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Influence of Petroleum and Biodegradable Quenchants on Properties of medium Carbon Steels

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***Abstract*: Properties of carbon and alloy steels vary with their composition and microstructure, which are dependent on the heat treatment and quenching process used. Petroleum and vegetable oils are the most commonly identified quenchents which are petroleum based and biodegradable and nontoxic respectively. Soybean oil is among the vegetable oils produced in greatest volumes in India and Brazil.**

In the present work low carbon steel has been heat treated by using two petroleum based quenchents ie Quench 311(slow cooling oil) and SF quench (fast cooling oil) and a biodegradable quenching ie soybean oil and evaluated for mechanical properties and microstructure. The results show that biodegradable quenchents can be used in place of petroleum oils with improved mechanical properties.

***Keywords*—Low carbon steel, SF quench, quench311, biodegradable quench, microstructure.**

1..0 INTRODUCTION

During heat treatment of steel, typically steel is heated to its austenitization temperature and then cooled sufficiently fast to avoid pearlite transformation to obtain maximum hardness and strength. The critical cooling rate is dependent on both the specific heat capacity and thermal conductivity of both the steel and the quenchants in addition to quench-bath temperature and agitation..

Currently, vegetable oils are one of the most commonly identified renewable, biodegradable and non-toxic quenchants. In addition to their relatively narrow viscosity range, vegetable oils exhibit considerably lower thermal-oxidative stability relative to petroleum oil, which has been a significant factor inhibiting its use in the industry.

In the present work soybean oil is used as quenchant to study its effectiveness as of late industries look for natural and environmental friendly chemistries. Its widespread availability and low cost make soybean oil an ideal component for developing renewable, bio-based products.. After heating the steel it is quenched in two petroleum quenchants and one biodegradable quenchant ie soybean oil and tested for various mechanical properties. The results of testing and microstructure have shown improvement in the mechanical properties of steel for which soybean is used as a quenchent.

2.0 Heat Treatment Heat treating is accomplished in major stages as follows

- Stage l — The specimens are heated to 860^0 c
- Stage 2 -Soaking (holding) the metal at 860^0 c for 2 hours and then quenched in different quenchants as discussed earlier

- Stage 3 - After quenching specimens are tempered at 560^0 c.
- Stage 4-After tempering the specimens are evaluated for mechanical properties and microstructures are examined.

3.0Results and Discussion

3.1 Tensile strength of specimen

The figure 1 shows the variation in the tensile strength of steel specimen before heat treatment and after heat treated in three different quenchants i.e. soybean oil, super quench and quench 311 respectively.

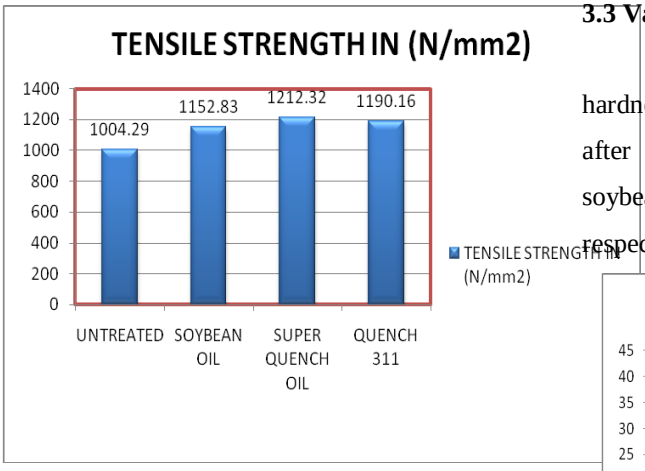

Figure *1* Variations in the tensile strength of specimen

3.2 Yield strength of specimen

The figure 2 shows the variation in the Yield strength of steel specimen before heat treatment and after heat treated in three different quenchants i.e. soybean oil, super quench and quench 311 respectively

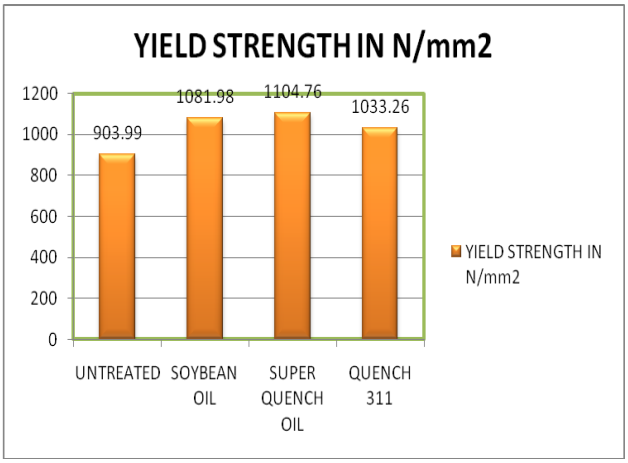

Figure 2 Variations in the Yield strength of specimen

3.3 Variations in the Hardness of specimen

The figure 3 shows the variation in the hardness of steel specimen before heat treatment and after heat treated in three different quenchants i.e. soybean oil, super quench and quench 311 respectively

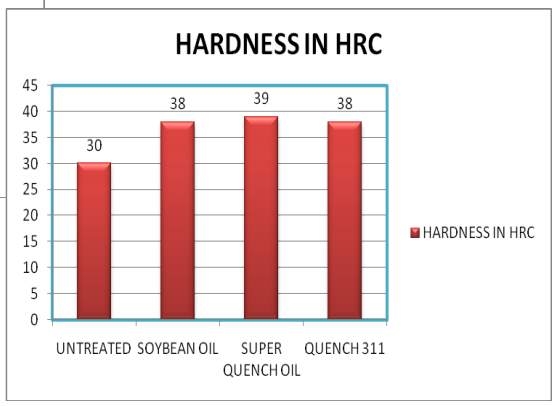

Figure 3 Variations in the hardness of specimen

3.4 Toughness of the specimen

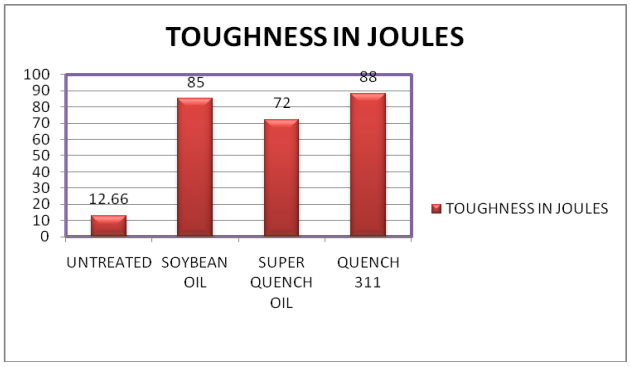

Figure 4 Variations in the toughness of specimen

The figure 4 shows the variation in the toughness of steel specimen before heat treatment and after heat treated in three different quenchants i.e. soybean oil, super quench and quench 311 respectively

3.5 Variations in the Toughness of Specimen

The figure 5 shows the variation in the hardness of steel specimen before heat treatment and after heat treated in three different quenchants i.e. soybean oil, super quench and quench 311 respectively

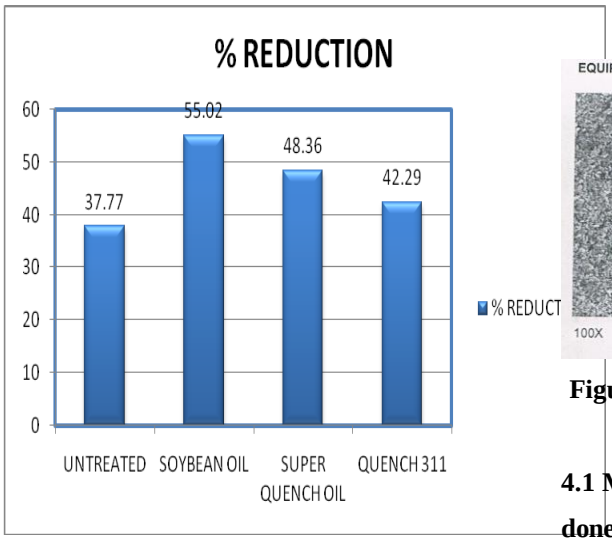

Figure 5 Variations in the toughness of specimen

. 3.6 Elongation of specimen

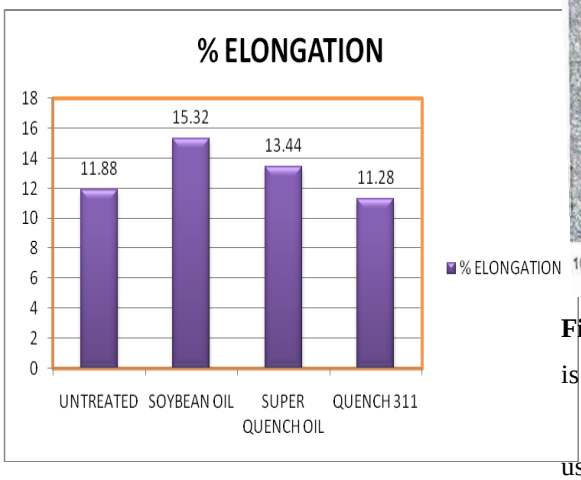

Figure 6 Variations in the % Elongation of specimen

The figure 6 shows the variation in the % Elongation of steel specimen before heat treatment and after heat treated in three different quenchants i.e. soybean oil, super quench and quench 311 respectively.

4.0 Microstructure of EN19 steel at untreated condition.

Figure 7 shows the microstructure of EN19 alloy steel, since it is purchased from local steel market and it is in untreated condition that is heat treatment is not done. The microstructure examination carried out and we obtained that the Microstructure consists of bainite with some fine grains of ferrite.

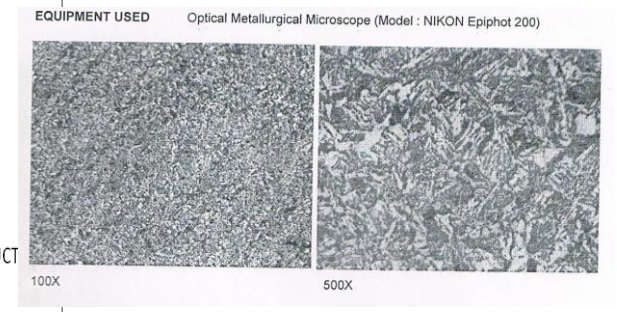

Figure 7: - Microstructure of EN19 steel at untreated condition

4.1 Microstructure of EN19 steel when treatment is done by SF Quench i.e. slow Cooling oil

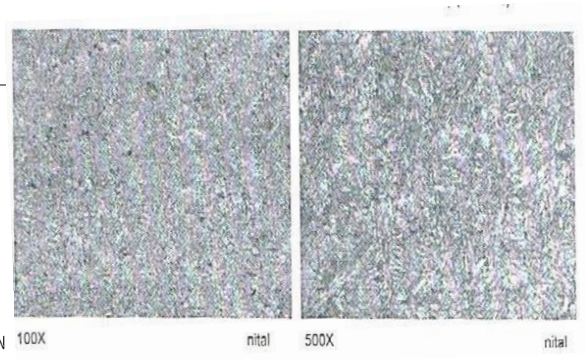

Figure 8 Microstructure of EN19 steel when treatment is done by SF Quench i.e. fast cooling oil.

The heat treatment of steel is carried out using SF Quench; Since the SF Quench is a fast cooling petroleum quenchant, the microstructure examined on the optical metallurgical microscope, the result obtained as Microstructure consists of tempered martensite. It is in hardened and tempered condition. Figure 8 shows the Microstructure consists of tempered martensite. It is in hardened and tempered condition.

4.2 Microstructure of EN19 steel when heat treatment is done by QUECH311 i.e. slow cooling oil.

Figure. 9. Microstructure shows Microstructure consists of tempered martensite. It is in hardened and tempered condition.

The heat treatment of steel is carried out using QUECH 311 i.e. slow cooling oil.; Since the SF Quench is a slow and uniform cooling petroleum quenchant, the microstructure examined on the optical metallurgical microscope, the result obtained as Microstructure consists of tempered martensite. It is hardened and tempered condition, shown in the figure 9

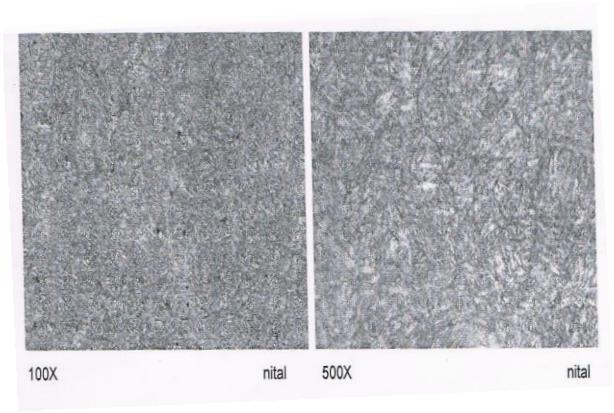

Figure 9 microstructure of EN19 steel heat treatment is done by Quench 311 i.e. slow cooling oil.

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4.3 Microstructure of EN19 steel when heat treatment is done by soybean oil.

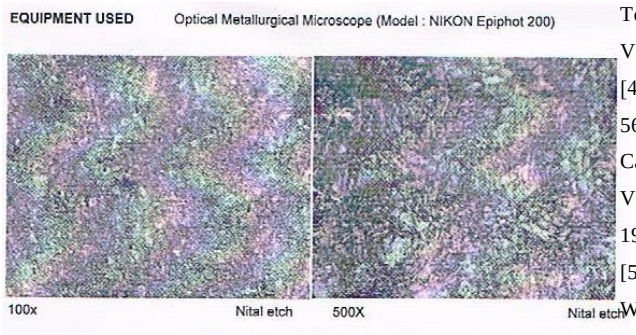

Figure 10. Microstructure of EN19 steel heat treatment is done by soybean oil

Figure 10 shows the Microstructure consists of a tempered martensite. The heat treatment of steel is carried out using soybean oil. Since the soybean oil quenches the steel fast as compare to petroleum quenchants the microstructure obtained is a tempered martensite.

CONCLUSION

From the results of the present work, it can be concluded that

- The soybean oil quenches the steel very fast and also there is a no flame when the heated steel specimen is dipped in the soybean quenchant as compared to petroleum quenchants.
- The heat treatment of steel using soybean quenchnent gives the better mechanical properties and microstructure as those results from petroleum quenchants, hence we can use the soybean oil as an alternative to the petroleum quenchants.

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