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Research Inveny: International Journal of Engineering And Science Vol.11, Issue 9 (September 2021), PP 45-50
 Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinveny.com Study Of The Effect Carburizing Agent Gigantochloa Verticillata Munro Charcoal-Barium Carbonat On Pack Carburizing Low Carbon Steel *Sujita Darmo1, Rudy Sutanto1 1Department of Mechanical Engineering, Faculty Engineering Mataram University, Majapahit Street 62, Mataram 63185, Indonesia. 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 800°C and 900°C, with a soaking time of 3 hours. Carburizing agent in the form of a mixture ofGigantochloa verticillata munrocharcoal (GVMC) and BaCO₃, 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/mm², tensile strength 496,3 MPa on Pack Carburizing with temerature 900°C, composition Carburizing agent GVMC 70% and BaCO₃ 30%., but the lowest impact energy is53,33 J.The use of carburizing agent GVMC charcoal and BaCO₃ 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, BaCO₃, 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 and energizer. To speed up the process of carburizing added barium carbonate (BaCO_3), sodium carbonate (NaCO_3) or calcium carbonate (CaCO_3). All three materials serve as an energizer 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 carbon steel by a pack carburizing process. It has been done in the temperature 850 °C, 900 °C and 950 °C, for 15 and 30 minutes at this soaking temperature then have been cooled. The result temperature and soaking time of carburizing influenced for mechanical property of a specimen. The studies (Aramide, 2010) have been done by using an alternative carburizing agent like that bamboo charcoal, pulverized cow bone, kernel shell charcoal. Oluwafemi, 2015 have studied the influence of temperature and soaking time of pack carburizing process followed by quenching process with oil and tempering to impact toughness mild steel. Saini, (2012) have conducted research on the fatigue propagation 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 the surface hardness number after pack carburizing treatment is continued with further heat treatment: 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. Element Content (%) Fe 99,16 – 99,62 Mn 0,30-0,60 S $\leq 0,05$ P $\leq 0,040$ 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 °C and 900 °C, 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 carburizing agent are 90%:10%, 80%:20%, and 70%:30%. The test carried out is the Vickers hardness, tensile and impact test, sequentially according to standard ASTM 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 that plant age more than 5 years. GVMC is made by burning bamboo into charcoal then milled, sieved with a grain size of 200 mesh 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/mm² on the initial specimens (untreatment). The causing is, no additional carbon in materials surface. The highest of surface hardness number specimens is 606,36 Kg/mm², on pack carburizing at temperature 900 °C, soaking time 3 hours

and carburizing agent 70% GVMC and 30% BaCO₃. 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 energizer (BaCO₃), 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 percentage 80% and 90% GVMC, is similar to the discoveries of Ward, (Fahriadi, 2003) where he found that the tensile strength of carburized samples of some steel grades were some increased. Figure 2. The surface hardness number Surface Hardness Number (kg/mm²) 700 600 500 400 300 200 100 0 CA. A CA. B CA. C UT 800 900 Temperatur (oC) 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 BaCO₃ in the carburizing agent](#). The maximum value of 402,3 MPa at temperature 900 °C and content of BaCO₃ in the carburizing agent 30% wt. For the lower percentage of BaCO₃ in carburizing agent (BaCO₃ 10% wt and 20% wt), the tensile strength initially 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 carburizing temperature of 800 °C, is 395,6 MPa at content of BaCO₃ in the carburizing agent 30% wt. So [the tensile strength of the specimen is lower than that of](#) pack carburizing at temperature 900 °C, even though the BaCO₃ content in the carburizing agent is the same. Figure 3. The tensile strength of specimens 410 400 T ensile Strength (MPa) 390 380 370 360 350 340 CA. A CA. B CA. C UT 800 900 Temperatur (oC) 3.3

The energy impact of specimens From Figure 4, it is observed that the absorbed (impact) energy increases with decrease in the pack carburizing temperature and percentage of BaCO₃ in the carburizing agent. The maximum value of 123,33 J at temperature 800 °C and content of BaCO₃ in the carburizing agent 10% wt. For the higher percentage of BaCO₃ in carburizing agent (BaCO₃ 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 carburizing temperature of 900 °C, is 73,33 J at content of BaCO₃ in the carburizing agent 10% wt. So the energy impact of the specimen is lower than that of pack carburizing at temperature 800 °C, even though the BaCO₃ content in the carburizing agent is the same. In general, the ductility of the specimen decreases, after pack carburizing treatment, in proportion to the increase in temperature pack carburizing and content of BaCO₃ 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. [180 160 140 Impact Energy \(J\) 120 100 80 60 40 20 0](#) Figure 4. The energy impact of specimens CA. A CA. B CA. C UT 800 900 Temperatur (oC) 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/mm², tensile strength 402,3 MPa on pack carburizing at temperature 900 °C, soaking time 3 hours and carburizing agent 70% GVMC and 30% BaCO₃. But the The maximum value of energy impact is 123,33 J at temperature 800 °C and content of BaCO₃ in the carburizing agent 10% wt. In general, the surface hardness number and tensile strength increased, but the ductility of the specimen decreases, after pack carburizing treatment, in proportion to the increase in temperature pack carburizing and content of BaCO₃ in the carburizing agent. Conflict of interest There is no conflict to disclose. ACKNOWLEDGEMENT The authors thank Prof. Rudy Soenoko, Prof. Wahyono Suprpto are acknowledged for invaluable endless collaboration. [Prof. I.G.N Wardhana Director Postgraduated Doctor Mechanical Engineering Program Brawijaya University permission to use of laboratory and other resource materials](#) REFERENCES [1]. Ahmad, J. K. Carburizing of Steel. (2015). International Journal of Materials Science and Applications, . 4(2), 11. <https://doi.org/10.11648/j.ijmsa.s.2015040201.13>. [2]. Fatai O. A.,

