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EFFECT OF VARIATIONS OF NaCl QUENCHING MEDIA ON LOW AISI 1020 CARBON STEEL WITH CARBURIZING PROCESS

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Abstrak.
Tujuan studi ini adalah untuk menganalisis hasil variasi media quenching dengan NaCl akan *the value of hardness* (Nilai Kekerasan), *energy value of the impact* (Nilai Impak), *and the microstructure phase* (Fasa Mikrostruktur) yang didapatkan dari *pack carburizing*. Setelah studi ini dilakukan, didapatkan hasil Quenching dengan NaCl 25% merupakan *the value of hardness* paling tinggi dan Raw Material (spesimen tanpa perlakuan) merupakan *the value of hardness* paling rendah, maka dengan demikian garam yang semakin tinggi kadarnya dapat memberikan pengaruh yang lebih besar pula terhadap nilai kekerasannya. Untuk uji impak didapatkan hasil bahwa spesimen Raw Material menunjukkan nilai tertinggi dengan nilai 14,234 Joule spesimen dengan quenching NaCl 25% menunjukkan nilai terendah dengan nilai 5,694 Joule, dengan demikian maka nilai ke uletan yang baik terdapat pada spesimen tanpa perlakuan, sedangkan yang menunjukkan kegetasan terjadi pada spesimen dengan proses quenching. Pengujian Metalografi mendapatkan hasil bahwa pada proses quenching terbentuk martensif sedangkan pada Raw Material terbentuk ferlit.

Kata kunci: *Carburizing, AISI 1020, quenching NaCl*

Abstract.
The purpose of this study was to analyze the results of the variation of quenching media with NaCl on the value of hardness, energy value of the impact, and the microstructure phase obtained from pack carburizing. After this study was conducted, it was found that Quenching with 25% NaCl is the highest value of hardness and Raw Material (non-treated specimens) is the lowest value of hardness, thus higher salt levels can have a greater effect. to the hardness value. For the impact test, the results showed that the Raw Material specimen showed the highest value with a value of 14,234 Joules, specimens with 25% NaCl quenching showed the lowest value with a value of 5,694 Joules, thus the good ductility values were found in untreated specimens, while those showing brittleness occurred in specimen by quenching process. Metallographic testing found that in the quenching process martensive was formed while in the Raw Material ferlite was formed.

Keywords: *AISI 1020, quenching NaCl, Carburizing*

Introduction

AISI 1020 steel is currently widely used as a construction material and as an engine part material, so research to improve its mechanical and surface properties is important [1]. The American Iron and Steel Institute (AISI) is a carbon steel where there are no minimum content specifications for chromium, cobalt, molybdenum, Nickel, Niobium, Titanium, Tungsten, Vanadium, Zirconium or other elements added to form an alloying effect [2].

The heat treatment process on metals is very useful for improving metal properties [3]. Heat treatment is one of the treatment methods for metallic materials that produces a fine microstructure with a working temperature between hot and cold working. Heat treatment parameters can also be used to control the properties of the resulting plate. This is in line with the principle which states that the nature of the material is influenced by the structure of the material and the structure is influenced by the composition of the material and the processing/working process. The heat treatment carried out after the carburizing process aims to produce a hard surface and produce a wear-resistant surface, from several steel properties, hardness and wear are properties that are highly considered in planning machine construction, especially in component parts that slide or rub against each other. Wear is a change in the dimensions of the material caused by the displacement of the material surface due to erosion as a result of mechanical action, this occurs in components whose surfaces rub against each other in a sliding motion [4].

In general, in austenite, with increasing dissolved carbon concentration, the mechanical properties of carbon steel can increase. This can occur during heat treatment before cooling, due to the transformation of austenite to martensite, thus cooling in a suitable medium can accelerate the mechanical strength of carbon steel. the type of treatment to be used, the composition of the steel, the size and shape of the part are the main factors that influence the selection of the cooling medium [5].

So based on this, it is necessary to do research on the effect of variations in NaCl quenching media on the hardness of low carbon steel AISI 1020 with the carburizing process.

Research Method

This research was conducted using an experimental method in a laboratory supported by supporting literature. This experimental research procedure begins with the preparation of AISI 1020 steel with a carburizing process. Furthermore, the heat treatment process was carried out and ended with quenching using NaCl salt water. Materials that are ready to be used are then subjected to a hardness test. The flow of the research procedure is presented in Figure 1.

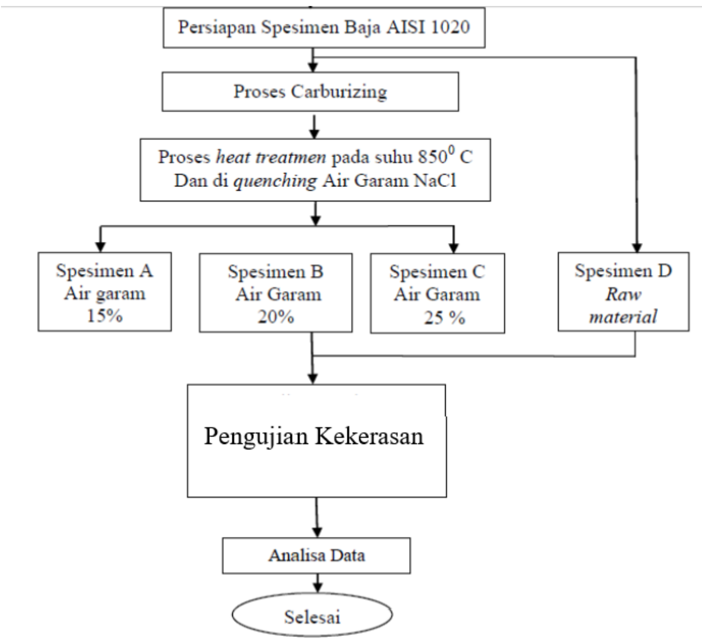

Figure 1 Research Flow

Carburizing Process

The active charcoal used is coconut shell charcoal with a grain size of 30 mesh then mixed with barium carbonate ($BaCO_2$) with the composition: 900 grams of shell charcoal. 100 grams of barium carbonate

After these two materials are mixed perfectly, 9 pieces of AISI 1020 Steel test materials are added and the distance between them is set to 2 cm, then the carburization media mixture is added again, after that the steel contacts are closed.

After combustion in the chamber of the pack carburising furnace is complete, enter the steel contacts in the waiting room. Then close the lid, control the heat at a temperature of 950 ^{o} C, and hold it for 2 hours.

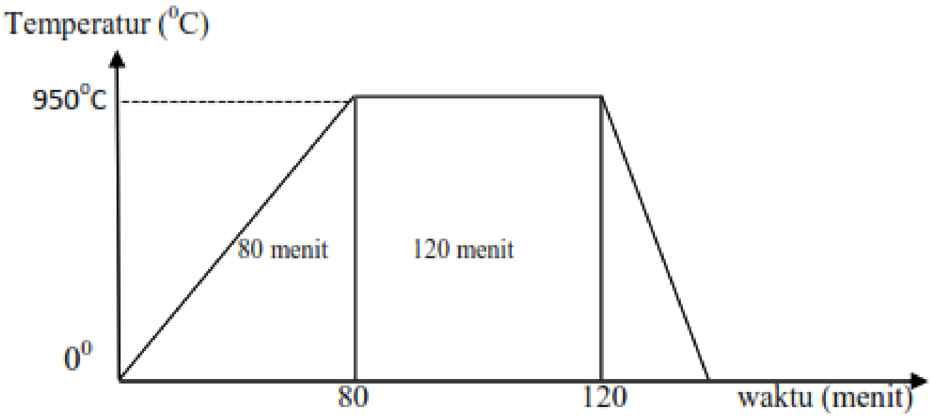

Figure 2 Carburizing Schematic

Heat Treatment

In addition to forging specimens and cutting according to the desired dimensions, the next process is heat treatment of the specimens.
In this work, the quenching process will be carried out. At this stage the furnace is prepared with a holding time of 15 minutes at a temperature of 850 ^{o} C then enter the specimen into the furnace and press the start button. Here is the heat treatment scheme.

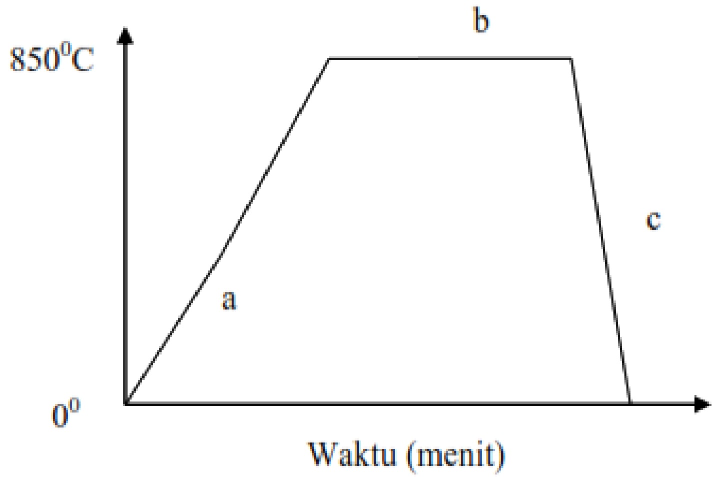

Figure 3 Schematic of Heat Treatment

Quenching

The prepared specimens were then put into a furnace at a temperature of 850 ^{o} C for 15 minutes so that the sample temperature was homogeneous. The sample was immediately cooled quickly into a bucket of 15%, 20% and 25% NaCl brine.

Hardness Test

Vickers measurements were carried out with emphasis on a pyramidal diamond with a peak angle of 136^{o} . This test is often called the diamond pyramid hardness test because the shape of the impact is pyramidal. the load divided by the surface area of the indentation is called the pyramidal number (DPH), or the Vikers hardness number (VHN) or (VPH).

Impact Test

Impact test is a test using rapid loading . In the impact test, a large energy absorption process occurs when the load strikes the specimen. The energy absorbed by this material can be calculated using the principle of potential energy difference. The principle of this impact test is to calculate the energy absorbed by the specimen.

The charpy method (charpy method) of ordinary impack rods, is widely used in the United States. The Charpy specimen has a rectangular cross-sectional area (55 x 10 x 10 mm) and contains a V-450 notch with a base radius of 0.25 mm and a depth of 2 mm. The test object is placed on the support in a horizontal position and the part that is not notched is given an impact load by a pendulum swing (impact velocity is about 16 ft/sec). The specimen will bend and fracture at a high strain rate, approximately 10.3 seconds.

When the load is raised to a certain height, the load has a maximum potential energy, then when it hits the specimen, the kinetic energy reaches the maximum that will be partially absorbed by the specimen until the specimen breaks. The value of the impact value on a specimen is the energy absorbed per unit cross-sectional area latitude of the test specimen. the equation is as follows

HI = E/A

Where : HI = price of impack (J/mm2)

E = Impack Energy absorbed by specimen (joules)

A = Specimen cross-sectional area (mm)

Micro Structure

The microstructure was tested using metallographic tools. The microstructure observations were carried out with an optical microscope. Observation of the microstructure aims to see the size of the grains and see the formed phase.

The sample undergoes a cutting process for metallographic testing for easy observation. Then the sample is subjected to a mounting process to make it easier for the sanding and polishing process. Sanding is done by using sandpaper starting from coarse sandpaper to fine sandpaper to get a smooth and even surface of the test object on the entire surface. The size of the roughness of the sandpaper used is : /100, /120, /240, /400, /600, /800, /1000, /1500, /2000, /5000, then polished using TiO_2 velvet cloth and continued with etching using a mixture of liquid composition nital / nital acid 2 ml and alcohol 70% / 98 ml and water for observation using an optical microscope. After obtaining a micro photo of the test object, the microstructure was observed. Observations were made to see what phases occurred and what the microstructure looked like [6].

Results and Discussion

In the Heat Treatment process, the carburizing process was first carried out with coconut shell activated charcoal media with energizer barium carbonate ($BaCO_2$) at a temperature of 950 ^{o} C with a holding time of 2 hours with plain water cooling media. The carburizing process is carried out at the Sriwijaya State Polytechnic Mechanical Engineering Laboratory. then the heat treatment process is carried out on the AISI 1020 steel material at a temperature of 850 ^{o} C with a holding time of 15 minutes and then a rapid cooling of quenching is carried out with variations of the salt water (NaCl) cooling medium with a percent salt content of 15% 20% and 25%. The heat treatment process was carried out at the Mechanical Laboratory of the Technical Education Training Center, South Sumatra.

Hardness Test Results

Hardness testing was carried out in this study using the Vickers Hardness Number method , namely by pressing the surface of the specimen using a pyramid indenter. Data collection was carried out at 3 (three) points to analyze the uniformity of values in the sample. The test was carried out with the Vickers Hardness Tester machine type VKH-2E.

Later it will be known the difference in the hardness value of each variation in the level of variation in the percentage of 15% 20% and 25% brine and raw materials that are not heat treated. The preparation of the test object is carried out by sanding the surface of the test object which aims to remove corrosion impurities.

Table 1. Hardness Test Results

No	Specimen	Salt Water Content (NaCl)	Vickers Hardness Value (VHN)
1	A	15%	123.94
2	B	20%	128.64
3	C	25%	136.76
4	D	-	119.63

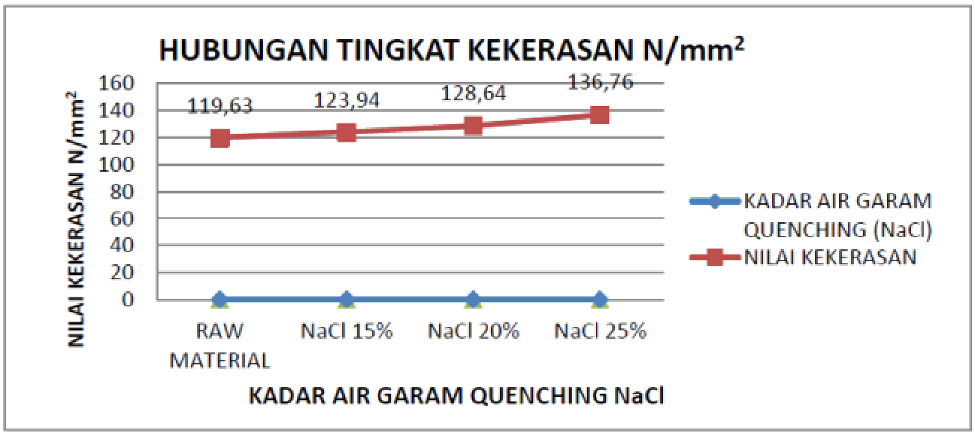

Figure 4. Violence Relationship

In specimen D, which is AISI 1020 steel without undergoing heat treatment, it has a Vickers hardness value of 119.63 N/mm^2, while specimen A with heat treatment and quenching with a percentage level of 15% brine has a VHN hardness value of 123.94 N/mm^2 increased by 3.60%. Meanwhile, Specimen B with 20% NaCl level had a hardness value of 128.64 N/mm^2, an increase of 3.79%. and specimen C with a percentage level of 25% brine has a hardness value of 136.76 N/mm^2. An increase of 6.31% from specimen B. Based on the test results above, it can be seen that along with the increase in the level of salt water content, the steel experiences an increase in hardness when the cooling medium is rapidly quenched .

Impact Test Results

The purpose of the impact test is to determine the amount of energy required to break the material. The impack testing standard used in this case is JIS Z 2242 and the standard for the test sample is JIS Z 2202. For testing with the charpy method, the impact testing machine is according to the JIS B 7722 standard. Charpy impact testing machine type CI-30 made by tokyo testing machine. MFG. CO. LTD in 1922.

In this test, the object is cut according to the test standard in this test using the Charpy impack test method (55x10x10) with a notch depth of 2mm.

The following are the results of the complete impack test which can be seen in Table 2.

Table 2. Impact Test Results

No	Spesimen	Kadar Air Garam (NaCl)	Energi Impack (J)	Energi persatuan Luas (J/mm^2)
1	A	15%	8,541	0,103
2	B	20%	7,13	0,085
3	C	25%	5,694	0,071
4	D	-	14,234	0,173

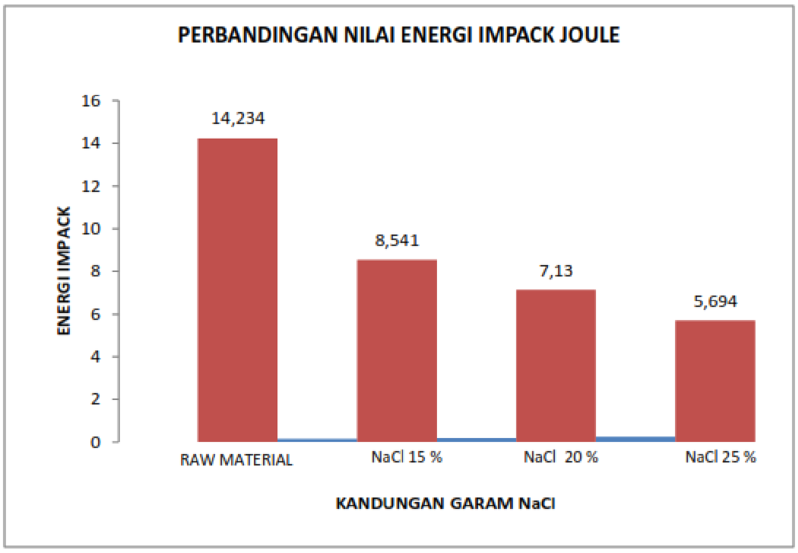

Figure 5. Comparison of Impact Values

Table 2 shows the impack values obtained from testing on specimens with the carburizing process and continued with the heat treatment process with a holding time of 15 minutes and continued with the quenching process with NaCl salt water media. The results of the impact test showed the following results: on specimen D without treatment, the impact energy yield was 14,234 J. Meanwhile , specimen A with a 15% salt water percentage level had an impack energy of 8,541 J, decreased by 66.6%. Meanwhile, Specimen B with a 20% concentration level had an impack value of 7.13 J, decreased again by 19.78% and specimen C with a 25% salt water percentage level had an Impack Energy of 5,694 J. It decreased by 25.21% from specimen B. on specimen D without treatment with a yield of 14,234 J compared to the results With heating treatment and continued with quenching This statement is in accordance with statement [7] which states that the fast cooling quenching process has a hard and brittle martensite structure

Microstructure Test Results

This metallographic test aims to see the phase that is formed on the specimen that is given heat treatment and does not undergo heat treatment. Microstructure testing was carried out at Sriwijaya University, Metallographic Laboratory, Mechanical Engineering Department, Sriwijaya University Engineering using a microscope with 4 specimens, 3 with heat treatment and quenching and 1 without treatment with dimensions of 10 mm x 10 mm and then mounted before arriving at the process of observing and taking pictures using a microscope, including sanding.

Sanding starts from a small grid of /100 to /5000 after which the polishing process continues. Polishing is done using a velvet cloth with toothpaste on the surface. After polishing, etching is carried out where this process aims to corrode grain boundaries. after that the specimen was allowed to stand for a few minutes and then continued with the process of observing and taking pictures. The results of the study of microstructure testing which include structure and changes in shape after the heat treatment process can be seen in full in Figures 7, 8, 9, 10.

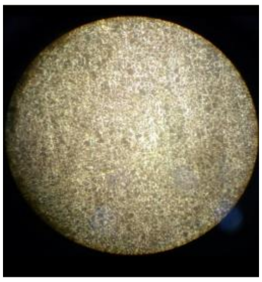

Figure 7. Microstructure of raw material

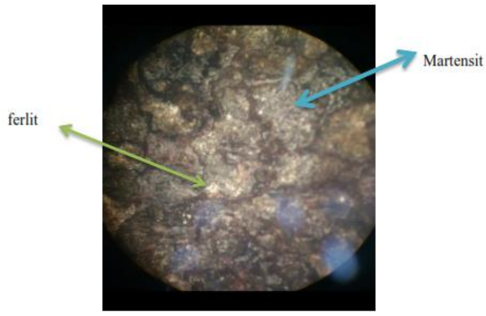

Figure 8. Microstructure of 15% NaCl Specimen

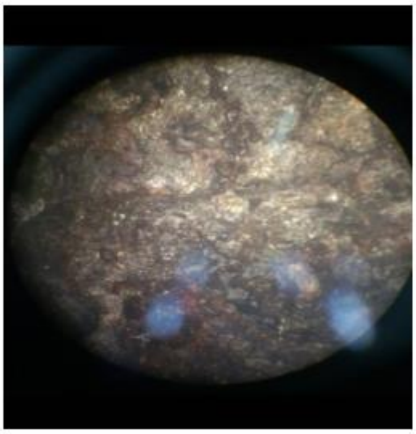

Figure 9. Microstructure of 20% NaCl Specimen

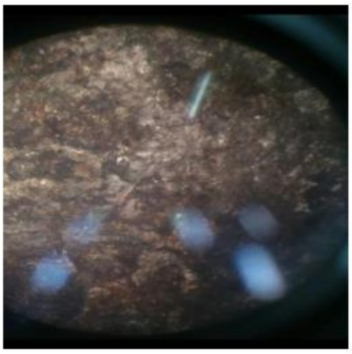

Figure 10. Microstructure of 25% NaCl Specimen

Based on the data obtained from the microstructure testing above, it can be stated that changes in the microstructure occurred in each specimen that was treated with heat and quenching. In specimens AB and C, which were quenched with salt water at a temperature of 850º C, they were held for 15 minutes and first the carburizing process was carried out at 950º C and held for 2 hours. The higher the salt content, the more martensite structure formed fine. This shows that with an increase in salt content, the cooling process in the quenching process can take place more quickly.

Conclusion

Based on the results and discussion, it can be concluded:

1. From the results of the hardness test, the higher the percentage of salt, the higher the hardness value. The highest increase in hardness value was in specimen C with a salt content of 25%. Which is heated at a temperature of 950º C in the carburizing process and 850º C which is held for 15 minutes and quenched with salt water medium of 136.76 N/mm 2 .

2. From the results of the impack test, the highest impact energy was found in specimen D without any treatment at all with an impact energy of 14.234 J and was ductile.

3. In the observation of the microstructure, the martensite phase appears in the specimens that are heat treated and quenched, the higher the salt content in the brine cooling media immersion, the higher the hardness value and the increased brittleness because the more martensite formed which is characterized by hard and brittle

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