INVOTEK

Jurnal Inovasi Vokasional dan Teknologi

http://invotek.ppj.unp.ac.id/index.php/invotek

Vol. 22, No. 2, June 2022

ISSN: 1411 – 3411 (p)
ISSN: 2549 – 9815 (e)

Analysis of Hardness on the Tapping Knife of Rubber Plants Made of Medium Carbon Steel Resulting from Quenching Process with Different Cooling Mediums

Niko Adima Brawira [1,2], Hendri Nurdin[1,2*], Remon Lapisa[1], and Budi Syahri [1]

[1] Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Kampus UNP, Air Tawar Padang, Indonesia-25131

[2] Metrology Laboratory, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Kampus UNP, Air Tawar Padang, Indonesia-25131

Corresponding author: hens2tm@ft.unp.ac.id,

Doi :https://doi.org/10.24036/invotek.v22i2.1017

Abstract

The quenching process carried out by the Blacksmith was still simple and used regular water cooling. This results in the knife not having a good value of hardness. This study aimed to analyze the effects of quenching with different cooling media on the hardness of the JIS SUP 9 knife from Blacksmith. The research method used an experimental method with research objects made of carbon steel per leaf or the JIS SUP 9 which was given hardening with a temperature of 800 ° C with a holding time of 30 minutes then quenching with water cooling media and oil. The data analysis found that the knife quenching with water had an average hardness of 295.6 HVN, Oil had an average hardness of 720.7 HVN, and control specimens with a hardness of 256.6 HVN. Thus, the medium quenching oil has the highest value of hardness, while the oil quenching media also has a good hardness value with no acceleration of the process of expansion. From the results of the study, the authors recommend in the quenching process use of oil cooling media, as well as adding variations of cooling media to get a better hardness value.

Keywords: Quenching, cooling media, hardness, carbon steel

1. Introduction

Many cutting knives are made quickly and precisely using sophisticated machines, especially in many productions and large industries. Improving the quality of the knife products is produced by improving the physical and mechanical properties of the knife material and the proper hardening process in metals is very useful to improve the properties of the kitchen knife. In addition to large industries that already used tools in a modern way, there are also cottage industries that cut knives with simple tools. Each area also has a place to make simple knives or a home, for example in the area of West Sumatra in Padang. Those methods are done for generations. In the process of manufacturing, home industrial equipment uses quenching by cooling workpieces using only water, which results in cheap results. The shock and cracks contained in the equipment produced are caused because only water is used as a cooling medium after the hardening process. Though not only water for cooling media in the process of hardening knives, many other alternatives use cooling media to get superior products as desired. Hardening is the process that gives a hardening to an object with temperature austenitization to produce a hard object that is then quenching. The purpose of heat treatment is to obtain hard, resilient metals, increase engine capableness, and eliminate residual voltage with oil cooling media, saltwater or seawater, and water that has a different cooling speed [1].

Chemically pure iron (Ferro or Fe) is not suitable as a material because it is too soft. Technically process-able iron is always an alloy between iron (Fe) with charcoal (C) and other elements. The measurement that determines hardness, tenacity, and strength is the large levels of charcoal (carbon) in the bladder in iron [2]. Hardness testing is a process whose purpose is to determine the resistance of a

Received date 15/02/2022, Revised date 03/06/2022, Accepted date 21/06/2022

P-ISSN: 1411-3414
E-ISSN: 2549-9815

material to deformation in the local area or material surface, namely plastic deformation. Plastic deformation is acondition of a material which when given a force, the microstructure will not return to its original shape [3]. Different types of hardness testing are available that can be classified against two basic defining aspects, namely, the loading procedure and the indenter geometry [4]. To find out the hardness value of a material, a hardness test is carried out on the material using an appropriate method. In the Vickers method, the presentation is done by applying a force to the diamond pyramid with an angle of 136 ° which is emphasized on the surface being tested. Then, the value of hardness is determined by dividing the force exerted by the surface area [5].

Steel usually contains several alloy elements, the element whose most dominant effect on the properties of steel is the element carbon, although other elements cannot be ignored. The small percentage of carbon element will have an impact on the mechanical properties of the steel, for example in terms of hardness. The hardness of carbon steel depends on the carbon content contained in it [6].

Low carbon steel or medium carbon steel usually uses water, while high carbon steel uses oil. Quenching is a process of Heath Transfer cooling very quickly from the austenite phase in general temperature between 815 ° Ca-a870 ° C for steel materials. Cooling media commonly used for quenching processes are water, oil, saline solution, and air [7]. Hold time between 30 minutes and 1 hour [8]. The quenching process is a rapid cooling process with dyeing on steel that has been done heat treatment with oil cooling media, ice water, and seawater [9].

In research entitled “The Effect of Heat Treatment on Lace Alloy Steel for Rod-Shaming Knife Material”, it can be understood that the results of hardness testing due to cooling water cooling rate faster, carbon trapped from austenite structure (FCC) to martensite (BCC) more and austenite scales at room temperature that did not have time to transform into less martensite [10]. In similar research entitled “The Influence of Quenching and Tempering on The Hardness and Tensile Strength of Medium Carbon Steel Microstructures for Palm Harvester Blades”, it can be concluded that the maximum hardness results in water quenching are higher than air. In the relationship between the size of the grain and the violence, the smaller the granules means the harder [11]. The heat treatment process is a combination of heating and cooling operation at a certain speed that made the metal or alloy in a solid-state, in an attempt to obtain certain properties. In other words, the heat treatment process basically consists of several stages, starting with a warm-up to a certain temperature, followed by detention for a few moments, and then cooling at a particular speed [12]. Heat treatment can also occur accidentally as a result of the process being carried out on steel [13].

Quenching is the process used for the purpose of increasing a metal’s hardness and is accomplished by the rapid cooling of an austenitic metal to transform the austenite into martensite. However, martensite is very brittle with very low toughness, ductility, and high residual stress [14]. Another research entitled “The Influence of Quenching Media On Hardness and Microstructures Post-Hardfacing” also revealed that rapid quenching after being heated to high temperatures and hold time would produce martensite structures that could make the hard properties of steel increase. The result of quenching hardness using water was higher than using air, oil, and non-treatment because quenching used water faster the cooling process resulting in higher hardness values and harder steel [15]. Quenching is usually performed in order to prevent ferrite or pearlite precipitation and facilitate the formation of martensite or bainite [16].

Increasing hardness in metals is the main goal in quenching while setting the rate of cooling in metals is the main factor in the quenching process. There are several important factors, are the length of the quenching process, among others, equipment design, cooling media, cooling concentration, temperature, and cooling movement rate [17]. These factors can affect the final nature of the process of the metal material, therefore, must be regulated in the process of quenching takes place. Therefore, choose the cooling media enough.

2. Research Methodology

The method used in this study was the experimental method. The experimental research method is a type of research method used by researchers to determine the effect of one treatment on others under controlled conditions [18]. The treatment in question was heat treatment. Thus, the researchers wanted to know the influence of water cooling media and oil with the results of the quenching process on the hardness of Steel JIS SUP 9. The type of data used was primary where the researchers continued to

P-ISSN: 1411-3414
E-ISSN: 2549-9815

observe doing the stages of the process that was done to analyze various voltages that arose to reduce cracking and distortion and provided the rate of cooling at the same time in order to get the final hardness result [19].

This study aimed to analyze the effect of quenching with different cooling media on the hardness value of the JIS SUP 9 (0.52-0.6 Carbon composition) tapping knife (Figure 1), in order to get a knife that was not shaken and hard the patient testing. The study was conducted at the FT UNP Padang Metallurgy and Metrology Laboratory.

Figure 1 Tapping knife

The object of the study was to use a knife made of medium carbon steel with a type of leaf spring steel (JIS SUP 9) measuring 180x25x1.8 mm with several specimens of 7 knives, namely 1 control specimen and 7 specimens using oil cooling media and water. Control specimens were specimens that did not through the quenching process, control specimens are cooled by the air. The selection of cooling media in it was based on its viscosity value which was one of the factors affecting the rate of cooling. The value of viscosity of oil (v = 4,01 Pa.s), water (v = 1,01 Pa.s). Objects went through the heat treatment process as well as the quenching process. Heated the material using an electric furnace (Temperature Operation 750°C - 850°C) with a temperature of 800 ° C above the critical temperature and held for 30 minutes.

3. Result and Discussion

3.1 Test Results

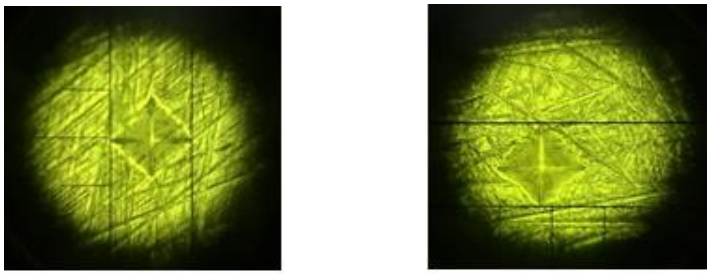
Hardness test results data were obtained in this study by testing all specimens, namely specimens with water cooling, used oil cooling specimens, and control specimens so that graphs of test results were obtained. In this study, hardness testing was carried out by the Vickers hardness tester method with a load of 1000 gf or 1 Kgf.

Table 1 Test Results

No	Cooling Media	Specimen	HVN			Mean
			point 1	point 2	point 3	
1	Water	1	290.7	283.4	272.4	282.1
		2	292.6	305.8	294.5	297.6
		3	307.9	309.4	304.2	307.1
		Mean				295.6
2	Oil	1	711.3	711.7	715.2	712.7
		2	734.3	730,5	722.2	729.0
		3	725.5	712.6	723.7	720,6
		Mean				720,7
3	Control	1	259.7	249.1	261.2	256.6

Note: HVN: Vickers hardness number

P-ISSN: 1411-3414
E-ISSN: 2549-9815



a. b.

Figure 2 a. trace press Vickers hardness tester on one of cooling mediums water, b. trace press Vickers hardness tester on one of the cooling mediums oil

According to the data obtained, the average hardness value in the first specimen of water cooling media was 295.6 HVN. The average hardness value in the second specimen of oil cooling media was 720.7 HVN. The hardness value of the Control specimen is 256.6 HVN.

While the value of the turold on each specimen against 3 knives with different colling mediums is as follows:

Table 2 Data of all specimens

No	Cooling Media	The value of Vickers violence (HV)
1	Water	295.6
2	Oil	720,7
3	Control	256.6

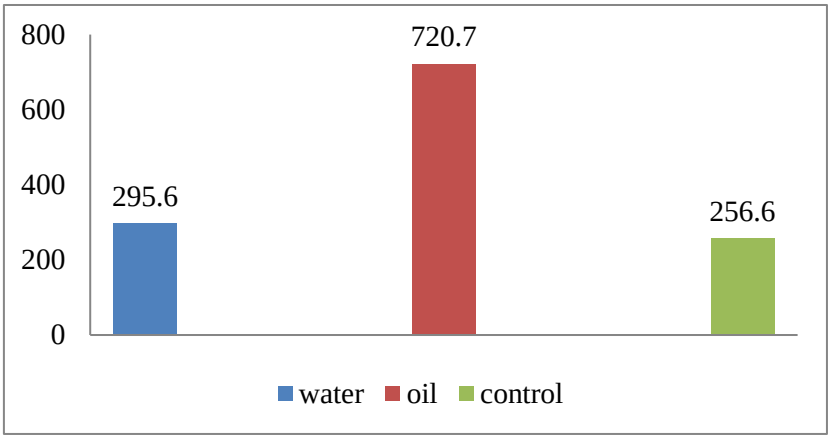


Figure 3 Graph of Comparison of Hardness Values of All Specimens

Based on the data that was obtained from the results of hardness testing and was analyzed, it can be seen that for the value of each specimen that has the highest hardness value is the oil with an average of 720.7 HVN and the lowest in the control group with an average of 256.6 HVN.

3.2 Discussion

3.2.1. Hardness

a). Hardness testing on control specimens with water quenching specimens

The results of hardness testing (micro Vickers) obtained an average hardness of medium carbon steel or steel per non-treatment leaf of 256.6 HVN. And steel per leaf quenching at 800ºC holding time of 30 minutes cooled with water the average hardness value is 295.6 HVN, and the difference of the

increase in hardness value between the control specimen and the water quenching specimen is as follows 295.6 HVN – 256.6 HVN = 39.0 HVN.

b). Hardness testing on control specimens with oil quenching specimens.

The results of hardness testing (micro Vickers) obtained an average hardness of medium carbon steel or steel per non-treatment leaf of 256.6 HVN. And steel per leaf quenching at 800ºC holding time of 30 minutes cooled with oil of an average hardness value of 720.7 HVN, the difference of the increase in hardness value between the control specimen and the oil quenching specimen is as follows 720.7 HVN – 256.6 HVN = 464.1 HVN.

The results of the study were supported by previous regarding the increase in hardness specimens that through the hardening and quenching process with water cooling media increased by about 17,28% from the control specimens [6]. The specimens of low carbon steel and medium carbon steel, reveal that oil quenching has higher toughness than water quenching [20].

3.2.2. The influence of the hardness value of the knife with cooling media

It can be understood that the best cooling medium for knife manufacturing is oil. Because the oil had a hardness value of 720.7 HVN compared to the hardness value of water, which was 295.6 HVN. The oil cooling media had the advantage of minimum damage tendency compared to water. If the oil was compared with water, according to the results of the hardness of the Vickers, the oil had a hardness of 720.7 HVN. This was due to the viscosity value and density of the oil (ρ = 981 kg/m3, v = 4.01 Pa.s). The structure formed during the cooling process will affect the resulting hardness [21].

4. Conclusion

The average hardness in the first specimen with a water cooling medium was 295.6 HVN. The average hardness value in specimens of both mediums with seawater cooling was 754.5 HVN. The average hardness value in the third specimen with an oil cooling medium was 720.7 HVN and the average value on the control specimen was 256.6 HVN. The process of heat treatment and quenching with different cooling media can increase the hardness of the material to be higher.

References

[1] Trihutomo**,** Prihanto. 2015. Analisa Kekerasan pada Pisau Berbahan Baja KarbonaMenengahaHasilvProsesaHardeningadenganaMediaaPendinginayang Berbeda. Malang :JurnalaTenikaMesin. No.1a

[2] Nurdin, H., (2019). METALURGI LOGAM. *UNP Press: Padang*

[3] Abadi, Z., Kurniawan, A., Arafat, A., Abdillah, N, I., & Raihan, D. (2021). Analysis of Riser Variations in Recycled Aluminum Sand Casting on Hardness Values. *Invotek.* Vol 21 (3).

[4] Wu, Hao, Dave, F, Mokhtari, M, et all. (2022). On the Application of Vickers Micro Hardness Testing to Isotactic Polypropylene. *Polymers.*Vol 14.

[5] Hidayat, Jufriyanto, M, Rizqi, A, W, et all. (2020). Analysis Of Load Variations On ST 60 Steel Using Vickers Method. *International Journal of Science, Engineering, and Information Technology.* Vol 5 (02).

[6] Budi Syahri, Zonny Amanda Putra , dan Nofri Helmi. 2017. *Analisis Kekerasan Baja Assab 705 Yang Diberi Perlakuan Panas Hardening Dan Media Pendingin*. Padang: Vol. 17, No. 1.

[7] Bahtiar, M. Iqbal, & Supramono. (2014). Pengaruh Media Pendingin Minyak Pelumas SAE40 Pada Proses Quenching dan Tempering Terhadap Ketangguhan Baja Karbon Rendah. *Jurnal Mekanikal* 5(1):455-463

[8] Sigh, Rajender. (2006). Introduction a Basic Manufacturing a Process and a Workshop Technology.NewaDelhi: NewaAgeaInternasional

[9] Salam, E. (2017). Uji kekerasan pada pegas daun pick up shu pemanasan 800c di quenching air laut. *Jurnal SIMES.*

[10] Murtiono, (2013). Pengaruh Quenching dan Tempering terhadap kekerasan dan kekuatan tarik serta struktur mikro Baja Karbon sedang untuk mata pisau pemanen Sawit. *e- Dinamis.* Universitas Sumatera Utara.

[11] Fatoni, Z. (2016). Upaya perlakuan panas terhadap sifat kekerasan Baja paduan rendah untuk bahan Pisau penyayat batang karet. *Jurnal desiminasi teknologi.* Vol 4 (1).

[12] Erizal. (2015). Study On The Experiment Of Medium Carbon Steel Welded With Smaw And Quenched With Sea Water. *Journal of Mechanical Science and Engineering.* 2 (2). ISSN 2354-9467

[13] Novendra, A., Refdinal., & Le, S. K. (2020). Hardness Analysis of Stone Breaker Chisel Made of Medium Carbon Steel as a Result of Hardening Using Water Cooling Media. *Teknomekanik.* Vol 3 (1). ISSN 2621-9980

[14] McCredie, & Euan. (2021). A Study Of The Effect Of Heat Treatments On EN9 Steel - Grain Structure And Mechanical Properties. *The Plymouth Student Scientist.* Vol 14 (1).

[15] Basori. (2018). Pengaruh media Quenching terhadap kekerasan dan struktur Mikro pasca Hardfacing. *Jurnal kajian teknik mesin*. Vol 3 (2).

[16] Abdulmumin, A., Anthony, O., Danjuma, Y., Ibraheem, S., & Sam, S. (2012). Effect of Water Temperature on the Mechanical Properties of Water Quenched Medium Carbon Steel. *Journal of Energy Technologies and Policy.* Vol 2 (4).

[17] Yunaidi. (2016). Pengaruh jumlah konsentrasi larutan garam pada proses quenching baja karbon sedang S45C. *jurnal mekanika dan system termal*. Vol 1 (3). E-ISSN: 2525-4910

[18] Sugiyono. 2012. *Metode Penelitian Pendidikan (Pendidikan Kuantitatif, Kualitatif, dan R&D).* Bandung: Alfabeta

[19] Chaves, J.C., 2001, The Effect of Surface Condition and High-Temperature Oxidation on Quenching Performance of 4140 Steel in Mineral Oil, in Manufacturing Engineering, Worcester Polytechnic Institute.

[20] Qasim, B, M., Khaidir, T, C., Hameed, A, E., & Abduljabbar, A, A. (2018). Influence Of Heat Treatment On The Absorbed Energy Of Carbon Steel Alloys Using Oil Quenching And Water Quenching. *Journal of Mechanical Engineering Research and Developments (JMERD).* Vol 4 (3).

[21] Novendra, A., Rafdinal., & Le, S. K. (2020). Hardness Analysis of Stone Breaker Chisel Made of Medium Carbon Steel as a Result of Hardening Using Water Cooling Media. *Teknomekanik*. Vol 3 (1). e-ISSN: 2621 - 8720