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Study the Effect of Heat Treatment on Abrasive Wear with Silt clay loam Soil Texture

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Abstract

In this paper, a general verification of possible heat treatment of steel has been done with view of conditions of real abrasive wear of rotivater with soil texture. This technique is found promising to improve the quality of agriculture components working with the soil in dry condition. Abrasive wear resistance is very important in many applications and in most cases it is directly correlated with hardness of materials surface. Responded of heat treatments were carried out in various media (Still air, Cottonseed oil, and Brine water10 %) and follow by low temperature tempering (250Cº) was applied on steel type (AISI 1030). After heat treatment was applied wear with soil texture by using tillage process to determine the (actual wear rate) of the specimens depending on weight loss method. It was found; (i) the wear resistance Increases with increase hardness with varying quenching media as follows; 30HRC, 45HRC, 52 HRC and 60 HRC for no-treated (as received) cooling media as Still air, Cottonseed oil, and Brine water 10 % respectively.(ii) Martensitic structure with retained austenite can be obtained depending on the quenching medium. (iii) Wear was presented on the worn surfaces of the steels which were used in this work.

Keywords: Microstructures, hardness, abrasive wear, heat treatment, soil texture.

Introduction

Abrasive wear has been emerged as a serious problem in the field of engineering particularly for the metallic surface of working components in machines. Important shortening of service life by abrasive wear appears on parts of machines working in soil. Alloy steel is mainly used to overcome abrasive wear-related problems due to their high strength and toughness. Various efforts are going on to reduce abrasive wear rate by changing the chemical composition, microstructure, and mechanical properties. Many researchers suggested heat treatment process as a suitable technique for obtaining combination of properties to resist the abrasive wear.

The martensitic phase is usually considered for improved wear resistance of steel. **Chahar, VK, Tiwari, GS [1],** studies the abrasive wear of the soil-engineering components such as reversible shovel are usually fitted on cultivator as soil working tool for many purposes such as loosen the soil, destroy weeds and to mix soil particles. En 45 springs steel material is used in the manufacturing of reversible shovel was cause of concern as cause's damage to material and found increases the cost and time lost in replacing worn parts of agriculture machinery. Cryogenics is neither a substitute for heat treatment not a coating but an affecting factor of the entire volume of the material. **Bressan et al [2],** studies the several techniques developed over the year to increase the abrasive wear resistance of soil tools in order to improve the efficiency and agricultural equipments for the help of electro deposition, vapor deposition, thermal spraying surface, hard facing, cladding, ion implantation and heat treatment. They found the microstructure of high chromium after weld depositing consists of hypoeutectic, eutectic or hypereutectic micro-structure. **Das et al [3],** studies the effect of different heat treatment process on abrasive wear behavior of medium carbon alloy steel for enhancing the service life of soil working components of agricultural machineries. Finds out that increase of the wear resistance depends on the way in which the metal is being hardened (alloying, heat treatment or work-hardening) and that in some cases wear resistance decrease with increase of hardness.

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The aim of the research is to study the effect of heat treatment techniques with different media cooling as (Still air, Cottonseed oil, and Brine water10%) on the microstructure, hardness and abrasive wear resistance of steel blade type (AISI 1030) with soil texture compared with blade which is no heat treated. Also study the effect of quenching media on wear appearance on the worn surfaces of the steels which were used in this work.

Experimental procedure

A. Materials

The compositions of materials were used in this work see Table1). The specimens were preparation for abrasion wear as manufacturing by flame cutting and milling as final dimensions 10 mm lengths, 10mm widths, and 6mm thicknesses.

TABLE I Chemical Composition of Steel Blade (AISI 1030)

Element	C%	Si%	Mn%	P%	S%	Cr%	Fe%
wt%	0.321	0.252	0.442	0.018	0.047	0.081	Rem

B. Heat Treatments Process

Three specimens of materials which applied heat treatment processing were carried out in furnace model F62730, with different quenching media (see Table 2).

C. Specimen Preparation

The metallographic examination of the specimen's preparation involves the following steps:-

1- The specimens are cut to dimensions as, 10 mm lengths, 10mm widths, and 6mm thicknesses.

2- All specimens are ground with SiC emery grinding and polished by using emery paper of grit 80, 120, 600, 800, and 1000. Slurry of Al_2O_3 particles of size of 5µm and 0.5 µm were used for polishing process, with a special cloth.

3- Etching process was carried out using the solution consisting of 2% nitric acid (HNO_3) and 98% alcohol and followed by dried in air.

4- The optical microscopy type RGH, with digital camera connected to the computer is used optical microscope model (C 0.46X) TVLENS. All The etched specimens were studies using optical microscope. J-Image program was used to measurements of grain size.

D. Abrasive Wear Test

Abrasion wear test of steel blade materials were carried to study the effect of heat treatments technique on wear properties of alloy steel blade (AISI 1030). Flat specimen with dimension 225mm length, 65mm width, and 6mm thickness was prepared for abrasion test. The experimental wear resistance was carried out with tillage process of soil, testing applies with agriculture equipment (rotivator blade) actually with 15 cm average depth in soil texture type silt clay loam as shown in Table 3, Physical and chemical properties of soil. Table 4; shows the used parameters during the testing operation. The agriculture equipment carried out with tractate machine type (New Holland TD-80). Fig. 1; has shown the arrangement of specimen blades with different heat treatment and used experimental tillage process with the soil texture. Each specimen was weighed on a weighing machine (sensitive balance) with a least count 0.001gm before and after the wear test that were conducted for all the specimen of various types' treatment. Three times tillage times as 10hr, 20hr and 30hr applied for all spacemen with different heat treated compared with sample which no treated (as received). The mathematical model is weight losses calculated as eq. (1) [4, 5].

$$\Delta W = W1 - W2 \quad (1)$$

Where:

ΔW: variation in mass losses (gm).

W1: weight of the specimen before the test (gm).

W2: weight of the specimen after the test (gm)

Table II Samples& Process, Austenising Temperature, Soaking Time and Quenching Media

Specimen	Austenising temp. (^oC)	Soaking time (min)	Que. media
A	910	45	Still air
B	910	45	Cottonseed oil
C	910	45	Brine water10%

Table III Soil Physical and Chemical Properties

Properties	Depth 15 cm	Soil analysis
Ph	7.70	Clay 37.2 %
Ec(ds/m)	2.74	Silt 35.6 %
Bulk density (gm/cm^3)	1.32	Sand 27.2 %
Moisture content (%)	16-17 %	

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Table IV Parameters Used in the Wear Test

Tractor type	Tillage equipment	Tractor speed	P.T.O speed
New Holland	Rotavator blade	7.185 Km/hr	1000 r.p.m

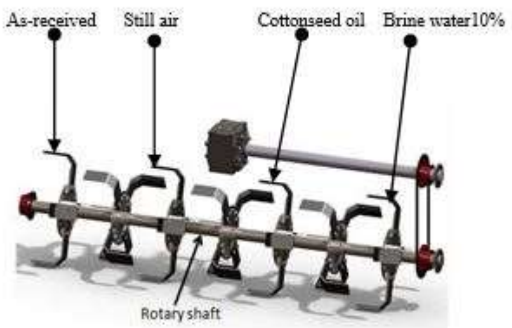

Fig. 1 shows the assembly of specimen blades with various quenched media

Results and discussions

A. Microstructure Evaluation

Fig. 2; show the specimen (A), effect of heat treatment (quenching in still air media and followed tempering), the microstructure was consists of martensitic structures, and retained austenite with large grain size (19, 11) µm. These results are good agreements with result of [6]. The effect of heat treatment (quenching in cottonseed oil media and followed tempering) specimen (B) on microstructure was consisting of martensitic structures, and some carbide. The grain size (15.34) µm, are smaller in size thane sample A and B. the results was good agreements with results of [7]. Specimen (C), show the effect of heat treatment (quenching in brine water 10% media and followed tempering) on microstructure was consist of martensitic structures and some carbide particles with small amount of retained austenite. The grains are smallest grain size (12.31) µm than sample B and C. the result was good agreements with results of [8].

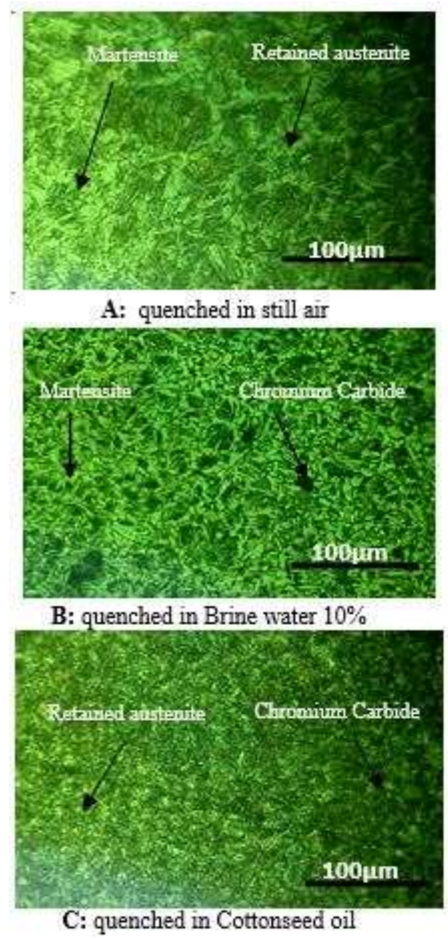

Fig. 2 Optical micrographs of specimens A, B and C after heat treatment

A. Hardness Test

Table 5; Shows the relationship between hardness and different quenching media of the samples after each heat treatment. The hardness of the sample, due to transformation of austenite to martensite and also finer shape of the laths in the microstructure. The media quenching effects to change in Rockwell hardness number after most of the austenite is transformed. It is clear from the table that the effect of varies quenching media was lead to increase the hardness number from 45HRC, and 52 HRC to 60HRC) compared with no treated (as received) as 30 HRC, and that's effect to decreases in losses weights, because is owing to lath martensite forming with precipitate some carbides. The hardness was increase result from consist of fine grain size of martensite structure. These results are a good agreement with results of [9].

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Table V Hardness of Samples at Different Quenching Media

Specimens	Quenching media	Hardness , (HRC)
A	Still air	45
B	Cottonseed oil	52
C	Brine water 10 %	60
D	As-received	30

C. Mass Loss

Fig. 3; Shows the typical variation of specific mass as function of the testing time (30hr) for blade of steel (AISI 1030) with different quenching cooling media compared with no heat treated specimen (D- as received). It's very clear when increase hardness due to heat treatment and effect to decrease in mass losses, that's means increase wear resistance. Cooling media are effects on the hardness value and that's effects on wear resistance. The best specimen where have a good wear resistance low losses mass in materials as specimen (C), was cooling in Brine water 10 % media (fast cooling rates) that effect to increase in hardness, and the results was a good agreement with results of [10]. Fig. 4 shows the worn surfaces with quenching media decrease the pit and scratch with increase surface hardness.

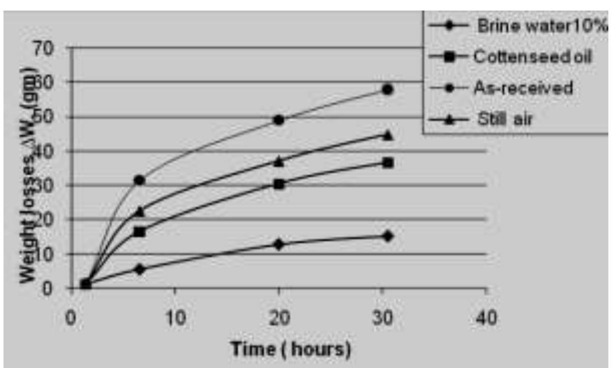

Fig. 3 Variation of specific mass loss of specimens as function of media cooling with testing time

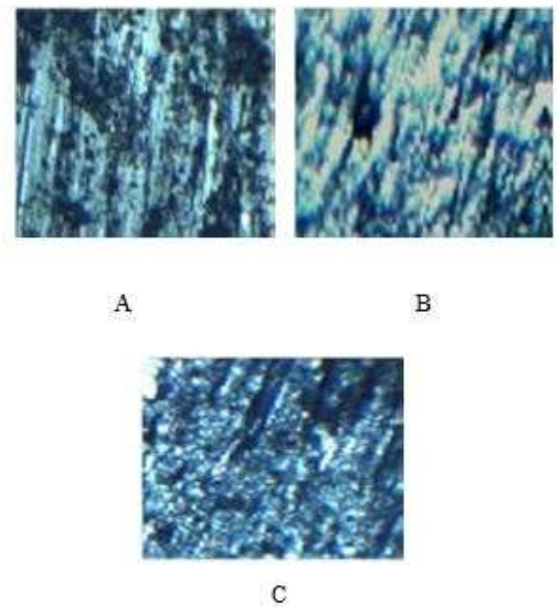

Fig. 4 Topography of the AISI 1030 steel specimen surface with different quenching media; A: Quenching in still air and tempered at 250 OC, (300X), B: Quenching in cottonseed oil and tempered at 250 OC, (300X) and C: Quenching in Brine water 10% and tempered at 250 OC, (300X).

Conclusion

1. Quenching media (Still air, Cottonseed oil, and Brine water10 %), effects to increase the hardness and those effects to increase the abrasive wear resistance.
2. Increases wear resistance result from formed the Martensitic and retained austenite in microstructure steel as a function of quenching media.
3. Wear was presented on the worn surfaces as a function of hardness.

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