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Investigation of Surface Hardening of Medium Carbon Steel Using Snail and Melon Shells

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ABSTRACT : Investigation of surface hardening of medium carbon steel using snail and melon shells has been critically examined using charcoal as base enhancer. The samples were proportionally mixed in percentages of 5, 10, 15, 20 and 25 % snail and melon shells with charcoal taking the rest as base enhancer. The samples were then carburized at a temperature of 950 °C and allowed to cool to room temperature for 8 hours for diffusion to completely take place. The un-carburized and carburized samples were then subjected to Vickers hardness test with the variation into the core from the outer surface from .2 to 1.6 mm. The results for the un-carburized samples were 313 -302 Hv. For the carburized ones the hardness values were in the range of 561-971 respectively. For samples B, D and F the gradients at 0.2 mm were 767, 841 and 971 Hv respectively. The results indicates that snail and melon shells can be used for surface hardening of medium carbon steel.
KEYWORDS -Carbon steel, Charcoal, Diffusion, Energizers, Melon shell, Snail shell, Surface hardening.

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I INTRODUCTION

Surface hardening is a heat treatment process used essentially to produce hard saturated outer layer of steel with carbon, usually the formation of high carbon surface/layer is required of mild steel making it much more useful in engineering application, parts such as gears reciprocating /rubbing rods like crank shaft, cam shaft and frictional and wear resistant plates can be surfaced hardened [1].

Plain steels are widely used for many industrial application and manufacturing on the account of their low cost and ease of fabrication [2]. They are classified on the basis of their carbon content as the major alloying element [3]. Steels with carbon content (0.25-0.65%) are classified as medium carbon, while those within the range of 0.65-1.5% are high carbon steels. Steels with less than 0.25% carbon are termed low carbon steels. Hardness and other mechanical properties of plain carbon steels increases with the rise in carbon concentration dissolved in austenite prior to heat treatment [3], [4] which may be due to transformation of austenite in to martensite [5]. Therefore, the mechanical strength of medium carbon steel can be improved by quenching in appropriate media [6], [7]. However the major influencing factors in the choice of the quenching medium are the kind of heat treatment, composition of the steel, the size and shape of the parts [8].

Melon is a cover crop, the seed when dried is coated with a brown shell containing traces of calcium carbonate ($CaCO_3$) in limited quantity, while snail shell contains high Calcium carbonate ($CaCO_3$) [9]. Charcoal obtained as by product from hard wood (black) contains very high carbon [10].

II MATERIALS AND METHODS

Mild steel rod was purchased at the Iron and steel market located in Makurdi, Benue State, Nigeria as the material to be surfaced hardened. The snail and melon shells were collected from a waste dumpsite located close to Makurdi modern market while charcoal was collected in bulk at a local alcohol brewing spot at North Bank also in Makurdi. They were used as hardening agents/energizers.

The chemical composition of the steel was determined using a computerized mass spectrographic analyzer. The mild steel rod was then cut into 30 mm lengths as samples/specimens. The charcoal was used as a base compound and influencer. The snail and melon shells were dried and ground separately, then sieved to less than 600 µm to enhance diffusion and reaction during carburization. The surface hardening/carburization was done using the following proportional mixture/additives respectively on the mild steel as shown in Table 1.

The steel samples were packed in the steel carburization boxes and placed in a carbolite furnace and fired to a constant temperature of 950 °C for 8 hours according to standard procedure and allowed to cool to room temperature. The rate of diffusion was then determined using (1).

$$J = -DA\left(\frac{\partial c}{\partial x}\right) \quad (1)$$

where$J$ = the amount of carbon content which passes in unit time across the area A to be carburized in the x-plane, $(\partial c/\partial x)$ = the variation of carbon content with depth below the carburized surface (concentration gradient of the carbon), D = the diffusion coefficient (cm^2), x = depth of penetration (cm) and t = time of diffusion (s).

Table 1: proportional mixture of agents.

Sample group (mild steel)	Carburizing agent
A	100% Cc
B	90% Cc + 5% Ss + 5% Ms
C	80% Cc + 10% Ss + 10% Ms
D	70% Cc + 15% Ss + 15% Ms
E	60% Cc + 20% Ss + 20% Ms
F	50% Cc + 25% Ss + 25% Ms

Key: Cc = Charcoal, Ss = Snail shell, Ms = Melon shell

The case depth was determined using (2).

$$Case\ depth = k\sqrt{t} \qquad (2)$$

where the diffusivity constant k depends on the temperature, the chemical composition of the steel and the composition gradient of the hardening elements.

The samples were then subjected to surface hardness test using Vickers hardness testing machine. The diagonals indented were measured and the mean determined. The values were read from the Vickers hardness table as the hardness values (Hv). The distance from the edge of each sample was taken in the order/step of 0.2 from 0.2 to 1.6 mm into the core. This was done for both the un-carburized steel samples and the carburized samples.

III RESULTS AND DISCUSSION

The results of the experiment are presented below in Tables 2 and 3. The percentage carbon contained in the steel is 0.253 as shown in Table 2, and this agrees with [2] placing the steel as medium carbon steel. The result of hardness value of the un-carburized mild steel in Table 3 reveals that as the distance from the outer surface proceeds into the core, the hardness decreases from 313 to 302. The values for the carburized samples also show a similar tendency as the distance increases into the core from 0.2 -1.6 mm varying between 971 to 572 Hv accordingly. Furthermore, the results confirm the fact that the surface hardness of mild steel is improved by the process. Also, the Table shows that the composition of the carburizing agent had a significant effect on the surface hardness of the sample. Increasing the other components at the expense of charcoal produced better surface hardening.

Table 2: The chemical composition of medium carbon steel.

Element	Average Content	Element	Average Content
C	0.253	W	0.001
Si	0.242	As	0.004
S	0.038	Sn	0.010
P	0.031	Co	0.008
Mn	0.697	Al	0.003
Ni	0.057	Pb	0.000
Cr	0.122	Ca	-
Mo	0.012	Zn	0.005
V	0.002	Fe	98.233
Cu	0.104		

Figure 1 shows the depth/hardness plot of representative carburized steel samples using agents B, D and F with different mixture compositions. They trends summarizes the foregoing discussion. They show reducing hardness with increasing depth into the core as well as the effect of carburizing agent composition on the hardness produced. The plots also show that the effect on hardness is more distinct near the surface and reduces more uniformly farther into the steel.

Table 3: Average hardness value (Hv) for the steel samples.

Distance (mm)	Un-carburized Mild Steel	A	B	C	D	E	F
0.2	313	738	767	829	841	869	971
0.4	313	688	702	570	741	775	929
0.6	312	646	661	675	684	707	837
0.8	311	612	638	640	653	658	759
1.0	310	592	621	610	621	626	734
1.2	309	580	605	591	599	613	701
1.4	306	572	593	580	583	590	682
1.6	302	561	579	575	571	577	650

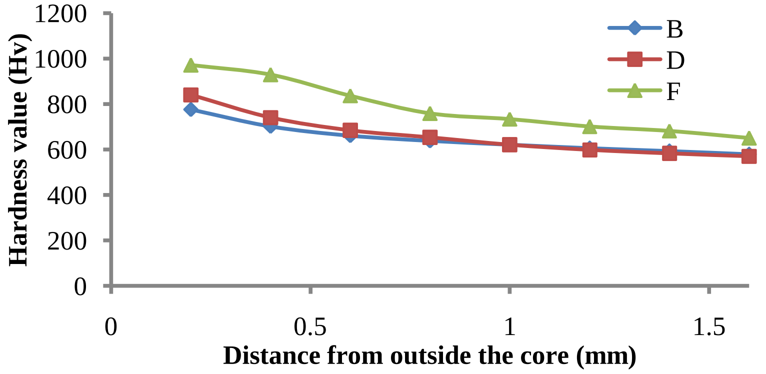

Figure 1. Depth against hardness diagram

IV CONCLUSION

Based on the experimentation and results obtained the following conclusions are drawn:-

i. The mild steel bar is medium carbon steel.
ii. Snail and Melon shells can be used for surface hardening of medium carbon steel.
iii. Better composition for the surface hardening is 50% charcoal, 25% snail shell and 25% melon shell.

The max case depth stand at 1.6mm.

REFERENCES

[1]. K. Kaustubh, Surface hardening of steels, Paper presentation TEQIP. Workshop on micro- structure engineering though heat treatment. Department of materials science and engineering, Indian institute of Technology. Kanpur, 2015.
[2]. W. F. Smithand J. Hashemi, Foundations of material science and engineering 4thed Mc Graw-Hill, New York, USA, 2006.
[3]. T. V. RajanC. P. Sharma and A. Sharma, Heat treatment principles and techniques. Prentice- Hall of India private Ltd. New Delhi, India, 1989, .36-58.
[4]. K. E. Thelnig, Steel and its heat treatment. 2nd ed. Butterworth, London, England Uk., 1994.
[5]. C. Feng and I. K. Tahhir, The effect of quenching medium on the wear behavior of a Ti-6Al-4V alloy J. Mater. Sci., 43(2), 2008, 788-792.
[6]. K. O. Jamiu K.A.Tajudeen and B. R. Abdulkarim, Evaluation of mechanical properties of medium carbon steel quenched in water and oil. AUJ, T 15(4), 2012, 218-224.
[7]. A. P. Ihom Case hardening of mild steel using cow bones B.Eng. Degree project submitted to the Dept. of Mat. & Met. Engr. University of Jos, 1991.
[8]. J. Rassizadehghani, S. H. Raygan and M. Askari, Comparison of the quenching capacities of hot salt and oil salt baths. Metal Sci. Heat Treat., 48(5-6, 2006, 193-198.
[9]. A. P. IhomG. B. Nyior, I. J. Nor and N. J. Ogbodo, Investigation of Egg shell waste as an enhancer in carburization of mild steel. AMJ Master Sc. Eng, 1(2), 2013, 29-33.
[10]. P. R. Carey and D. L. Winters, Updating Resin Binder processes Part V. McGraw Hill, New York, 2008, 46-52.

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