ANALYSIS OF HARDNESS ON SAE 1040 USING DIFFERENT HEAT TREATMENT PROCESS

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ABSTRACT

The Heat Treatment process is most commonly used in industries to enhance the mechanical properties of materials by controlling the temperature of heating and cooling. In this present work an attempt has been made to analyze the effect of different heat treatment processes such as annealing, normalizing, tempering and water quenching on hardness of material SAE 1040. The Rockwell hardness tester was used to measure the hardness of material and Muffle furnace was used to carry out the heating process. The material SAE 1040 was so chosen due to its wide application such as crankshafts, couplings, cold headed parts etc. The specimen taken for an experiment was 2 cm in diameter and 15 cm in length. The results revealed out that the maximum hardness was observed by tempering heat treatment process.

Keywords: Heat Treatment, Hardness, SAE 1040

I. INTRODUCTION

In manufacturing organization heat treatment process become popular to improve the physical and mechanical properties of materials. The researcher has been putted many effort to enhanced the properties of material by using various heat treatment process. In annealing process metal is heated and allow the material to cool up to room temperature. The annealing process is used to remove the internal stresses of material and to refine microstructure. The cooling method of annealing is depending upon the properties of materials required. The normalizing heat treatment process is mainly done to improve the properties of ferrous metal. The two basic difference between annealing and normalizing is that in normalizing material is heated at higher temperature and second is cooling of material is done in air only. In water quenching metal is heated above critical temperature and then after holding material up to 1 to 2 hrs, metal cooling is done in water. In tempering process material is heated above critical temperature then allows cooling down in the furnace below critical temperature, following this material is allowed to cool in still air. The tempering is mainly performed to improve the toughness of iron alloys. Literature review revealed that choice of heat treatments is depend upon the application and properties of material desired. In present study SAE 1040 material is used to analyze the effect of various heat treatment process on hardness of SAE 1040 material. The specification of SAE 1040 material is shown in Table 1.

Table 1 Sae 1040 Specification

Analysis	Critical range		Thermal treatment	
CARBON .37/.44	Ac_1 F	1340°	NORMALIZE	1600-1750° F
MANGNESE .60/.90	Ac_3 F	1445°		
PHOSPHORUS .04MAX	Acr_3	1350° F	ANNEAL F	1450- 1550°
SULPHUR .05MAX	Ar_1	1250° F	HARDEN(WATER)	1525-1575° F

II. LITERATURE REVIEW

The analysis of mechanical properties on medium carbon steel has been done by using temperature range during tempering heat treatment process. It was concluded that hardness of medium carbon steel reach to maximum value HRC 58 at temperature of 900^0C hardening. The result revealed out that the value of yield strength was higher at 350^0C and the value percentage of elongation was least at 450^0C [1]. The effect of different heat treatment process on fracture toughness and hardness was examined on hot die steel (H13). The experiment was done by using different temperature range and result shown that toughness of H13 first increase then decrease vice-versa in Hardness with increasing in temperature during experiments [2]. The effect of heat treatment process on mechanical properties and microstructure on high - chromium martensitic GX12CrMoVNbN9-1 (GP91) cast steel has been examined. The result showed that impact energy of GP91 was improved at temperature of 700^0C. The maximum strength was observed after hardening from the austanizing temperature of 1040ºC [3]. The experimental work has been conducted to enhance the properties of the CA-15 steel by using heat treatment process. It was concluded that to enhance the mechanical properties the temperature of annealing process must be increased. The result showed out that increase the annealing temperature results in appearance of a coarse sorbite [4]. The experimental work was carried out to investigate mechanical properties together as well as wears mechanism of paper knife-edge die made of A 681 steel with different coating such as TiN, TiCN and DLC. It was concluded that the duplex treatment (nitriding/TiN) is efficient method to achieve dense structure [5]. The experimental work has been carried out to enhance the mechanical properties of cold work tool steels by using various heat treatment processes. The result showed that toughness of D2 is directly proportion to temperature. The hardness of D2 tool steel is inversely proportional to tempering temperature range (160oC-200oC). The finer microstructure and improved mechanical properties were observed after tempering heat treatment process [6]. The effect of various heat treatments on medium carbon steel has been examined to analyze mechanical properties and microstructure. Two different grades of Steel were used during the experimental work to make result more realistic. It was concluded that steel with copper has improve hardness, ultimate tensile strength but reduce ductility. The result showed that internal stresses was minimize during tempering at higher temperature [7].

III. PRESENT WORK

The Adopted Methodology In Present Work Is Shown In Figure1.

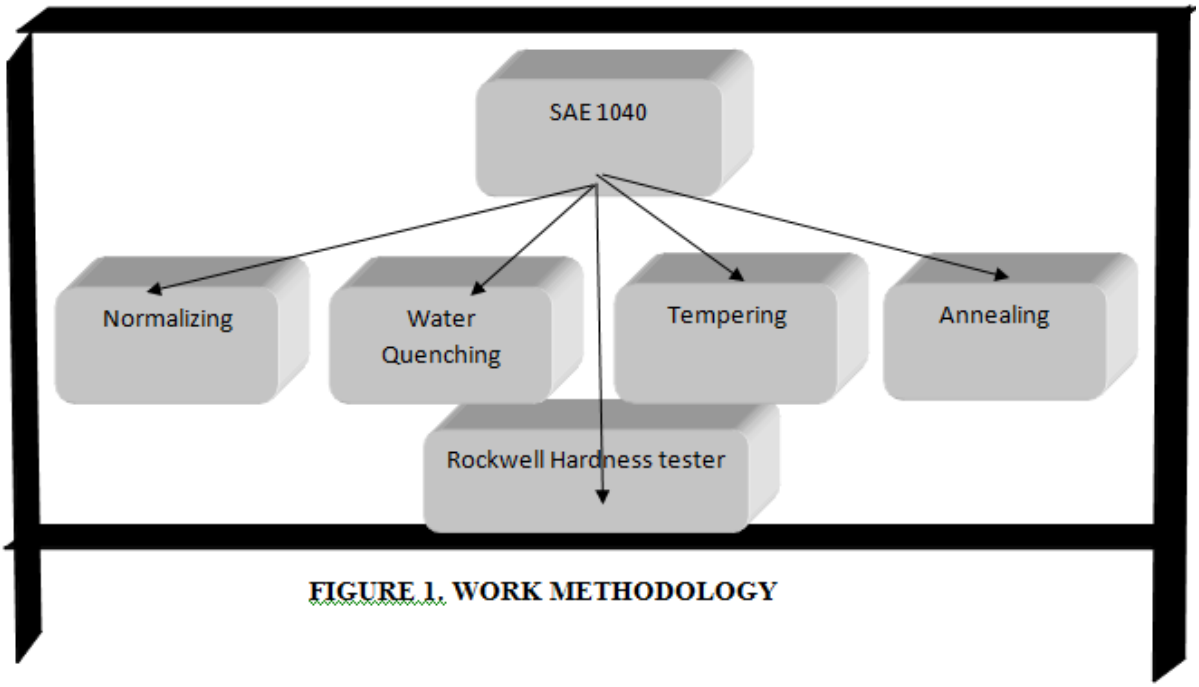

FIGURE 1. WORK METHODOLOGY

IV. EQUIPMENT USED

The equipments used in present work are shown in Table 2.

Table 2 Equipment Used

Sr. No	Equipment	Purpose
1	Rockwell Hardness tester	Compute the hardness
2	Muffel Furnace	Heating the specimen

V. EXPERIMENTAL RESULT

The experimental results of various heat treatments are shown in Table 3 and figure 4.

Table 3 Experimental Results

Sr. No.	Heat treatment process	Hardness
1	Annealing	C42.1
2	Normalizing	C23.2
3	Tempering	C56
4	Work Quenching	C24.4

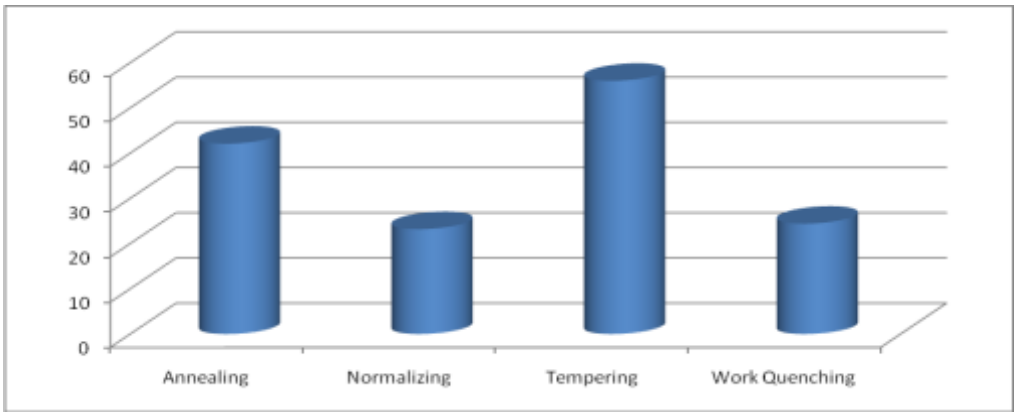

Figure 2 Experimental Result Of Various Heat Treatment Process

VI. CONCLUSIONS AND FUTURE SCOPES

In this present study effect of different heat treatment process such as annealing, tempering, on material hardness has been investigated. The hardness of material before heat treatment was observed C 14. The harness of material was observed C 24.4, C 23.2, C 42.1, and C 56 by using full water quenching, normalizing, annealing and tempering respectively. The average of five reading of harness was taken for every experiment to minimize the human errors. The results shown that hardness of SAE 1040 can be improved to extent by using tempering heat treatment process. The further study could be extended to analysis the effect of different heat treatment process on microstructure of materials.

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