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A STUDY ON MECHANICAL BEHAVIOUR OF STEP TEMPERED, VEGETABLE OIL QUENCHED MEDIUM CARBON LOW ALLOY STEELS

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Abstract: Medium carbon low alloy steel are family of ultra-high strength steels which includes AISI 4140(EN19) and AISI 4340(EN 24) where EN 19 is Nickel free steel and EN 24 has very low percentage of steel. Here an attempt is made to study the mechanical properties such as impact strength, tensile strength, hardness by experimental approach of heat treated medium carbon low alloys steel quenched in different types of vegetable oils. Specimens for testing are prepared from 2 rods of EN 19 and EN 24 (Rolled Condition) of 20 mm diameter and one and half meter length selected from yard. The specimens are machined according to the standard dimensions. Different heat treatment processes will be carried out in different stages . Then the heat treated specimens will be quenched in vegetable oils such as Castor oil, Gingelly oil. Specimens will be tested to study the mechanical properties. Impact test will be carried out with the help of Charpy impact test machine, tensile test will be carried with the help of tensometer. Hardness test will be carried out with help of Brinell hardness testing machine.The results will be compared between two stages of heat treated, oil quenched EN 19 and EN 24 medium carbon low alloys steels.

Keywords: Medium Carbon Low Alloy Steels, EN 19 and EN 24, Vegetable Oils, Heat Treatment, Quenching

I. INTRODUCTION

Steel is usually defined as an alloy of iron and carbon with the carbon with the carbon content between a few Hundreds of a percentageup to about 2 weight %.other alloying elements can amount is used in our electricity power line towers, natural gas pipelines, machine tools and military weapons. The various uses of steel which in turn is a measure of adaptability of steel can be judged from the characteristics properties depending on composition as well as the phases and micro constituents present, which in turn depend on of steel like hot and stainless steels. Steels can exhibit a wide variety of formability, weld ability, suitable machinability, hard tough and resistance, corrosion in more highly alloyed. Steels such as tool steels resistant, heat resistant and resistance to deformation. Steel has had a major influence on our lives, the cars we drive, the building we work in, the homes in which we live and countless other facets in between. Steel is by far the most important, multifunctional and most adaptable of materials. The various uses of steel which in turn is a measure of adaptability of steel can be judged from the following characteristics of steel: a) Hot and cold formable b) Weldabalityc) Suitable Machinabilityd) Hard, tough and resistance e) Corrosion resistant f) Heat resistant andresistanceto deformation at high temperature.

Steel compared to other material so fits type has low production cost. The energy required for extracting ironfro more is about 25% of what is needed for extracting Aluminum. Steel is environment friendly as it can be recycled. 5.6% of element iron is present in earth crust, representing a secure raw material base. Steel production is 20 times higher as compared to production of all nonferrous metals put together.

S.B. Agboola: A research has been made on the hardening characteristics of medium carbon steel using neem oil as quenching medium has been investigated

M.B.Ndaliman: A proposal has been made to the mechanical properties of medium carbon steel were investigated under two different quenching.

T.Sendhilkumar&T.K.Ajiboye: A study was made on the importance of various forms of heat treatment operations on medium carbon steel in order to forester the problem that may arise in making a wrong choice of the steel materials.

Here an attempt is made to study the mechanical properties such as impact strength, tensile strength, hardness by experimental approach of heat treated medium carbon low alloys steel quenched in different types of vegetable oils. Specimens for testing are prepared from 2 rods of EN 19 and EN 24 (Rolled Condition) of 20 mm diameter and one and half meter length selected from yard

Materials used:

Steel	%C	%Si	%Mn	%Ni	%Cr	%Mo	%S	%P
EN19	0.35	0.6	0.65	_	0.3	0.15	_	_
EN24	0.4	0.3	0.6	1.5	1.2	0.25	0.005	0.01

Chemical composition of EN 19 and EN 24 medium carbon low alloy steels:

The medium-carbon low-alloy family of ultrahigh-strength steels includes AISI/SAE 4130 the higher-strength AISI 4140 (EN19) and the deeper hardening, higher-strength 4340. (EN24) Several modifications of the basic 4340 steel have been developed.

Heat treatment Process

Heat treating is the process of heating and cooling steel to obtain desired properties. Various types of heat treatment processes are used to change the mechanical and physical properties or conditions of steel. In general, we heat treat

steel in order to improve the toughness, improve the machinability, increase the hardness, refine the grain structure, increase the ductility, remove internal/residual stresses and improve the wear resistance.

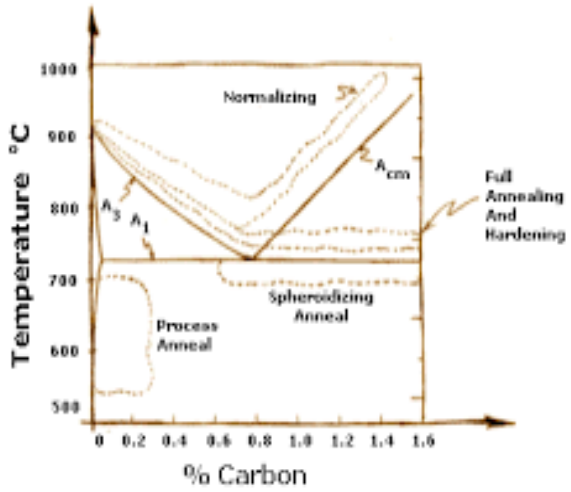
- Annealing
- Normalizing
- Tempering
- Hardening

Annealing

Annealing is the process of heating steel to and holding at some specified elevated temperature and cooling fairly slowly. Metals are annealed to relieve internal stresses, soften them, make them more ductile, and refine their grain structures.

Hardening

Hardening is the process of austenitizing steel at a prescribed temperature, holding at that temperature for a length of time to homogenize the austenite, and then quenching at a fast rate enough to prevent transformation to any product other than martensite.



HEAT TREATMENT PROCESS

Tempering

Steel is usually harder than necessary and too brittle for practical use after being hardened. Severe internal stresses are set up during the rapid cooling of the metal. Steel is tempered after being hardened to relieve the internal stresses and reduce its brittleness. Tempering consists of heating the metal to a specified temperature and then permitting the metal to cool. The rate of cooling usually has no effect on the metal structure during tempering. Therefore, the metal is usually permitted to cool in still air. Temperatures used for tempering are normally much \lower than the hardening temperatures. The higher the tempering temperature used, the softer the metal becomes. High-speed steel is one of the few metals that become harder instead of softer after it is tempered.

Quenching

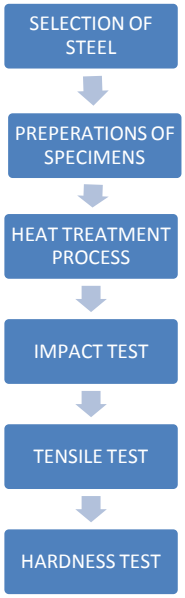
The process of quenching steel refers to the rapid cooling from an austenitizing or solutionizing temperature to a significantly cooler temperature. For steel this refers to heating into the austenite phase field, typically to 845°C for AISI 4140 steel, and then rapidly cooling to a temperature below the martensite finish temperature. The purpose of quenching steel is to produce the martensitic phase that is hard and strong, while minimizing distortion and residual stress. These steels need to be tempered after quenching to increase the toughness.

Vegetable Oils

For quenching of medium carbon low alloy steel following oils were used.

- CASTOR OIL.
- GINGELLY OIL.

II. METHODOLOGY



Selection of steels

Two medium carbon low alloy steels are selected for present study. EN 19 steels can be successfully nitride for maximum abrasion EN 24 are normally heat treated by quenching in oil and tempering to desired hardness these grades exhibit good response to heat treatment, especially in large sections and possess a good combination of strength ductility and roughness in the quenched and temper conditions.

Preparation of specimens

The following specimens are prepared according to required dimensions from the 20mm diameter and one and half meter length rods of EN 19 and EN 24 steels with the help of lathe, milling, shaping machines.

Heat treatment processes

The materials used for heat treatment process are mainly medium carbon low alloy steels is direct hardened, heattreated and tempered condition. Corresponding to the grade EN19, EN24 and were used. Two stages comprising two of steel rods were taken for carrying out heat treatment. All stages of samples were heated in an electric furnace to various temperatures for 60 min. After heating,set of samples taken out of the furnace.

Details of heat treatment process

PROCESS	STAGE 1 EN 19& EN 24	STAGE 2 EN 19& EN 24
ANNEALING	865^{0}C 1Hr SOAKING	865^{0}C 1Hr SOAKING
HARDENING	855^{0}C 1Hr SOAKING	855^{0}C 1Hr SOAKING
TEMPERING	575^{0}C 220^{0}C 1Hr SOAKING	575^{0}C 220^{0}C 1Hr SOAKING
QUENCHING	AIR(annealing)	AIR (annealing)
	CASTOR OIL(Hardening)	GINGELLY OIL (Hardening)
	AIR(Step tempering)	AIR(step tempering

III. TESTING

Impact test

They were prepared by notching to 2mm depth at 450with the aid of the lathe machine. Four samples were prepared for each material like EN19, EN24, hardened and tempered condition as well as stage1, stage2 condition to be used in impact test. The impact strength was measure of the energy absorbed by the specimen when it failed as a result of the strike on it by the pendulum of the measuring device. The specimens' dimensions were as indicated in the impact test.

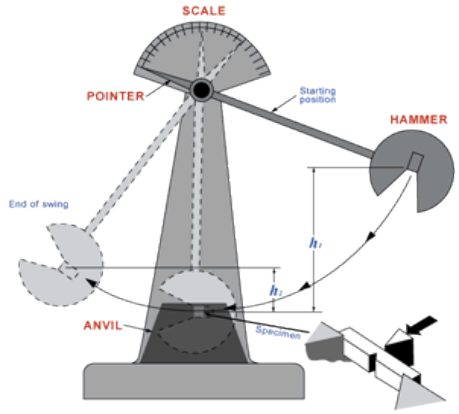


Fig 1. Impact test machine

Tensile test

Tensile test is carried out with the help of tensometer on EN 19 and EN24 specimens to evaluate the ultimate strength, tensile strength, yield strength and percentage of elongation... The specimens are shown in the figure

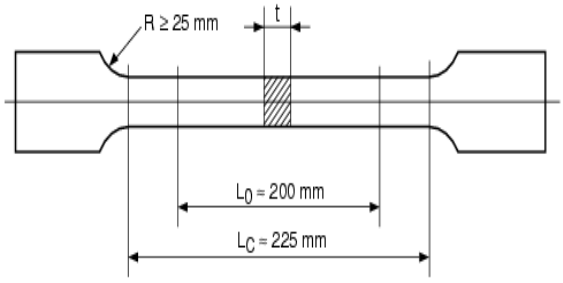


Fig 2. Tensometer

Hardness test

The Brinell test for this experiment used a 10-mm diameter steel ball which is pressed into a specimen by a 3000-kg load that is maintained for 15 to 30 seconds. (A 500-kg load is used for softer, non-ferrous materials.) The Brinell hardness number (BHN) is the ratio of the load (kilograms) to the impressed area (square millimetres), and is calculated by. Equation1. Where: F: test load [kg], D: diameter of the ball [mm], Di: diameter of indentation [mm] Since the Brinell number is based on the area of indentation, the diameter of the indentation must be measured. This is done with a microscope.

The scale seen through the microscope is in millimetres. The larger diameter indentation corresponds to a softer material and lower Brinell number. The Brinell hardness number can be used to predict the tensile strength of the material. The hardness test sample-This sample is obtained by grinding the surface with emery paper, to measure the indentation of ball by using microscope.

Fig 3.Brinell hardness Testing Machine

IV. RESULTS AND DISCUSSIONS

Impact test

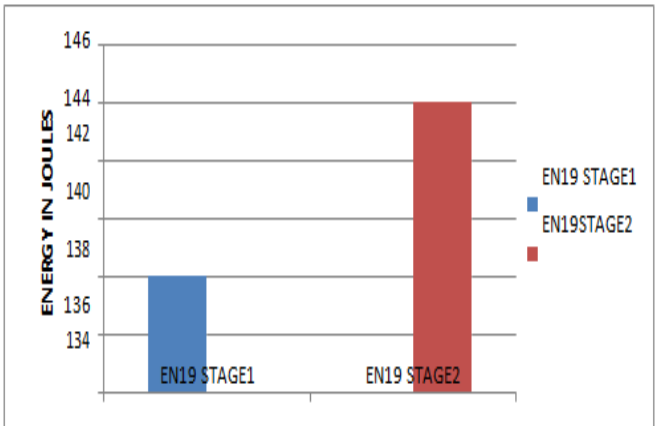
Charpy impact test machine

1 Division=2 Joules

Weight of the pendulum=21 K

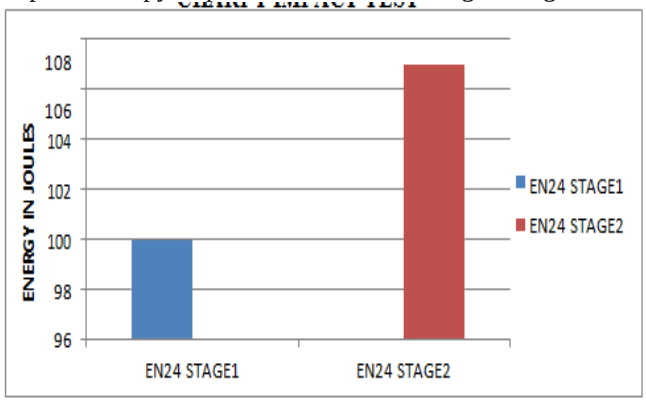
Angle =140°

Graph of Charpy Impact results of EN19 stage1, stage2.



As comparing to the above results the EN19 stage2havehigh toughness with EN19 stage1, dueto the annealed, castoroilquenched and tempered condition. Dueto the annealing process thestrength and toughness of thematerial increases.

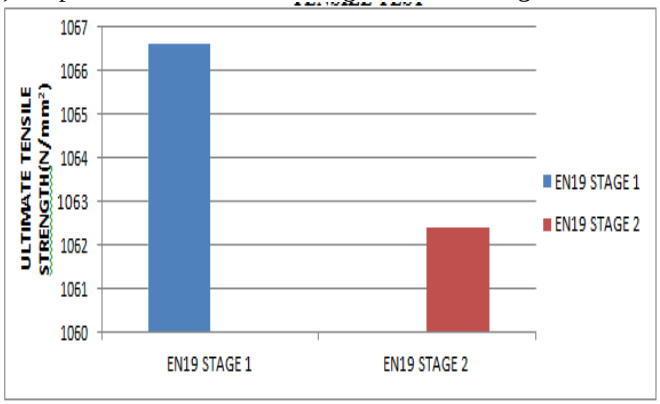
Graph of Charpy Impact results of EN24 stage1, stage2.



As comparing to the above resultstheEN24 stage2 have hightoughnesswithEN24 stage1,dueto the annealed, castoroilquenched and tempered condition. Due to the annealing process the strength and toughness of the material increases.

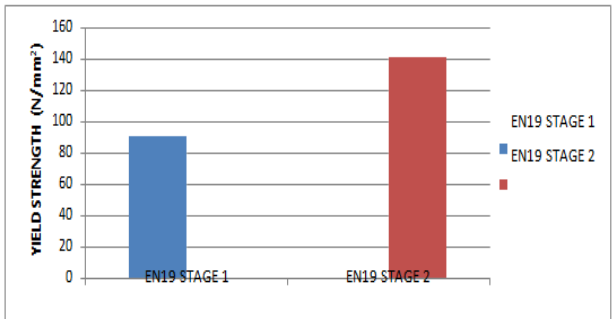
Tensile test

a) Graph of ultimate tensile strength of EN 19 stage 1, 2



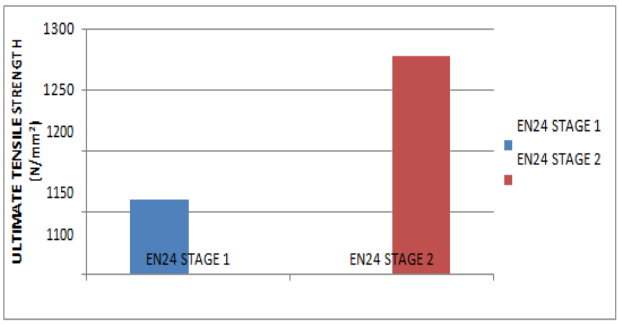
By comparing to above results EN19 stage1 has high ultimate tensile strength.

b) Graph of Yield strength of EN 19 stage 1, 2



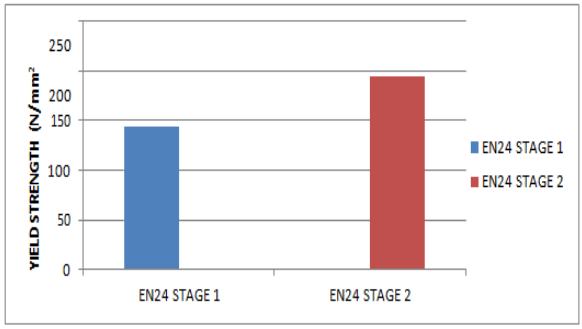
By comparing the above results, EN 19 stage2have high yield strength.

c) Graph of ultimate tensile strength of EN 24 stage1, 2



By comparing the above results, EN24 stage2have high ultimate tensile strength.

d) Graph of yield strength of EN 24 stage 1,2



By comparing the above results, EN 24stage2 have high yield strength

Hardness test

BHN for EN 19 and EN 24 stage 1, stage 2

STEEL/LOAD	100 Kgf	150 Kgf
EN 19 STAGE 1	392	397
EN 24 STAGE 1	315	392
EN 19 STAGE 2	319	352
EN 24 STAGE 2	392	397

Here we observed that EN 19 stage1 for different loads the BHN much increases because of the harden ability due to annealing, hardening, tempering and quenching with castor oil. EN 19stage 2 for different loads BHN much increases due to annealing, hardening, tempering and quenching with Gingellyoil.

V. CONCLUSIONS

- EN 19stage 2 have good charpy impact strength.
- EN 24 stage 2 have good charpy impact strength.
- EN 19 stage 1 have good Ultimate tensile strength
- EN 19 stage2have high yield strength.
- EN24 stage2have high ultimate tensile strength.
- EN 24stage2 have high yield strength
- EN 19 stage1 for different loads the BHN much increases because of the harden ability due to annealing, hardening, tempering and quenching with castor oil.
- EN 19stage 2 for different loads BHN much increases due to annealing, hardening, tempering and quenching with Gingellyoil.

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