties not readily obtained in the as- cast condition. As cast matrix microstructures usually consist of ferrite or pearlite or combinations of both, depending on cast section size and/or alloy composition The principle objective of the project is to carry out the heat treatment of Mild steel and then to compare the mechanical properties.

Heat treatment are done in electrical furnace at 900º C for three hours and rapid quench with three different medium such as water, oil, brine. The continuous heating of steel at above critical temperature, it undergoes a phase change, recrystallizing as austenite. The quenching process transform the phase to Martensite.

2.3 Quenching:

This experiment was performed to harden the Mild steel. The process involved Putting the red hot Mild steel directly in to a liquid medium.

a) The specimen was heated to the temp of around 900° Celsius and were allowed to homogenize at that temp for 3 hour.
b) An oil bath was maintained at a constant temperature in which the specimen had to be put.
c) After 3 hour the specimen was taken out of the furnace and directly quenched in the oil, water and brine bath.
d) After around half an hour the specimen was taken out of the bath and cleaned properly.
e) Now the specimen attains the liquid bath temp within few minutes. But the rate of cooling is very fast because the liquid doesn’t release heat readily.

2.4 Electric salt bath furnace

Salt bath furnaces offer remarkably high temperature uniformity and excellent heat transferto the work piece. Salt bath furnaces TS 20/15 TSB 90/80 are especially useful for heat-treating of metals in neutral or active salt baths. Processes such as quenching up to 900 °C, carburizing up to 950 °C, or bright annealing up to 1000 °C can be realized. In their standard version these furnaces are equipped with safety technology for heat treatment of steel. As additional feature they can be equipped with extended safety technology for heat treatment of light metals.

Fig. 1 Photographic image of furnace

Fig. 2 Photographic image of heat treated sample

TABLE I ABBREVIATION USED

S.NO	SAMPLE	ABBREVIATION
1	Untreated sample	Sample MP1
2	Heat treated and quenched in brine bath	Sample MP2
3	Heat treated and quenched in water bath	Sample MP3
4	Heat treated and quenched in oil bath	Sample MP4

2.5 Mechanical tests: The various mechanical tests has been conducted to the heat treated specimen and the following result are observed.

2.5.1 Utimate Tensile Test :

The heat treated specimens were treated in UTS Machine for obtaining the percentage elongation, Ultimate Tensile Strength, yield Strength. The procedures for obtaining these values can be listed as follows;

1) At first the cross section area of the specimen was measured by means of an electronic slide calliper and then the gauge length was calculated.
2) Now the distance between the jaws of the UTS was fixed to the gauge length of the specimen
3) The specimen was gripped by the jaws of the holder
4) The maximum load was set at 150 KN.
5) The specimen was loaded till it fails
6) The corresponding Load vs. Displacement diagrams were plotted by using the testing machine. From the data obtained the % elongation, yield strength and ultimate tensile strength were calculated

.

2.5.2 Hardness testing:

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

1. First the diamond indenter was inserted in the machine; the load is adjusted to150 kg.
2. The minor load of a 10 kg was first applied to seat of the specimen.
3. Now the major load applied and the depth of indentation is automatically recorded on a dial gauge 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.

2.5.3. Rockwell hardness test

This test determines the hardness of metals by measuring the depth of impression which can be made by a hard test point under a known load. The softer the metal, the deeper the impression. Soft metals will be indicated by low hardness numbers.

Harder metals permit less of an impression to be made, resulting in higher hardness numbers. Rockwell hardness testing is accomplished by using the Rockwell hardness testing machine.

2.5.4 Experimental impact testing:

Each of the impact test specimens after subjected to a predetermined quenching temperature was fixed in an Izod impact testing machine as simple beam. The specimen were notched just at the middle and the notch face was fixed on the impact testing machine to receive fast moving hammer blow when released from a fixed position at a fixed height. Upon released, a knife edge mounted on the pendulum hammer strike and fractured the specimen at the notched face. The energy absorbed at fracture was determined from the dial gauge of the impact testing machine and the value indicated by the pointer was noted. The tests were repeated for the remaining specimens at different quenchant. The impact test sample before and after test are shown in fig.3and fig.4

Fig. 3 Photographic image of sample before test

Fig. 4 Photographic image of sample after test

III. RESULT AND DISCUSSION

The broad possibilities provided by the use of steel are attributed mainly to two all-important metallurgical phenomena: iron is an allotropic element; that is, it can exist in more than one crystalline form; and the carbon atom is only 1⁄30 the size of the iron atom. These phenomena are thus the underlying principles that permit the achievements that are possible through heat treatment. In entering the following discussion of constitution, however, it must be emphasized that a maximum of technical description is unavoidable. This portion of the subject is inherently technical. The purpose of this chapter is, therefore, to reduce the prominent technical features toward their broadest generalizations and to present those generalizations and underlying principles in a manner that should instruct the reader interested in the metallurgical principles of steel. This is done at the risk of some oversimplification.

For every different heat treatment processes of mild steels, the microstructure of the steel changed. Microstructure is the representation of structural features of mild steel as steel under microscopic condition. The study of microstructure isalso called microscopy or metallographic. Various microstructures of mild steels are often known as cementite, ferrite, pearlite, austenite and martensite. Most of the phase transformation of interest will involve deviation from equilibrium microstructure, resulting in partial transformation and the reaction of metastable phase. The microstructure of iron-base alloys is very complicated and diverse, being influenced bychemicalcomposition,material homogeneity, and processing and section size. Pearlite forms by the solid state transformation front. The ferrite, cementite and austenite can then exist in equilibrium at the eutectoid temperature. In alloy steels as Fe, Mn and c, the three phase equilibrium with austenite. Martensite is a phase when formed by quenching but becomes a constituent after tempering as in decomposes from body centered tetragonal martensite to body centered cubic (bcc) ferrite and cementite.The microstructures of Mild steel before and after various heat treatment modes at constant temperature (900°C) and soaking time (3hr). The microstructure of the as-received sample showed ferrite in the grain boundaries of the acicular pearlite grains. For this reason, the microstructure of the steel can be described as having a ferrite-austenite duplex phase. Subjecting the steel to quenching heat treatment at 900°C affected the spatial distribution of martensite at the grain boundaries, and scales were observed to be present in ferrite. This was due to oxidation at the metal surface. On the other hand, quenching yielded a uniform fine grained microstructure of ferrite and pearlite with large grain sizes. Furthermore, age- hardening heat treatment revealed the presence of scales more widely distributed on the metal surface and highly dispersed ferrite. The microstructure of the E250 steel were studied at a magnification scale of 100X. The microstructure of the base metal shows uniform structure pattern of δ - ferrite in austenite matrix. The grain shape of the base material was in the pentagonal shape. And the microstructure of heat affected zone shows partially elongated δ - ferrite grains in austenite matrix. The microstructure of the test specimen at optimal combination of process variables at different quenching condition.Due to fine grains size in heat affected zone the hardness is highest there. For transverse testing, the test specimens were cut at the centre. And test specimen also have base metal on the both ends. The test specimen was broken away from the mild steel of base material end, but not from the middle of plate.

The microstructure of the mild steel shows no uniform structure pattern of δ - ferrite in austenite matrix.The fig:5 shows the microstructure image of a specimen. Inorder to carry out the study of microstructure test four different sample specimen are tested amd their result has been discussed.

Fig. 5 Photographic image of microstructure

Fig. 6 Photographic image of microstructure analysis of MP1

Untreated sample (MP1) is first studied shown in fig:5 under Metallurgical Microscope – METSCOPE-1A and Etchant 4% Nital is obcerved . The microstructure revealed at surface fine tempered martensite and core shows low carbon martensite structure .The same result has been observed for Heat treated and quenched in brine bath (MP2) as well as MP3 as shown in fig : and fig: respectively.

But in MP4 sample the different microstructure is observed and revealed fine grains of pearlite in matrix of ferrite as shown in fig:6

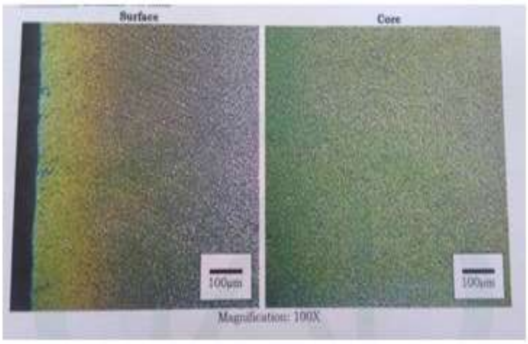

Fig. 7 Photographic image of microstructure analysis of MP2

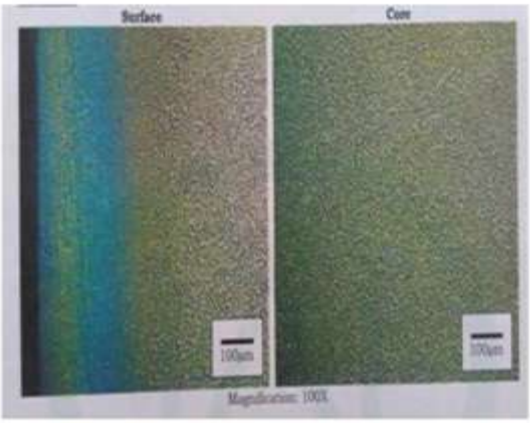

Fig. 8 Photographic image of microstructure analysis of MP3

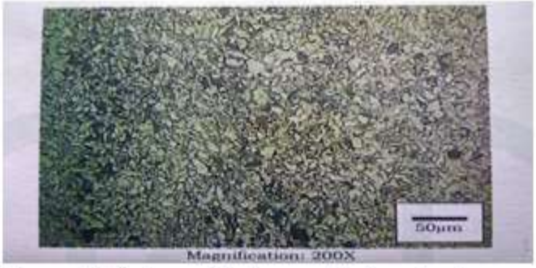

Fig. 9 Photographic image of microstructure analysis of MP4

Fig. 10 Photographic image of sample after testing

The various mechanical test has been carried out with respect to the each type of sample and optimum results were observed. It is also observed from The Table:2 and Table:3that sample MP2 and sampleMP3 type of specimen exhibiting good hardness properties as compared with sampleMP1 and MP4.it is also observed from the experimental studies that impact strength of the corresponding samples optimally reduces whereas the tensile test unable to perform as its go beyond UTM machinery capacity.CAE analysis has been carried out for both displacement as well as for von misses stress analysis as shown in fig:11 and fig :12 respectively.

TABLE II RESULT OF ROCKWELL HARDNESS TEST

S.NO	SAMPLE NAME	HARDNESS, HRC
1	Sample MP1	33
2	Sample MP2	90
3	Sample MP3	82
4	Sample MP4	43

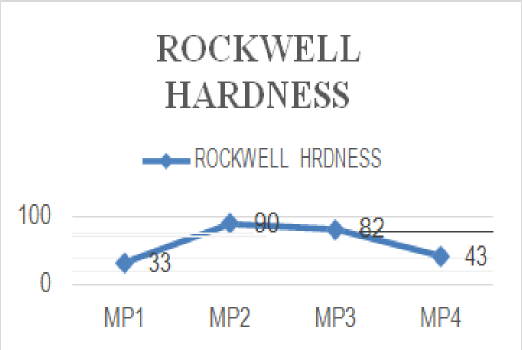

Fig. 11 A graphical representations for Rockwell hardness testing

TABLE III VICKERS HARDNESS TEST

S.NO	Sample name	Surface hardness	Core hardness
1	Sample MP1	562	281
2	Sample MP2	740	196
3	Sample MP3	709	202
4	Sample MP4	610	174

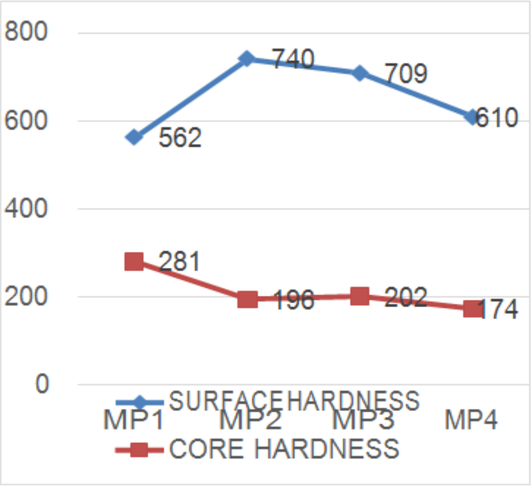

Fig. 12 Vickers hardness testing

Fig. 13 Graphical representation of impact test

TABLE IV RESULT OF TENSILE TEST

S.No	Sample	Tensile strength Mpa	Yield strength Mpa	Elongation %
1	Sample MP1	484	370	32
2	Sample MP2	-	-	-
3	Sample MP3	-	-	-
4	Sample MP4	430	367	13

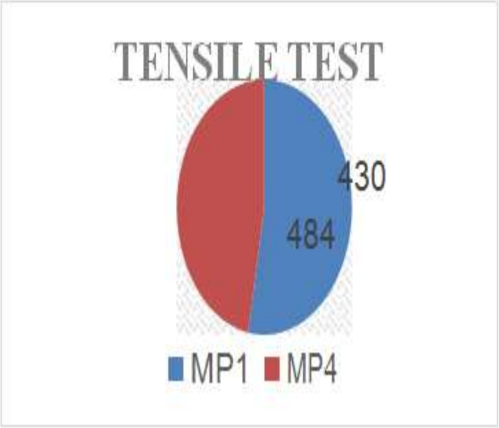

Fig.14 Tensile test result

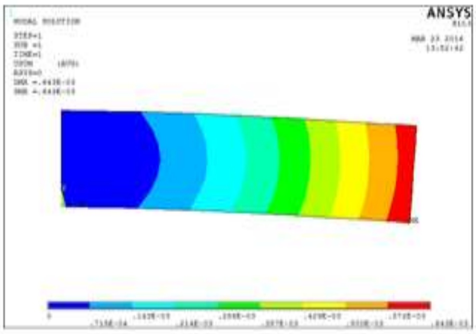

Fig. 15 CAE image of sample MP1 in displacement

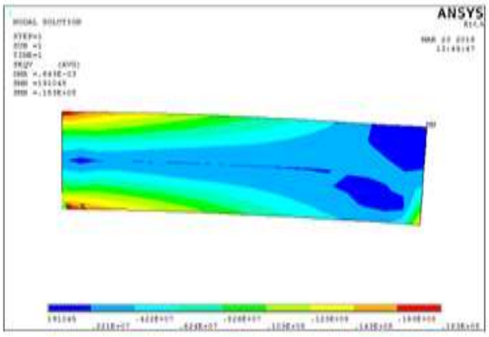

Fig. 16 sample MP1 in von mises stress

Maximum Stress: 0.183×10^{8} N/mm^2 Minimum Stress: 1.91×10^{5} N/mm^2

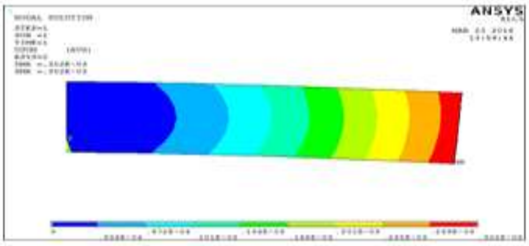

Fig. 17 CAE image of sample MP4 in displacement

Maximum Displacement: 0.302×10^{-3} m
Minimum Displacement: 0.336×10^{-4} m

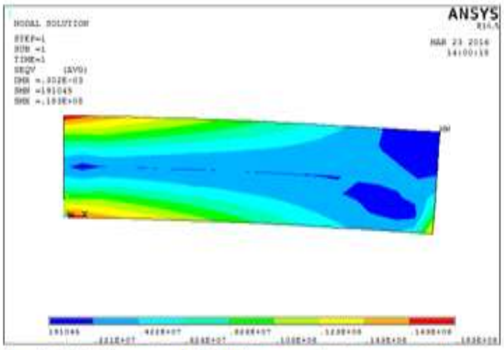

Fig. 18 CAE image of MP4 in von mises stress

Maximum Stress: 0.183×10^{8} N/mm^2
Minimum Stress: 1.91×10^{5} N/mm^2

IV. CONCLUSION

The results of this study shows that water quenched samples are better than the other quenchants in terms of strength and ductility. Therefore, water remains the most common quenchant. More importantly, water is inexpensive, easy to use and has minimal safe handling or disposal considerations. In terms of strength and hardness, the order of performance is as follows: Water-cooled > Control >0il cooled > Air cooled > Furnace cooled. The result shows that the oil quenched specimen gave the highest values of bending strength and deflection at break; thus, confirming the consistency of this method of cooling in improving the mechanical properties of mild steel as was the case in the tensile tests. When cost of quenching is put into consideration, it becomes obvious to conclude that using water, as a quenching media is more cost effective.

REFERENCE

[1]. SydneyH.Anver "Introduction to Physical Metallurgy" McGraw Hill Book Company, 2007
[2]. Raghavan.V "Materials Science and Engineering" Prentice Hall of India Pvt., Ltd., 2007
[3]. Timoshenko S.P "Elements of Strength of material" Tata McGraw Hill, New Delhi, 1997
[4]. Motagi B.S. and Bhosle R. "Effect of heat treatment on microstructure and mechanical properties of medium carbon steel" International Journal of engineering research and development, vol.2, No.1, 2012, pp 7-13
[5]. W. F. Smith "Principles of Materials Science and Engineering", McGraw-Hill
[6]. Technology Products Processes. 2006. Yield Strength and Heat Treatment. TPP Information Centre
[7]. Tamura, I., Tomota, Y., Ozawa, H, 1973. Strength and ductility of Fe-Ni-C alloys composed of austenite and martensite with various strengths. Proceedings of the 3rd International Conference on the Strength of Metals and Alloys, Cambridge, Vol. 1, 611-615.
[8]. S. G. Hong, S. H. Park, and C. S. Lee. 2010. Journal of Material Research 25: 784.