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EFFECT OF COOLING RATE ON HARDNESS OF AISI 1040 STEEL

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ABSTRACT
The aim of present work is to investigate the effect of cooling rate on hardness property of 1040 steel. The samples were prepared and heat-treated at 723 ºC and750 ºC subsequently were cooled by (Air, Water, and Furnace) three different methods. For this purpose, the hardness of the steel after heat treatment was examined by Vickers hardness test. The objective of this work is heating the material to obtaining desired properties of steel such as improving the toughness, ductility or removing the residual stresses, etc.

KEYWORDS: Steel Material; Furnace; Vickers hardness tester; Hardness. .

I. INTRODUCTION
Now a day's many industries are using heat treatment method to change or to get good mechanical properties of materials used in various applications [1]. It is an operation means to control the mechanical properties such as hardness, toughness, yield strength, ultimate tensile strength, Young's modulus, the percentage of elongation and reduction [2]. Heat treatment classified as thermal treatment, thermochemical and thermomechanical processes are useful, especially where most of the products are from recycled scrap materials [3]. Mechanical properties of steels are strongly depending on the carbon content of steel, heating and cooling rate [4, 5]. As the tempering time increase than the ultimate tensile strength, yield strength, elongation and ductility increases. Oil quenching produces an essentially ferrite-martensite dual phase structure with about 4 volume pct of fine particle and thin film retained austenite. [6-10]. The annealed specimen with mainly ferrite structure gives the lowest hardness value but highest ductility and toughness value. However, after quenching, the microstructure shows the formation of martensite and this increases the hardness of materials [11]. In the present work, the AISI 1040 steel material hardness has been reported.

II. EXPERIMENTAL WORK
The AISI 1040 Steel material specimens were prepared to carry out the work. The prepared specimens were heated in muffle furnace shown in fig.1. at a temperature of 723 ºC and 750 ºC and the specimens were cooled in three different methods i.e. air, furnace and water cooling, after cooling process is over we go for Vickers hardness test to carry out hardness test of all specimens were cooled by a different method. The hardness property of tempered specimens is measured as a function of tempering temperature and tempering time i.e. due to the decomposition of the martensite and coagulation of carbides of the cementite which precipitate from martensite. The water cooling has high hardness compared to air and furnace cooling.

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Fig.1. Muffle Furnace

Fig.2. AISI 1040 Steel rods

Fig.3. Vickers Hardness Tester

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III. RESULTS AND DISCUSSIONS

The specimens were heated at 723 ºC and 750 ºC and cooled in three modes and the hardness values are tabulated in below table.1.

S.No	Heating Temperatures(˚C)	Mode of Cooling	Time of Cooling (Min)	Hardness (VHN)
1.	723	Air cooling	16	188
2.	723	Furnace cooling	360	178
3.	723	Water cooling	6	206
4.	750	Air cooling	20	179
5.	750	Furnace cooling	385	170
6.	750	Water cooling	8	235

It was observed that the hardness depends on the time, a method of cooling and heating temperature of specimens. From the above table.1, the results were shown that the hardness value of water cooling method > Air cooling method > furnace cooling method. It also observed that the hardness value decreases with increasing temperature of specimens.

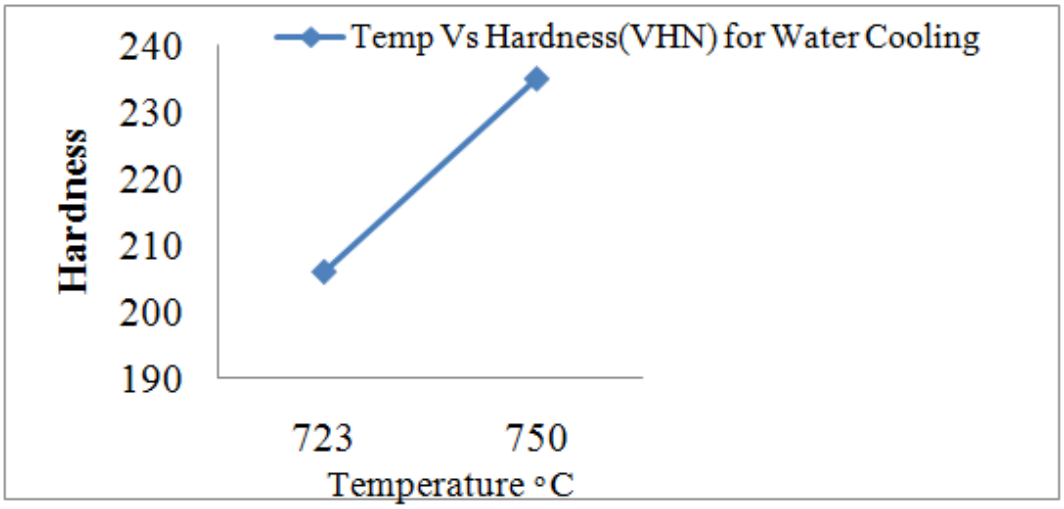

Fig.4. Temperature Vs Hardness for Water Cooling

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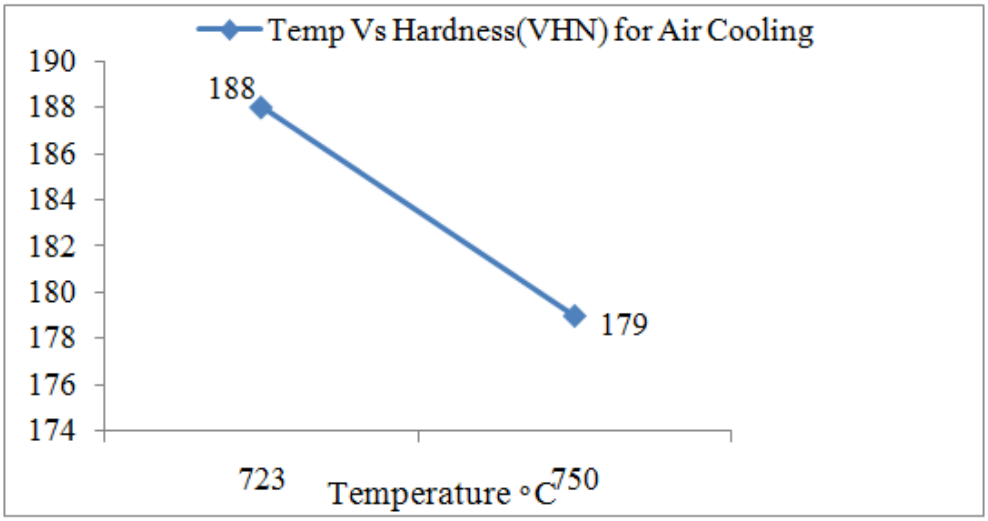

Fig.5. Temperature Vs Hardness for Air Cooling

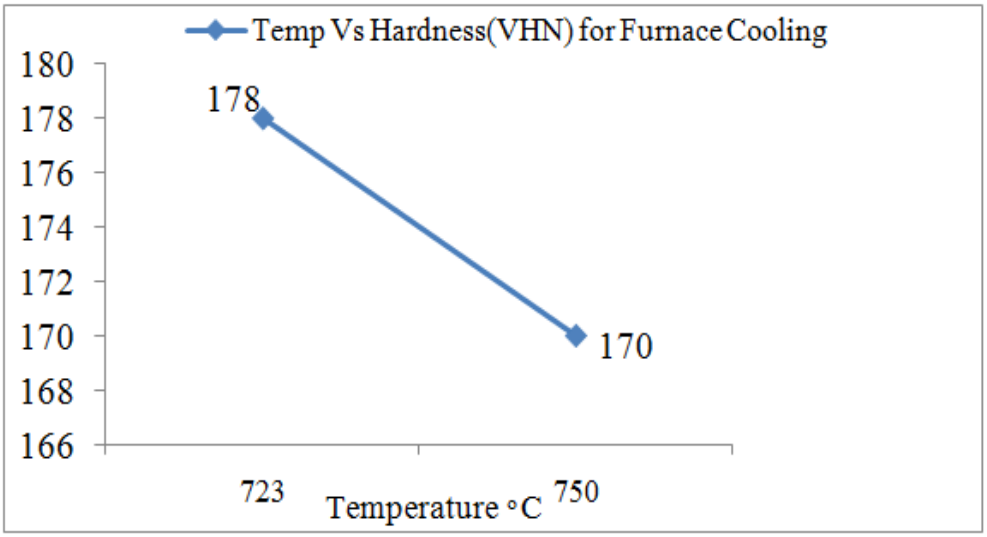

Fig.6. Temperature Vs Hardness for Furnace Cooling

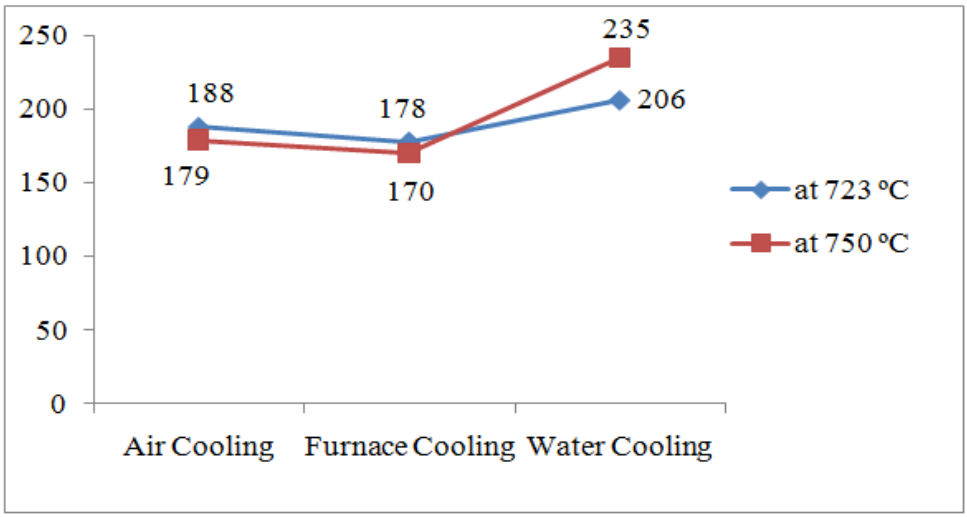

Fig.7. Temperature Vs Hardness for Various Cooling Methods

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From the above graphs, it was observed that the hardness value of water cooling > air cooling and least value of hardness was observed in furnace cooling. The hardness value of water cooling has maximum and least in furnace cooling at 750 ºC.

IV. CONCLUSIONS

It was concluded that the hardness depends on the temperature and method of cooling; the hardness value is higher for water cooling method as compared to the air and furnace cooling methods. The hardness value for water cooling has maximum and minimum for furnace cooling at 750 ºC.

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