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Study Of The Effect Carburizing Agent Gigantochloa Verticillata Munro Charcoal-Barium Carbonat On Pack Carburizing Low Carbon Steel

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Abstract:*This study aims to determine the effect carburizing agentGigantochloa verticillata munro charcoal-arium carbonaton pack carburizing low carbon steel.The specimen is AISI 1010 steel. Pack Carburizing was carried out at various temperatures of 800ºC and 900ºC, with a soaking time of 3 hours. Carburizing agent in the form of a mixture ofGigantochloa verticillata munrocharcoal (GVMC) and $BaCO_3$, with the composition 90%:10%, 80%:20%, and 70%:30%. The test carried out is the Vickers hardness, tensile and impact test. The test results showed that the highest average surface hardness number by 606,36 Kg/mm^2, tensile strength 496,3 MPa on Pack Carburizing with temerature 900ºC, composition Carburizing agent GVMC 70% and $BaCO_3$ 30%., but the lowest impact energy is53,33 J.The use of carburizing agent GVMC charcoal and $BaCO_3$ in the AISI Steel pack carburizing processAISI 1010steel, increases the surface hardness number, tensile strength but decreases the ductility, the material becomes more brittle.*

Keywords:*. Pack carburizing, carburizing agent, Gigantochloa verticillata munrocharcoal, $BaCO_3$, surface hardness number, tensile strength, impact energy.*

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I. INTRODUCTION

Surface hardness, tensile strength and ductility of low carbon steel are very important properties, to be considered in the planning of machine construction, especially component parts that slide or rub, and are subjected to loading. Thus, a hard material is needed to be resistant to friction, strong and must also be maintained at the core so that it remains tough or ductile, so that it is resilient to loads, especially dynamic loading.

One of the technologies used for surface hardening is the Carburizing Process. Carburizing is a surface hardening process with the addition of carbon elements on the surface of the material, but the core hardness does not change. The carburizing process is also a profitable and most widely used method for surface hardening of low carbon steels. Carburizing can be used as a variation of heat treatment on the material to improve the mechanical properties of the material. There are several ways to carry out the Carburizing process, namely Pack Carburizing, Liquid Carburizing, and Gas Carburizing. (Krauss G., 2017).

Carburizing is one of the most commonly performed steel heat treatments. For perhaps three thousand years it was performed by packing the low carbon wrought iron parts in charcoal, then raising the temperature of the pack to red heat for several hours. The entire pack, charcoal and all, was then dumped into water to quench it. The surface became very hard, while the interior or "core" of the part re- tained the toughness of low carbon steel (Fatai et al.,2010).

Carburizing process is the process of adding carbon element (C) into the metal, especially on the surface of the material where the carbon element is obtained from materials containing carbon so that the metal hardness can be increased, the surface hardening on the metal can be done by adding certain elements to the metal such as carbon, nitrogen, and others. These elements can be obtained around us such as bovine bone, bamboo charcoal and others that may be unused again, but the carburizing process produces less harm to the metal detail in (Ahmad, 2015). Disadvantages of carburizing process is the high cost of carburizing media and low hardness value of the metal can be improved by using alternative carburizing medium and cooling with different cooling media. The carburizing agent used in carburizing, charcoal andenergizer. To speed up the process of carburizing added barium carbonate (BaCO3),sodium carbonate (NaCO3) or calcium carbonate (CaCO3). All three materials serve as anenergizer in the process of pack carburizing was considered in (Fatai, 2010).Some researchers (Ihom, 2013; Ngakan, 2016) have attempted to improve mechanical properties of low carbonsteel by a pack carburizing process. It has been done in the temperature 850 ºC, 900 ºC and950 ºC, for 15 and 30 minutes at this soaking temperatur thenhave been cooled. The result temperature and soaking time of carburizing influenced for mechanicalproperty of a specimen. The studies (Aramide, 2010) have been done.by using a alternative carburizing agent like that bamboo charcoal, pulverized cow bone, kernel shell charcoal. Oluwafemi, 2015 have studied the influence of temperature andsoaking time of pack carburizing process followed by quenching process with oil and tempering toimpact toughness mild steel. Saini, (2012) have conducted research on the fatiguepropagation behavior of alloy steel undergoing carburizing process. The work (Priyadarshini, 214) consider the low carbon steels containing 0.15%to 0.3% of carbon do not change of hardness number if packed carburizing. To increase thesurface hardness number after pack carburizing treatment is continued with further heattreatment: annealing, normalizing, hardening and tempering treatment.Considering that the base of the bamboo andong (Gigantochloa verticillata munro) is very potential as charcoal for carburizing media, research is needed to determine its characteristics. Also a little study on the use of bamboo charcoal as a carburizing agent.

II. EXPERIMENTAL PROCEDURE

2.1 The material

The specimen is low carbon steel AISI 1010. The content is shown in Tabel 1.Carburizing agent are Gigantochloa verticillata munro charcoal (GVMC) and $BaCO_3$, shown in Figure 1.

Tabel 1. The chemical composition of AISI 1010

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Elemen	Content (%)
Fe	99,16 – 99,62
Mn	0,30-0.60
S	≤0, 05
P	≤0, 040
C	0,080 – 0,13

Figure 1. The material used in this study

Bamboo $BACO_3$ GVMC

2.2 The research method

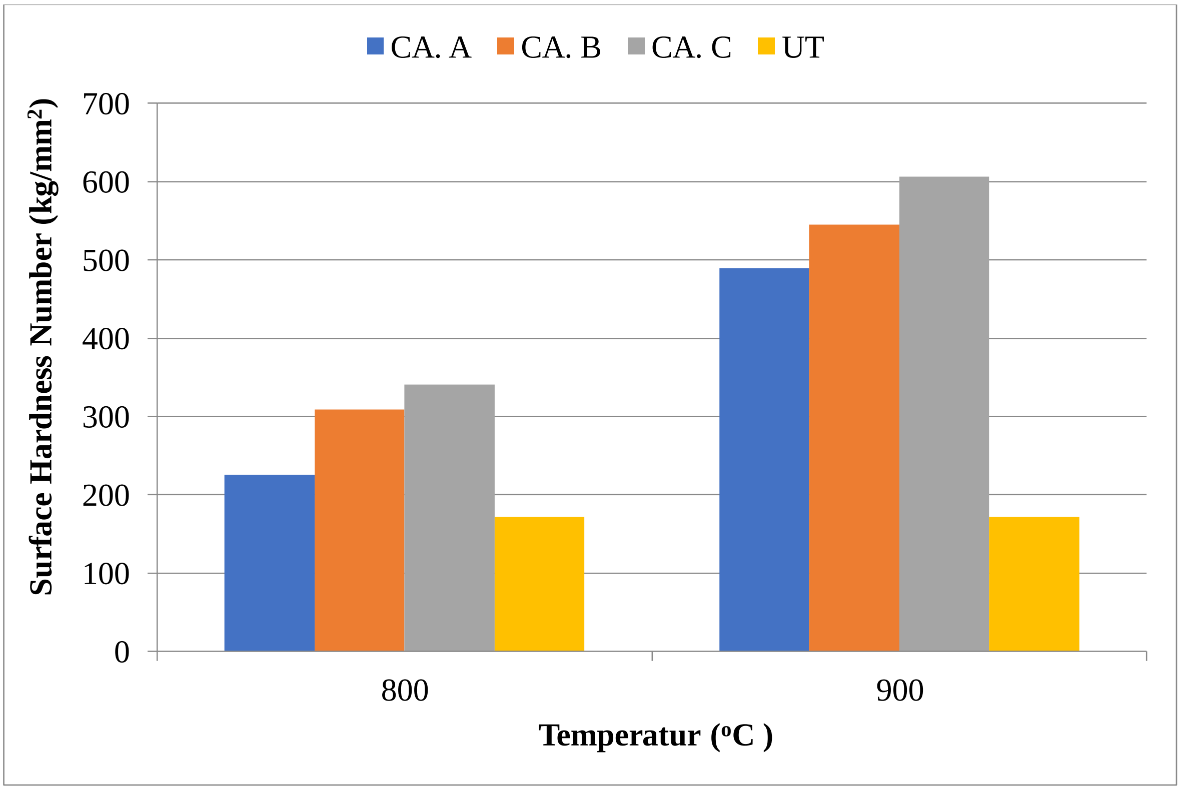
Pack Carburizing was carried out at various temperatures of 800 ºC and 900 ºC, with a soaking time of 3 hours. Carburizing agent in the form of a mixture of Gigantochloa verticillata munro charcoal (GVMC) and $BaCO_3$, shown in Figure 1. The composition carurizing agent are 90%:10%, 80%:20%, and 70%:30%. The test carried out is the Vickers hardness, tensile and impact test, sequentially according to standardASTM E92, ASTM E8 / E8M , ASTM E23. The type of bamboo used is Andong bamboo (Gigantochloa verticillata munro) which is cultivated in plantations in the North Lombok region, West Nusa Tenggara, Indonesia. GVMC was obtained from the base of the bamboo tree. thatplant age more than 5 years. GVMC is made by burning bamboo into charcoal then milled, sieved with a grain size of 200 mess GVMC serves as a carbon source, $BACO_3$ as an energizer serves to accelerate the reaction.

III. RESULTS AND DISCUSSIONS

3.1. The surface hardness number

The surface hardness test used Vickers method with load (P) of 60 Kg. The test results are shown in Figure 2. the lowest surface hardness number is 171,67 Kg/mm^2 on theinitial specimens(untreatment). The causing is, no additional carbon in materials surface. The highest of surface hardness number specimens is 606,36 Kg/mm^2, on pack carburizingat temperature 900 ºC, soaking time 3 hours and carburizing agent 70% GVMC and 30% $BaCO_3$. The increasing number of C atoms causes the surface hardness number of steel to increase. In this pack carburizing process, the greater the percentage of the enegizer ($BaCO_3$), the resulting surface hardness number increased, but for the percentage of carbon sources (GVMC) this is not the case. The percentage 70% GVMC causes the surface hardness number to be higher than the percentage80% and 90% GVMC, is similar to thediscoveries of ward, (Fahriadi, 2003) where he found thatthe tensile strength of carburized samples of some steel grades were some increaced.

Figure 2. The surface hardness number

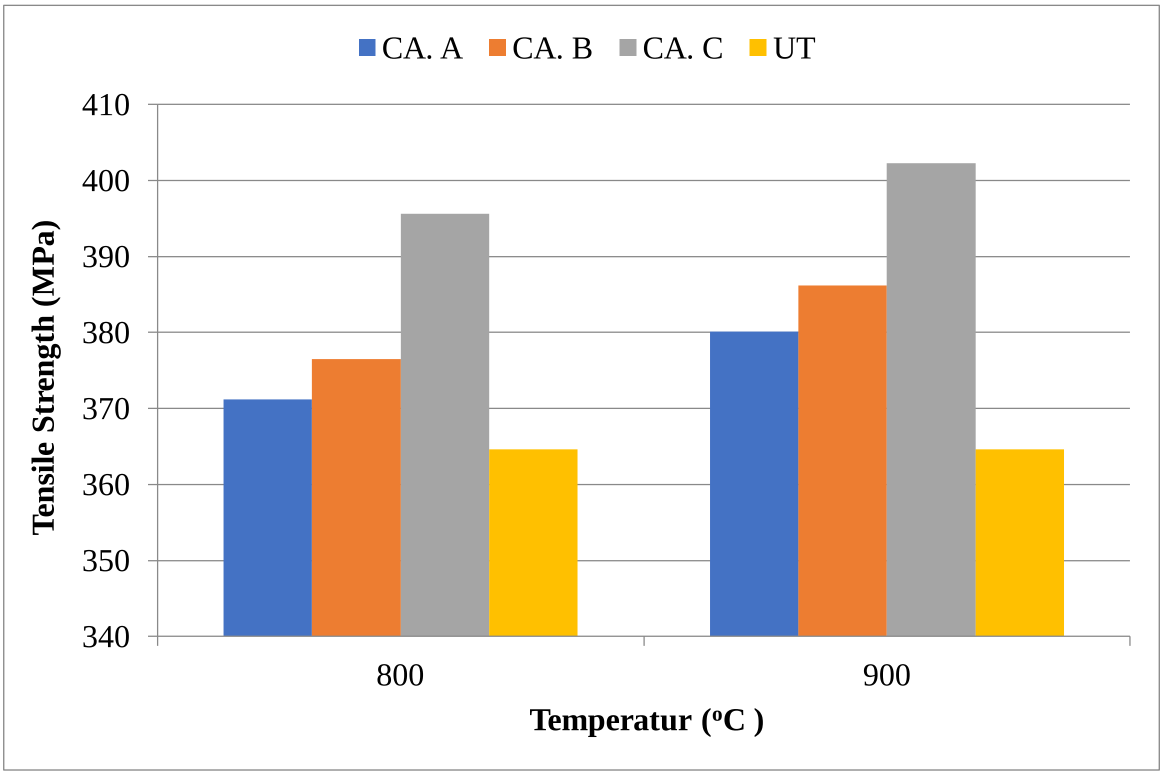


3.2 The tensile strength of specimens

Figure 3. shows the tensile strength of the specimen after pack carburizing treatment.In Figure 3, it is observed that for the samples treated pack carburizing at soaking time 3 hours, the tensile strength increases with increase in the carburizing temperature and percentage of $BaCO_3$ in the carburizing agent.The maximum value of 402,3 MPa at temperature 900 °C and content of$BaCO_3$ in the carburizing agent 30% wt. For the lowerpercentage of BaCO3 in carburizing agent ($BaCO_3$ 10% wt and 20% wt), the tensile strengthinitially decreased 380,1 MPa and 386,2 MPa. The trend of changes in tensile strength is the same as changes that occur in the surface hardness number.

The highest tensile strength at pack carbrizing temperature of 800 ºC, is 395,6 MPa at content of$BaCO_3$ in the carburizing agent 30% wt. So the tensile strength of the specimen is lower than that of pack carbrizing at temperature 900 ºC , even though the $BaCO_3$ content in the carburizing agent is the same.

Figure 3. The tensile strength of specimens

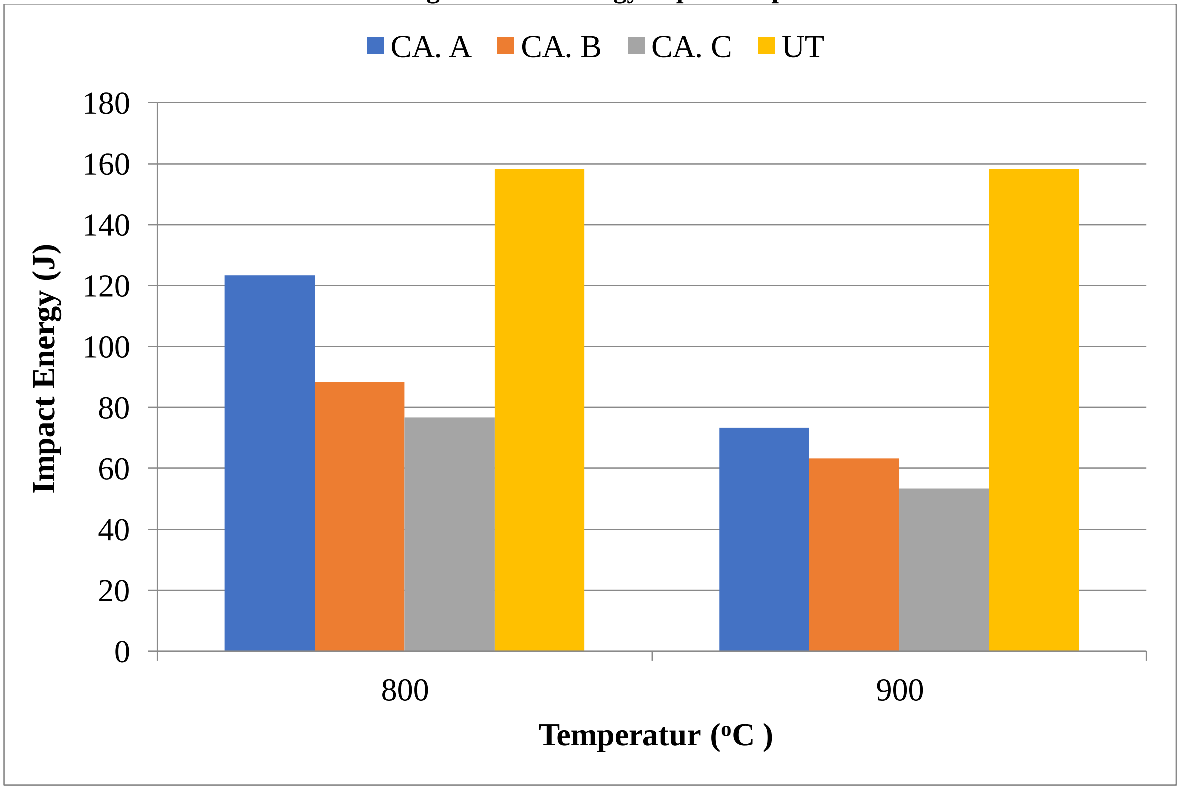


3.3 The energy impact of specimens

From Figure 4, it is observed that the absorbed (impact) energy increases with decreasein the pack carburizing temperature and percentage of $BaCO_3$ in the carburizing agent.The maximum value of 123,33 J at temperature 800 °C and content of$BaCO_3$ in the carburizing agent 10% wt. For the higherrpercentage of $BaCO_3$ in carburizing agent ($BaCO_3$ 20% wt and 30% wt), the energy impact initially decreased 88,33 J and 76,66 J. The trend of changes in tensile strength is the different that occur in the surface hardness number and tensile strength.

The energy impact at pack carbrizing temperature of 900 ºC, is 73,33 J at content of$BaCO_3$ in the carburizing agent 10% wt. So the energy impact of the specimen is lower than that of pack carbrizing at temperature 800 ºC, even though the $BaCO_3$ content in the carburizing agent is the same. In general, the ductility of the specimen decreases, after pack carbinzing treatment, in proportion to the increase in temperature pack carburizing and content of$BaCO_3$ in the carburizing agent, a similar result was arrived at by some researcher (Aramid, 2009) who studied the mechanical properties of mild steel using activated carbon as carburizing agent, subjected to pack carburizing.

Figure 4. The energy impact of specimens



IV. CONCLUSION

From data analysis and discussion that has been done, the conclusion are the pack carburizing treatment affected the surface hardness number,tensile strength and energy impact of the low carbon steel AISI 1010. The greater of surface hardness number specimens is 606,36 Kg/mm^2, tensile srength402,3 MPa on pack carburizingat temperature 900 °C, soaking time 3 hours and carburizing agent 70% GVMC and 30% $BaCO_3$. But the The maximum value of energy impact is 123,33 J at temperature 800 °C and content of$BaCO_3$ in the carburizing agent 10% wt. In general, the surface hardness number and tensle strength increased, but the ductility of the specimen decreases, after pack carbinzing treatment, in proportion to the increase in temperature pack carburizing and content of$BaCO_3$ in the carburizing agent.

Conflict of interest

There is no conflict to disclose.

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