AN ANALYSIS OF HAND TOOL MATERIAL USED FOR AGRICULTURE WORK IN RURAL INDIA

Mr. Jitendra Prasad[1], Mr. Mahesh Pratap Singh[2], Dr. A.K. Bajapai[3]

[1,2,3] Mechanical Engg., SRMSCET BLY./ UPTU, (India)

ABSTRACT

The heat treatment and carburization has been acknowledged by some means of improving the various properties of metals and alloys. In the present investigation the mechanical and wear behaviors of hand tool material (mild steel) carburized at different temperature range of 890, 920 and 950^{0}C have been studied and it is found that the simple heat treatment greatly improves the hardness, and wears resistance of the hand tool. The aim has been to examine the effects of these different carburization temperatures and conditions on the mechanical and wear properties of the carburized hand tools. For above purpose firstly the hand tool material is carburized under the different temperature range are subjected for different kind of test such as abrasive wear test, hardness test. The results of these experiment shows that the process of carburization greatly improves the mechanical and wear properties and these properties increases with increase in the carburization temperature The experimental results also shows that the mild steels carburized under different temperature range as stated above, with in which the mild steels carburized at the temperature of 950^{0}C gives the best results for the different kinds of mechanical and wear properties because at this temperature it gives highest hardness and wear resistance, so it must be preferred for the required applications.

Keywords: Abrasive Wears Test, Carburizing, Hardness Test, Result Analysis, Tempering, Tensile Test, Toughness.

I. INTRODUCTION

Agriculture is the backbone of economy for most of the developing nations including India and a source of income for more than 60% of their population. Most commonly used farm implements are ploughs, harrows, cultivators, peddlers, Furro opener, khurpy, kudali, etc. Indian agro industries and village artisans usually use cheaply and abundantly available low carbon and mild steels for the manufacture of these farm implements to suit every farmer, either rich or poor. During agricultural operations (either dry or wet) the farm implements undergo abrasion by the scratching actions of sand and stone particles present in the soil and it is the most common cause of their quick failure and damage. It is therefore necessary to minimize wear. Thus, there is an urgent need to substantially upgrade the wear resistance of low carbon and mild steels in actual soil conditions. The present work aims to improve the wear resistance property of mild steel by developing an economically feasible carburization technique. The carburization provides a gradual change in carbon content and carbide volume from the surface to the bulk, resulting in a gradual alteration of mechanical and wear properties. Carburizing is the addition of carbon to the surface of low-carbon steels at temperatures generally between 850 and 950°C (1560 and 1740°F), at which austenite, with its high solubility for carbon, is the stable crystal structure. Hardening is accomplished when the high-carbon surface layer is quenched to form martensite so that a high-carbon martens tic case with good wear and fatigue resistance is superimposed on a tough, low-carbon steel core. Carburizing steels for case hardening usually have base-carbon contents of about 0.2%, with the carbon content of the carburized layer generally being controlled at between 0.8 and 1% C. However, surface carbon is often limited to 0.9% because too high a carbon content can result in retained austenite and brittle martensite. Carburizing steel is widely used as a material of automobiles, form implements, machines, gears, springs and high strength wires etc. which are required to have the excellent strength, toughness, hardness and wear resistance, etc. because these parts are generally subjected to high load and impact. Such mechanical properties and wear resistance can be obtained from the carburization and quenching processes.

Fig-1

Composition for mild steel used for the analysis C=0.17%, Mn=0.34%, S=0.05%, P=0.2%, Ni= 0.01%, Cu=0.01%, Cr=0.015 & Fe.

1.1 Solid Carburization

The solid or pack carburization involves heating the steels parts embedded in powdery mixture of 85% coal and 15% $BaCO_3$ at a temperature in range 900-950 degree Celsius. The residual air in the box combines with carbon to produce Co gas. Carbon monoxide gas is unstable at the process temperature and thus decomposes upon contacting the iron surface by reaction.

$$2CO = C + CO_2$$

The atomic carbon enters the steel through the following reaction.

$$Fe + 2CO = Fe(C) + CO_2$$

The addition of $BaCO_3$ enhances the carburizing effect. $BaCO_3$ decomposes and evolves CO_2 which react with coal to form carbon monoxide.

$$C + CO_2 = 2CO$$

solid carburization is a time consuming procedure. Typical carburizing time to obtain a case depth of 1-2 mm is around 6-8 hours. Higher speed can be obtained by carburizing in gaseous medium.

1.2 Tempering

To relieve the internal stresses and reduce brittleness, you should temper the steel after it is hardened. Tempering consists of heating the steel to a specific temperature (below its hardening temperature), holding it at that temperature for the required length of time, and then cooling it, usually instill air. The resultant strength, hardness, and ductility depend on the temperature to which the steel is heated during the tempering process.

1.3 Coal Selection and Preparation

The vasundhara coal is taken for this purpose and it is crushed into -52 mesh size with the help of crusher and test sieve, about 4 kg of coal is prepared for this purpose and this coal is used for the pack carburization of mild steel samples.

II. MECHANICAL AND WEAR PROPERTIES STUDIED

The following mechanical and wear properties were studied and analyzed in the present work.

Abrasive wear

Hardness

2.1 Specimen for Abrasive Wear and Hardness Test

A standard specimen of dimensions (4cm x 2.5cm x 0.5cm) of mild steel is prepared.

Fig2 Brinell Hardness Machine

Fig3 Specimen for Abrasive Wear & Hardness Test

III.TEMPERING OF CARBURIZED MILD STEEL SAMPLES

Carburized steel samples were heated at the temperature of 220^{0}C for duration of 40 minutes and then cooling it usually in the still air.

Fig4 Muffle Furnace

3.1Abrasive Wear Test

In the present experimental work, speed and time wear kept constant while the load was varied from 15 N to 50 N. Parameters that remained constant throughout all the experiments are given in table.

RPM-310, Time- 330 second, Type of abrasive paper – emery 80grade size

3.1.1Wear Volume

Wear volume = weight loss / density

Density of specimen = 7.86 g /cm3

3.1.2Wear Rate

It is defined as wear volume per unit distance travelled.

Wear rate =wear volume / sliding distance(s)

Sliding distance (s) can be calculated as

Sliding distance (s) = V x time

Fig5 Pin on Disc Machine for Abrasive Wear Test

= (2 π R N / 60) x time

Where, R = radius of abrasive wheel (7.25cm)

N = R.P.M (310) Π = 3.14 (constant)

Time = 5.5 minute = 330 Sec.

Result of abrasive wear test forcarburized mild steel, at load 16 N, 31 N and 51N

Table1 (For 16 N load)

Carburization condition		Tempering condition		Weight loss, g	Wear Volume cm^{3}x10^{-2}	Wear rate, cm^{2}x10^{-7}	Wear resistance, cm^{-2}x10^7
Temp (°C)	Soak time(Hrs)	Temp(°C)	Soak time (Min.)				
Simple mild steel	-	-	-	0.205	2.61	3.36	0.297
890°C	2.5	220°C	40	0.120	1.69	2.17	0.461
920°C	2.5	220°C	40	0.110	1.53	1.97	0.508
950°C	2.5	220°C	40	0.102	1.30	1.31	0.763

Table2 (For 31 N load

Carburization condition		Tempring condition		Weight loss, g	Wear volume, cm^{3}x10^{-2}	Wear rate, cm^{2}x10^{-7}	Wear resistance cm^{-2}x10^7
Temp (°C)	Soak time(Hrs)	Temp(°C)	Soak time (Min)				
Simple mild steel	-	-	-	0.265	3.37	4.34	0.230
890°C	2.5	220°C	40	0.170	2.16	2.78	0.360
920°C	2.5	220°C	40	0.150	1.91	2.46	0.407
950°C	2.5	220°C	40	0.137	1.74	2.24	0.446

Table3 (For 51 N load)

Carburization condition		Tempering condition		Weight loss, g	Wear volume, cm^3x10^{-2}	Wear rate, cm^2x10^{-7}	Wear resistance, $cm^{-2}x10^7$
Temp (^0C)	Soak time(Hrs)	Temp(^0C)	Soak time (Min.)				
Simple mild steel	–	–	–	0.320	4.07	5.24	0.191
890^0C	2.5	220^0C	40	0.200	2.54	3.27	0.306
920^0C	2.5	220^0C	40	0.180	2.29	2.94	0.340
950^0C	2.5	220^0C	40	0.161	2.05	2.64	0.379

Result of Rockwell hardness of carburized mild steel at load 150kg.

Table4

Carburization condition		Tempering condition		Hardness(R_c)
Temp (^0C)	Soak time(Hrs)	Temp(^0C)	Soak time (minute)	
Simple mild steel	–	–	–	30
850^0C	2.5	220^0C	40	45
900^0C	2.5	220^0C	40	50
950^0C	2.5	220^0C	40	55

IV. CONCLUSION

From the present studies on "Mechanical and wear properties of carburized tool material samples" the following conclusion have been drawn.

a. The weight loss due abrasion, wear volume and wear rate increases with the increase in the applied load.

b. Hardness, wear resistance and tensile strength increases with increase in the carburization temperature.

c. Weight loss due to abrasion, wear volume, wear rate and toughness decreases with increase in the carburization temperature.

d. With increase in the hardness the wear resistance increases, but there is decrease in weight loss due to abrasion and wear rate.

e. As comparing for different carburization temperature. The tool material carburized - at the temperature of 950^0C shows the best combination of higher hardness, higher tensile strength and higher wear resistance with low weight loss and less wear rate.

f. Finally the net conclusion is that the mild steel carburized under the different- temperature range of 890, 920, and 950^0C with in which the mild steel carburized at the temperature of 950^0C is giving the best results for the mechanical and wear properties like tensile strength, hardness and wear resistance.

According to result we conclude that a former can improve the life of hand tools used for agriculture work and he can save the money, time and power wasted in short time resharping.

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