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International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) ISSN (P): 2249–6890; ISSN (E): 2249–8001 Vol. 10, Issue 2, Apr 2020, 1307–1316 © TJPRC Pvt. Ltd. THE INFLUENCE OF GRAIN SIZE CORN COB CHARCOAL ON SURFACE HARDNESS OF PACK CARBURIZING MILD STEEL SS400 SINAREP SINAREP & SUJITA DARMO Lecturer, Department of Mechanical Engineering, Mataram University, Mataram, Nusa Tenggara Barat, Indonesia ABSTRACT This work examines the effect of grain size on the surface hardness of pack carburizing mild steel. The pack carburizing procedure aims to add carbon into surface of speciments (mild steel SS400). The carbon source commonly used in previous researches is charcoal teak, coconut shell charcoal, bamboo charcoal and palm cernel shell charcoal. The corn cob charcoal has not been used in previous studies. In the study, used corncob charcoal with a variety of grain sizes, A carburizer composed of corn cob charcoal has been used for study together with barium carbonate (BaCO3) as energizer. The procedure was performed at carburizing temperatures of 900 oC and soakng period of 5 hours per day. Hardness evaluation was conducted in the metal samples. The outcome of the analysis demonstrated that surface hardness quantity of the light steel enhanced with a sway of grain dimensions of corn cob charcoal. The best package carburizing impact was attained in wheat cob charcoal of 150 μm grain dimensions. KEYWORDS: Mild Steel SS400, Pack Carburizing, Grain Size, Surface Hardness Number, Carburizing Time & Soaking Time Received: Dec 25, 2019; Accepted: Jan 15, 2020; Published: Apr 10, 2020; Paper Id.: IJMPERDAPR2020125 1. INTRODUCTION The carbon content in the steel structure will affect the hardability. The process of increasing hardness number for medium and high carbon steels is carried out by carburizing heat treatment. However, not all types of steel can be hardened in this way. Hardening by carburizing may only be conducted on steel with carbon content above 0.35%. Steel with carbon content below 0.35%, must go through the process of adding carbon [3]. Mild steel SS400 has good workability among other steel classes [2]. Its application area is in the parts of production machine such as gears, locks, pinions, hand tools, shafts, agricultural equipment. The price is cheap and it can be manufactured with less effort [3]. These elements need mechanical components of both impact strength, tensile strength and hardness to get secure and wear resistance functions. The quick penetration of an element in the steel surface may be successful only if the component diffuses interstitially. After diffusion, the components improve surface hardness by simply forming interstitial carbides, nitrides, or borids based on the kind of diffusion atoms [4]. Pack carburizing is one method used to add the carbon content in the steel using solid media [1]. Over the time, it performed by packaging the very low carbon iron components from charcoal , and then increased the temperature of this bunch into red heat for many hours. The consequent interstitial diffusion is more difficult compared to the bottom stuff, which enriches resistance with no diminishing durability [5]. Optimum structural substance is a massive concern in producing environments, in which large performance in mechanical properties like durability and hardness is in large demand [6]. An increase in concentration of carbon monoxide in austenite Original Article before quenching through hardening heat treatment contributes to a rise in hardness as well as additional mechanical properties of steels [6,7], throughout the transformation from austenite into martensite, whereas the core stays soft and demanding since a ferrite or pearlitic structure [8,9]. The potential of using coconut shell charcoal, bamboo charcoal and palm cernel shell charcoal as carburizer in carburized steel was investigated [10]. From the results, it was found that the addition of BaCO3 to charcoal generated a substantial gain in the carburization speed, hardness and tensile strength of carburized steel [11-13]. As the outcome, combined 70% burden of charcoal and 30 percent of BaCO3 because carburizerr, providing comparative efficacy of 72.5 percent. But, there is a limited study on the impact of grain size of charcoal because carburized on the surface hardness number of carburized steel. The study on metals heat treatment parameters has gained attention for some years [14-17]. The controlling parameters in carburization is a complex problem, but there has been relatively little work on process variables during the surface hardening process [18-20]. The important parameters influencing in pack carburizing were the carburizing temperature, carburizing time, source of quenching media and carbon potential [21-22]. The research is aimed at determining the possible usage of corn cob charcoal in mixture of Barium Carbonate (BaCO3) as steel energizer and the influence of charcoal grain sizes on the surface hardness number of pack carburizing mild steel SS400. 2. EXPERIMENTAL METHODOLOGY 2.1 Materials and Methods A flat bar of specimen (mild steel SS 400) was analyzed and obtained its chemical composition is given in Table 1. Table 1: Chemical Composition of Mild Steel SS 400 Steel C Si Mn P S Fe 0.17 % - 1.4 % 0.045 % 0,045 % 98.34 % The shape of the specimen is shown in Figure 1. Two basic material types used are: cylindrical specimens of 175 mm diameter, 100 mm thickness and cubes of 20 x 20 mm with 30 mm thickness. Figure 1: Specimens for Pack Carburizing Process. 2.2 Pack Carburizing Process Pack carburizing procedure was completed at a toaster. This CO reacts with the steel surface to form atomic carbon that divides the steel. The wealthy steel carburizing box has been charged to the furnace and allowed to heat in the temperatures of 900 °C. After the furnace temperatures reaches the necessary carburizing temperature, then it was subsequently carburizing in the temperature to the necessary time. The procedure for cooling and warming your specimen on the package carburizing procedure are revealed in Figure 0032. Temperature (0 C) Time [Hours] Figure 2: The Pack Carburizing Process for Specimen. 2.3 Hardness Number Test Figure 3: Location of Test Point and Surface Reduction. Vickers hardness test was performed on the bunch carburizing metal samples by utilizing a Matsuzawa Seiko Vickers micro hardness tester version MHT-1 using a Vickers diamond indenter The hardness of a sample is signaled with the penetration of the indenter in the stated sample and displaced from the system. 3. RESULTS AND DISCUSSIONS 3.1 Surface Hardness Number of Specimens before Pack Carburizing Process Figure 4: Surface Hardness Number Before Pack Carburizing Process. The test data using the micro Vickers hardness of raw material such as surface hardness is shown in Fig. 3. Prices rose at each measurement point. This measurement starts from the outer side with the distance to each point of 50 μm toward the inside. At each point difference in the value of hardness number is evident. Although different in hardness is noted, still there exists a correlation between these points. This is evident through the finding of a strong polynomial correlation line. (R arithmetic) of 0.995. The value indicates a high correlation at each point of measurement. Figure 5: Microstructure of Raw Material. The magnitude of hardness number at the depth of 50 μm is 146 $Kg.mm^{-2}$, hardness number at a depth of 300 μm is 150 $Kg.mm^{-2}$. The hardness number of all specimens is the same at a depth of 300 μm is shown in the Figure 5. 3.2 Hardness Number of Specimens after Pack Carburizing Process The result of hardness test of specimen which have done pack carburizing process, with variation of grain size of corncob charcoal is shown in Fig. 5. The result is contrary to the raw material. This difference is caused by the inclusion of carbon atoms into the steel structure. This event takes place continuously during the process of pack carburizing. Based on the image microstructure in Figure 6, it appears that carbon atoms have successfully diffused into SS400 steel structures. This bond forms a new cementite, the growth of cementite mixes with ferrit into pearlit crystals. Figure 6: Surface Hardness Number After Pack Carburizing Process. Figure 7: Microstructure Specimens A. These results indicate that the outside is more soft than the insideThe changes that occur due to heat during the carburizing process on the specimen have occurred an annealing process, and resulted in a decline in hardness number. Figure 8: Microstructure Specimens B. SCOPUS Indexed Journal These results show that there is a change in surface hardness on the edge and inside. The correlation of the measurement point with the value of hardness has a high correlation. At a distance measurement, point is 50 μm has the highest hardness number 206 Kg.mm. Figure 9: Micro Structure Specimen C. Based on Figure 9, the layer outer surface has a high hardness due to the build up of atoms more and deeper carbon have almost the same surface hardness number. Figure 10: Microstructure Specimens D. 4. CONCLUSIONS Based on the analysis results, it is concluded as follows: The size grain of corn cob charcoal used in pack carburizing process affects the surface hardness number of specimens. The use of 150 μm of corncobs gives the highest hardness as 206 $Kg.mm^{-2}$ at the depth 50 μm. The diffusion of carbon occurs only at the depth less than 300 μm REFERENCES 1. Khammas Hussein, A., Kais Abbas, L., & Kareem Hameed, *Asraa. (2018). Investigation Corrosion and Mechanical Properties of Carburized Low Carbon Steel. Journal of Engineering and Sustainable Development, 22(02), 8–17. doi:10.31272/jeasd.2018.2.79 2. Kandrotaitė Janutienė, R. (2013). Investigation of Hardening and Tempering Deformations of Carburized Low Alloy Steel. Mechanika, 19(2). doi:10.5755/j01.mech.19.2.4155 3. 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Prasad Sakat, Adwait Verulkar, Darshan Bamb & Santosh Joshi, “A Case Study on Response of Alloy Gear Steels to Case Carburizing and It’s Effect on Weight Optimization of a Transmission System”, IJMPERD, Vol. 7, Issue 2, pp. 47-56 AUTHORS PROFILE Sinarep Sinarep, was born in Mataram, December, 31st 1972. He started his education in a elementary school, SDN 1 Mataram on 1984, continued Junior high school, SMPN Mataram in 1987, and senior high school, SMAN 1 Mataram in 1990. He obtained Bachelor of Engineering from Mechanical Eng. Dept. Gajah Mada University, Yogyakarta in 1995 and received Master degree in Engineering from Mechanical Eng. Dept. Gajah Mada University, Yogyakarta, in 2001. He has been working as a lecturer in the Department of Mechanical Engineering, Universitas Mataram since 1997. He is the author of articles related to topic arenitriding, surface treatment, corrosion, metal casting, Engineering Journal, IJAER, IJETT. 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Expert Staff Mechanical Engineering of Association of Indonesian Construction Experts (ATAKI) branch of West Nusa Tenggara city. 1308 Sinarep Sinarep & Sujita Darmo The Influence of Grain Size Corn Cob Charcoal on Surface Hardness of Pack Carburizing Mild Steel SS400 1309 1310 Sinarep Sinarep & Sujita Darmo The Influence of Grain Size Corn Cob Charcoal on Surface Hardness of Pack Carburizing Mild Steel SS400 1311 1312 Sinarep Sinarep & Sujita Darmo The Influence of Grain Size Corn Cob Charcoal on Surface Hardness of Pack Carburizing Mild Steel SS400 1313 1314 Sinarep Sinarep & Sujita Darmo The Influence of Grain Size Corn Cob Charcoal on Surface Hardness of Pack Carburizing Mild Steel SS400 1315 www.tjprc.org SCOPUS Indexed Journal editor@tjprc.org Impact Factor (JCC): 8.8746 SCOPUS Indexed Journal NAAS Rating: 3.11 www.tjprc.org SCOPUS Indexed Journal editor@tjprc.org Impact Factor (JCC): 8.8746 SCOPUS Indexed Journal NAAS Rating: 3.11 www.tjprc.org editor@tjprc.org Impact Factor (JCC): 8.8746 SCOPUS Indexed Journal NAAS Rating: 3.11 www.tjprc.org SCOPUS Indexed Journal editor@tjprc.org Impact Factor (JCC): 8.8746 SCOPUS Indexed Journal NAAS Rating: 3.11 www.tjprc.org SCOPUS Indexed Journal editor@tjprc.org