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STUDY OF MECHANICAL PROPERTIES AND MICROSTRUCTURE OF MATERIALS USED FOR MANUFACTURE OF BALL SCREW

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ABSTRACT

Steels are the most common materials used in daily life. Low and medium carbon steels find wide applications in industrial tools and machineries. The low relative cost and ease of machinability makes it the best metal to be used in day to day applications in the industry. Ball screw is made up of number of parts and each part is made up of different material. Generally ball screw spindle is made up of CF-53 material. In this paper an attempt is made to replace CF-53 material with EN19. In this paper a comparative statement has been made for materials which are used for manufacture of ball screw i.e. CF-53, EN19 and EN31.

KeyWords:*Heat treatment,Microstructure,Machinability, Ball screw.*

1. INTRODUCTION

Ball screw is defined as a mechanical linear actuator which will translate rotational motion to linear motion. Ball screw consists of many parts like spindle, housing etc. Each part is made up of different material. Heat treatment process for each part is also different. Spindle is made up of CF-53 material and with induction hardening heat treatment. Steel ball is made up of EN31 and with flame hardening heat treatment process. CF-53 material is generally used in many industries. EN 19 can be used as an alternative for CF-53. In this paper a comparative study is carried out to find which material is more suitable because CF-53 material faces many issues like corrosion problem and distortion. Ball screw spindle breaks sometimes during straightening operation.

2. LITERATURE REVIEW

In heat treatment area number of researcher contributed lot for attaining the desired mechanical properties for particular application of the product, since here few of researchers view toward heat treatment is given as:

V.Ollilainen [1] studied on the effect of silicon, vanadium and nitrogen on the microstructure and hardness of air cooled medium carbon low alloy steels. It represents a comparison of structural investigation of four medium carbon low alloy steels: 38MnSi6, 38MnSiV5 and modifications with higher silicon and nitrogen contents.

Yusuf ozcatalbaset [2] studied on the effects of heat treatment on the machinability of mild steels. In this study, the effects of microstructure and mechanical properties on the machinability of hot rolled SAE 1050 steel that was annealed and normalized before machining have been investigated. The machinability hasbeen characterized by measuring the tool life, chip root morphology, cutting forces, surface finish and tool or chip interface temperature.

A.Ebrahim [3] studied on the evaluation of machinability in turning of micro alloyed and quenched-tempered steels; Tool wear, statistical analysis, chip morphology. The machinability of micro alloyed steel (30MNVS6) and quenched –tempered (QT) steels (AISI 1045 and AISI 51400, at different cutting condition are presented in the paper.

H.Y. Li [4] studied on Bainite transformation during the two-step quenching and partitioning process in a medium carbon steel containing silicon. A study of 40SiMnNiCr steel subjected to a two-step quenching and partitioning process (Q&P) is presented. The result suggests that strength variation of Q&P steels during the two-step Q&P process was a cumulative effect of increase of retained austenite fraction, decrease of carbon super saturation of virgin martensite, and particularly much of lower bainite formation.

3. EXPERIMENTAL SETUP

The samples were of raw materials were tested for chemical composition which is given in Table 3.1

Table 3.1. Chemical composition of raw material.

ELEMENTS	% BY WT	SPECIFICATION
Carbon	0.526	0.50-0.57
Silicon	0.31	0.15-0.35
Manganese	0.60	0.40-0.70
Phosphorous	0.011	0.025 Max
Sulphur	0.012	0.035 Max

(a) Chemicalcomposition of CF53

ELEMENTS	% BY WT	SPECIFICATION
Carbon	0.418	0.35-0.45
Silicon	0.24	0.10-0.35
Manganese	0.75	0.50-0.80
Phosphorous	0.013	0.05 Max
Sulphur	0.014	0.05 Max
Chromium	0.92	0.90-1.50
Molybdenum	0.21	0.20-0.40

(b) Chemical composition of EN19

3.1. HEAT TREATMENT

The diameter of CF-53 raw material was 56mm which was reduced to 50 mm for induction hardening. For EN19 two samples were prepared one with 50 mm diameter for induction hardening and other with 8 mm diameter for flame hardening. For EN31, 8mm diameter sample was prepared for flame hardening. Two heat treatment process carried out were: Induction hardening and flame hardening. After flame hardening samples of EN19 and EN31 were quenched with polymer and oil as coolant and then tempered for 1 hour at 180 degree celsius. After induction hardening there was distortion observed on both (CF-53 & EN19).Thermal expansion was measured and it was found that CF-53 is having 1.3mm thermal expansion and for EN 19 thermal expansion was 0.65mm which is relatively less when compared with CF-53.Due to this distortion ball screw spindle breaks and causes dimensional instability.

4. STUDY OF MECHANICAL PROPERTIES

As the objective of this paper is to compare the mechanical properties of Specimens, now the specimens were sent to hardness testing.

4.1. HARDNESS TESTING

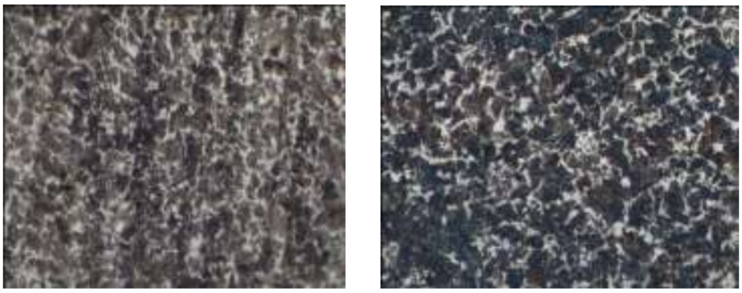
Using Rockwell Hardness Tester (HRC) machine, hardness of specimens were calculated. After heat treatment it was observed that hardness was increased. The table4.1 shows the hardness values of samples:

Table. 4.1 Hardness value of the material.

SL.NO	MATERIAL	HEAT TREATMENT	HARDNESS VALUE (HRC)
1	CF-53	Induction Hardening	60
2	EN 19	Induction Hardening	58
3	EN 19	Flame Hardening	55
4	EN 31	Flame Hardening	63

5. STUDY OF MICROSTRUCTURE

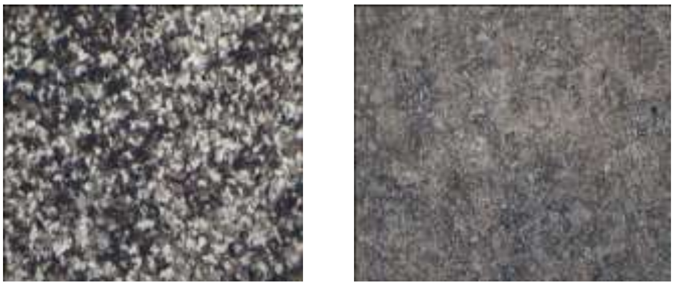
The specimens were prepared to observe the microstructure of CF-53 and EN19 before and after heat treatment.



(a) CF-53 (Raw Material) **(b) CF-53 (Heated material)**

Figure 5.1. Microstrure of raw material.

For raw material Microstructure structure in figure 5.1 reveals that grain boundary networks of iron nitride are present through the martensitic case where as for heated material Microstructure structure reveals metastable austenitic structure with localized Carbides are observed with shrinkage pores.



(a) EN 19 (Raw material) **(b) EN 19 (Heated material)**

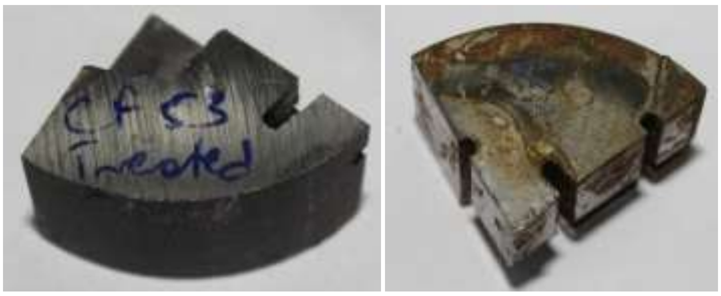
Figure 5.2. Microstrure of raw material.

For Raw material Microstructure structure reveals 50% pearlite (dark constituent) and undissolved particles of alloy carbide in a matrix of tempered martensite whereas for heated material Microstructure structure in figure 5.2 reveals metastable austenitic structure with localized Carbides are observed with shrinkage pores.

6. RESULTS AND DISCUSSION

6.1 CORROSION TEST

The salt spray test is a standardized test method used to check corrosion resistance of coated samples. Coatings provide corrosion resistance to metallic parts made of steel, or brass. Salt spray test is an accelerated corrosion test that produces a corrosive attack to the coated samples in order to predict its suitability in use as a protective finish. The appearance of corrosion products (oxides) is evaluated after a period of time. Test duration depends on the corrosion resistance of the coating; the more corrosion resistant the coating is, the longer the period in testing without showing signs of corrosion as shown in figure 6.1. **Observation:** Time taken to corrode was 15 hrs. and Red corrosion was observed



(a) Before Corrosion Test (b) After Test

Figure 6.1. Corrosion Test for CF-53 (Induction Hardening)

<u>**SAMPLE:** EN19- FLAME HARDENED</u>

(a) Before Test (b)After Test

Figure 6.2. Corrosion Test for CF-53 (Induction Hardening)

Corrosion Test for EN19 (Flame Hardening) is shown in figure 6.2. It can be observed that for EN19 material corrosion resistance is more than CF-53 material.

Observation: Time taken to corrode was 16 hrs. and red corrosion was observed.

7. CONCLUSION

Thus in this paper a comparative statement has been made for different heat treatment processes and for different materials. Due to dimensional instability ball screw spindle breaks. Distortion can be avoided by maintaining proper temperature during heat treatment process and by using coolants. Corrosion Property was checked for CF-53, EN19 and EN31 and red corrosion can be observed. Corrosion resistance of EN19 is more than CF-53. EN 19 material is better than CF-53 material due to its corrosion resistant and machinability.

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