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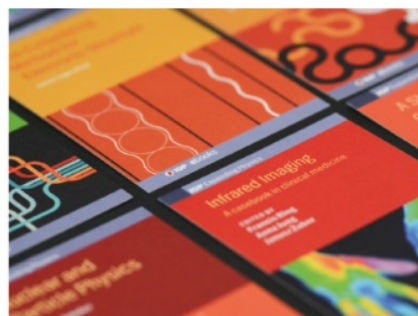
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The influence of acid and base solutions on the quenching process against the hardness of ST37 steel

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Abstract. Previous research stated that salt water cooling media has higher hardness value after going through the heat treatment process compared to freshwater cooling media. From this explanation, a study was conducted on the effect of using acid and alkaline solutions in the quenching process against the hardness of ST37 steel. This study uses vinegar water cooling media and soapy water. In this study several steps were carried out, namely: hardening on ST37 steel with a heating temperature of 700°C with a holding time of 15 minutes, direct quenching with acidic cooling media (vinegar: 2.4 pH) and alkaline solution (soap water: 9.3 pH) with a 15 minute holding time. After the heat treatment process and direct quenching on ST37 steel, Rockwell hardness was tested. From the test results, the use of acid and base solution cooling media in the quenching process has an effect on the hardness of ST37 steel, the best hardness value is an alkaline solution compared to an acid solution, alkaline solution has a hard value of 66.73 HRC, while acid solution has a hardness value of 64.31 HRC. The results of this study will be one of the references for further research, especially the use of weak acid-base solutions as a cooling medium.

1. Introduction

ST37 steel is low carbon steel which has a carbon content of less than 0.3%. This steel is often used for construction - machine construction that rubs against each other [1-7]. Besides steel with the main elements Fe and C can be combined with other elements such as Mn, S, P, etc. to get the desired mechanical properties. However the hardness of the ST37 steel surface is classified as very low, before being used it needs to be improved the hardness properties on the steel surface. Quenching has been a valuable method in steel hardening method especially in industrial scale [8], one of them is heat treatment and given cooling media quickly (quenching) with different cooling media. The aim is to be heat treated and fast dyed with different cooling media so that the hardness of the steel becomes harder when used for general construction [9]. Heat treatment is a treatment (treatment) that is applied to metals in order to obtain the desired properties. By means of heating and cooling by using cooling media with a certain speed that is carried out on metals in solid phase conditions in an effort to obtain certain properties of metals [10].

Water and oil are conventionally the most commonly used quenching media in the heat treatment processes because they are readily quenchable [11]. The cooling medium used has an effect on the cooling rate in the formation of austenite structure as a result of pearlite transformation. It is this Austenite that will determine how far the mechanical properties of heat treatment increase. In addition to influencing mechanical properties, cooling media can affect physical properties. In this study, we use acid solutions and alkaline solutions as cooling media, acidic solutions and alkaline solutions are



chosen because the two cooling media have different properties and cooling rates, which will produce different values of hardness [12]. Many papers on the use of various kinds of liquids as quenchants in heat treatment, but in this study focused on using acidic and wet solutions [13-14].

Based on the above considerations, it is necessary to conduct research to find out a clear analysis of "The Effect of Using Acid and Alkaline Solutions on Quenching Process on ST37 Steel Hardness".

2. Method

This research uses experimental method, ST37 steel is cut in the shape that has been determined as in Figure 1, with a total of 6 specimens. All specimens are heated to a temperature of 700°C, then held for a certain amount of time. Then Quenching process is carried out into 3 soap specimens and vinegar water cooling media as much as 3 specimens as well, the cooling time is 15 minutes, the temperature of acidic and basic solutions as cooling media is maintained in room temperature of 32⁰ C. Tests were carried out using the Rockwell method, using the HRC scale with diamond pyramid indentors and 1200 angles used, as well as the load used 1471N.

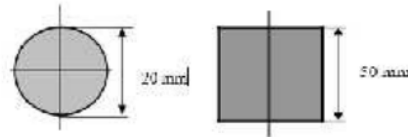


Figure 1. Specimen model.

2.1. Data analysis

Data processing techniques using descriptive techniques based on experimental results, while the analytical methods used Microsoft Office Excel processing. In the processing will be calculated to get the value hardness. Retrieval of data in testing this hardness study was carried out three times using different specimens for each repetition. The treatment of each specimen is of course using new acid or alkaline solution water, so that it is not contaminated with used testing. This data is taken only at 700°C heating temperatures, although in this series of studies carried out with various variations in heating temperature, this is to focus more on the temperature at which micro structures of steel change. The results of this experimental data can be seen in table 1.

Table 1. Hardness value (HRC) ST37 steel of acid and base solution effect.

Treatments	Heating Temp.	Hardness Value (HRC)			
		Spec 1	Spec 2	Spec 3	AVG
Vinegar Water (Acid Solutions)	700°C	66.25	66.9	67.03	66.73
Soap Water (Base Solutions)	700°C	63.9	64.3	64.75	64.31

3. Result and discussions

Figure 2 shows the treatment results of ST37 steel which is heated to a temperature of 700°C then quenched in an acidic and base solution, and the average value indicated by the barbar. The results of this study indicate that the cooling media has an effect on the hardness value of ST37 steel, with a contribution value of 11.63%. This proves that steel given a cooling medium with quenching treatment

will affect the hardness value of steel. In this heat treatment, ST37 steel is heated at a certain temperature and then cooled with cooling media, it can also increase the hardness value of steel compared to the steel raw material itself. This can occur because the formation of a marten site structure in steel after the austenite phase is heated and then cooled quickly to a low temperature, the martensitic structure in steel is often called the saturation solution of carbon and has very strong properties. With this rapid cooling, there is not enough time for austenite to turn into pearlite and ferrite or pearlite and cementite. The transformation from the austenite to ferrite phase takes place in a reconnaissance and grain growth process that is influenced by time. Because the cooling rate is so fast, the carbon atoms are trapped in the solution to form a martensitic structure. Whereas the cooling media which influences the hardness of ST37 steel is soap and vinegar water, when the steel is given an acidic cooling medium, after the heat treatment process it causes higher corrosion on the steel surface than the alkaline solution cooling media, and corrosion can reduce the hardness of the steel. According to Toshiaki Koga and friends, that a strong acid solution can reduce molecular absorption in each compound, so that it can be interpreted that the more acidic the solution, the cooling process will be slower [15]. In several research, too much acidic content can cause slow chemical reactions, at the slowing down of this reaction also causing the cooling process to proceed more slowly. The results of this study will be one of the references for further research, especially the use of weak acid-base solutions as a cooling medium.

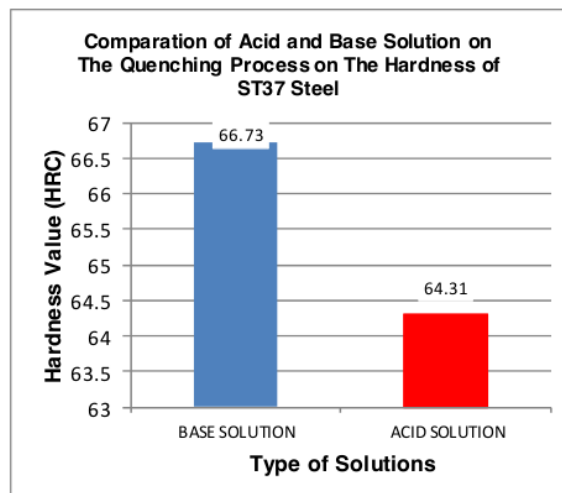


Figure 2. Comparison of acid and base solution on the quenching process on the hardness of ST37 steel.

4. Conclusion

From the results of experiments and analyzes that have been carried out, it was concluded that the use of acidic and alkaline solution cooling media in the quenching process affected the hardness of ST37 steel. The best hardness value is the treatment of alkaline solution (soapy water) with a hardness value of 66.73 HRC, while the treatment of acidic solution (vinegar water) the hardness value is 64.31 HRC.

References

- [1] Manugula V L, Rajulapati K V, Madhus G, udhan Reddy, Mythili R and Bhanu Sankara Rao K 2017 *Met. & Mater. Transc. A.* **48** 3702-3720
- [2] Ramesh R, Dinaharan I, Kumar R and Akinlabi E T 2017 *Mater. Sci. & Eng* **A687**

- [3] Pradeep A and Muthukumaran S 2013 *Mater & Des.* **5** 25-35
- [4] Liu Y, Dong D, Wang L, Chu X, Wang P and Jin M 2015 *Mater & Des.* **A627** 296-305
- [5] Brewer L N, Bennett M S, Baker B W, Payzant E A and Sochalski-Kolbus L M 2015 *Mater. Sci. & Eng.* **A647** 313-321
- [6] El-Batahgy A M, Miura T, Ueji R and Fujii H 2016 *Mater. Sci. & Eng.* **A651** 904-913
- [7] Rodriguez J and Ramirez A J 2015 *Mater Character* **110** 126-135
- [8] Kresnodrianto H, Putra R and Yahya M 2018 Characterization of water based nanofluid for quench medium *IOP Conf. Series: Materials Science and Engineering* **348**
- [9] Bahtiar, M Iqbal and Supramono 2014 Pengaruh Media Pendingin Minyak Pelumas SAE40 pada Proses *Quenching* dan *Tempering* Terhadap Ketangguhan Baja Karbon Rendah *Jurnal Mekanikal* **5** (1) 455-463
- [10] Amanto H 1999 *Ilmu Bahan* (Jakarta: Bumi Angkasa)
- [11] Abdul-Hussein A A-A 2018 Plasticity investigation of Medium Carbon Steel (AISI CK45) treated by Quenching media *Journal of University of Thi-Qar* **13** (1) 74-83
- [12] Agboola B, Abubakre O, Mudiare E and Adeyemi M 2015 Effects of Bath Temperature on Cooling Rate, Mechanical Properties and Microstructure of Medium Carbon Steel during Quenching Operations *Journal of Energy Technologies and Policy* **5** (3) 18-26
- [13] Momoh I, Bamike B, Saliu A and Adeyemi O 2015 Effects of Polyethylene Glycol on the Mechanical Properties of Medium Carbon Low Alloy Steel *Nigerian Journal of Technological Development* **12** (2) 61-4
- [14] Chandan B, Pramod V, Ramesha C and Sharanraj V 2017 Evaluation of Mechanical Properties of Medium Carbon Low Alloy Forged Steels by Polymer Quenching *IOP Conference Series: Materials Science and Engineering IOP Publishing*
- [15] Koga T, Hirakawa C, Takeshita M and Terasaki N 2018 Quenching characteristics of bathocuproinedisulfonic acid, disodium salt in aqueous solution and copper sulfate plating solution *The Japan Society of Applied Physics Japanese Journal of Applied Physics* **57** (4S)

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