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International Journal of Mechanical Engineering and Technology (IJMET) Volume 9, Issue 6, June 2018, pp. 443–449, Article ID: IJMET_09_06_050 Available online at http://www.iaeme.com/ijmet/issues.asp?JType=IJMET&VType=9&IType=6 ISSN Print: 0976-6340 and ISSN Online: 0976-6359 © IAEME Publication Scopus Indexed STUDY PACK CARBURIZING FOR SUBSOIL PLOW CHISEL WITH ALTERNATIVE CARBURIZER MEDIA CORN COB CHARCOAL– PICTADA MAXIMA SHELL POWDER Sujita Darmo Department of Mechanical Engineering, Mataram University, Mataram, Indonesia Rudy Soenoko, Eko Siswanto and Teguh Dwi Widodo Department of Mechanical Engineering, Brawijaya University, Malang, Indonesia. ABSTRACT Longevity of tillage tools, mainly depends on their parts' material wear resistance and strength. The article summarizes information about steel physically-mechanical of subsoil plow chisel that are most useful for soil tillage. The chisel is given heat treatment pack carburizing process with media carburizer corn cob charcoal and pictada maxima shell powder. The physical properties of chisels from various competitions of media carburizer are analyzed. The findings of this study indicated that pack carburizing process with carburizer media Corn Cob Charcoal – Pictada Maxima Shell Powder (PMSP) can increase the hardness number and the carburizing layer from Subsoil plow Chisel. The highest hardness number rate is 662 Kg/mm2, and the effective depth of the maximum carburizing layer reaches of 372 μm at carburizing temperature 950 ° C and percentage of PMSP 30% Keywords: chisel, subsoil plow, pack carburizing, hardness number, carburizer media Cite this Article: Sujita Darmo, Rudy Soenoko, Eko Siswanto and Teguh Dwi Widodo, Study Pack Carburizing for Subsoil Plow Chisel with Alternative Carburizer Media Corn Cob Charcoal–Pictada Maxima Shell Powder, International Journal of Mechanical Engineering and Technology, 9(6), 2018, pp. 443–449 http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=9&IType=6 1. INTRODUCTION Surface heat treatment of steel components is one of the primary aspects of mechanical engineering. Based on the chemical composition of the given material, it is possible to achieve optimal mechanical properties and durability of replaceable parts [1]. Depending on the variety and quantity of machinery in use in an agricultural enterprise, appropriate heat treatment can significantly reduce operating costs. Mechanical engineers of agricultural machines have always been seeking for techniques increasing the efficiency of tillage tools, saving energy and decreasing the expenses of tillage operations [4]. Although the wear of tillage instruments have been introduced as the main effective factor regarding energy consumption in agricultural sector, only a few studies have been done on the hardeness number of chisel subsoil plow dealing with soil in agricultural sector [5] [15-16]. Studies on wear indicate that damages resulting from the wear of instruments and engineering parts have been calculated to be 1%, 2.5%, and 1.5% of the gross national production in England, Germany, and the United States, respectively [17-18]. Studies carried out in Turkey indicate that the wear rate is (90 – 210 gr) in moldboard plow blades, (60 - 120 gr) in cultivator sweeps, and (23 – 40 gr) in Chisel plow blades per hectare [2]. A great number of researchers have investigated the effect of using steel alloys, cast iron with hard chrome covering or nickel and also surface coverings such as aluminum, tungsten carbide, cobalt, chrome as well as nitrification in order to protect metals against the wear [6-9] used three types of rotary tiller blades in order to determine the effect of hardened covering of blades and found that blades with aluminum covering cannot provide enough resistance on blade edges, whereas blades with cobalt and tungsten coverings have enough resistance around 43 times more than the resistance created by the blades with aluminum covering. Currently, polymer particle composites are coming into widespread use. These composites are applied directly onto the most abrasively stressed parts of the ploughing unit [13-14]. A significant advantage of these materials is above all the possibility of combining them with other steel particles, thus creating a composite coating with excellent toughness and abrasive resistance [10-11]. Tests to increase the durability of new components were performed also on ploughing units where the weld deposits of zig zag strips were created directly on the plough blade diagonally to the direction of travel. The advantage of this arrangement is the creation of a plow chisel effect and thus reducing the tensile resistance of the machine as a whole [12- 14]. However, long term use of these blades carries the risk of creating saw-like shapes also on the subsequent parts of the device, which would lead to their faster abrasive degradation. For this reason, it is necessary to choose a material that is homogenous in the entirety of the cross-section and optimize its heat treatment. This study aims at examining the mechanical properties of subsoil plow chisel after pack carburizing with alternative carburizer media corn cob charcoal – pictada maxima shell powder. Besides, determining the optimal composition of carburizer media to produce the best mechanical properties 2. MATERIALS AND EXPERIMENTAL PROCEDURES 2.1. Materials Carburizing This study focused on SS400 steel, a structural steel used widely for subsoil plow chisel parts where hardened case is desired for increase hardness number and wear resistance. This particular steel is very commonly used in gears, ring gears, shafts and crank shafts. The chemical composition of SS400 steel is given in Table 1. For this study, specimens were cut from a long bar subsoil plow chisel parts. The specimen is given in Fig.1. Both surfaces of specimens were CNC milled followed by surface grinding to minimize surface roughness prior to heat treatment (pack carburizing). The specimens are arranged in the carburizing box and then put in to the electric furnace for heating is given Fig.3. It is made of low carbon steel with thickness 5 mm, length 100 mm, width 100 mm and height 100 mm. The specimens were carburized at 8500 C, 9000 C, 9500 C for 3 hours with with carburizer media corn cob charcoal and pictada maxima shell powder of 10%, 20% and 30% Table 1 Chemical composition [weight %] C Mn P S Fe 0.17 1.4 0.045 0.045 98.34 Figure 1 Dimension of the specimen 2.2. Experimental Procedures The specimens were carburized at were carburized at 8500 C, 9000 C, 9500 C for 3 hours with with media carburizer corn cob charcoal and pictada maxima shell powder of 10%, 20% and 30% . The carburizer media is given in Fig.2 Figure 2 Media carburizer Figure 3 Pack carburizing process After pack carburizing process, followed by hardness testing process and microstructural observation in conforming to the ASTM E 3 standard. Micro Hardness Test uses, Vickers scale with 1 Kg load and test time for 10 seconds. The specimens have been machined at the edges with 120 number abrasive paper until 1000 number and polished until shiny. The test is started from the outer edge with the distance 50μm and then the test is done with a distance of 100 μm. The microstructure observation was done by using Scanning Elektron Microscope (SEM) 3. RESULTS AND DISCUSSION 3.1. Hardness Number of Carburizing Layer Pack the result of hardness number test for raw materials were 130 Kg/mm2. Test results of hardness number after pack carburizing process at temperature 8500C, 9000C, 9500C carburizing time 3 hours with addition pictada maxima shell powder (PMSP) as energizer : 10, 20, 30 of weight percentage powder is given in Fig 4 until Fig 6. In Figure 4 it is shown that the carburizing pack process at 8500C temperatures can increase the hardness number of the specimen surface. The surface hardness number of the specimens is influenced by the addition of energizer. The magnitude of hardness number with the addition of 10%, 20%, 30% (weight percentage PMSP) of is 275 Kg/mm2, 325 Kg/mm2, 410 Kg/mm2. There was an increase of 111 %, 150 % and 215 % compared to the raw material Figure 4 Hardness number of the carburizing layer at temperature of 8500C and carburizing time 3 hours. Figure 5 Hardness number of the carburizing layer at temperature of 9000C and carburizing time 3 hours The surface hardness number results pack carburizing at temperatures of 9000 C, are 350 Kg/mm2, 525 Kg/mm2, and 595 Kg/mm2 is given in Fig.5, respectively, with an increase in addition PMSP as enegizer. The percentage increase in surface hardness number compared to the raw materials 169%, 303% and 357%. Figure 6 Hardness number of the carburizing layer at temperature of 9500C and carburizing time 3 hours The surface hardness number results pack carburizing at temperatures of 9500 C, are 384 Kg/mm2, 615 Kg/mm2, and 662 Kg/mm2 is given in Fig.6, respectively with an increase in addition PMSP as enegizer. The percentage increase in surface hardness number Compared to the raw materials 195%, 373% and 409%. 3.2. Thickness of Carburizing Layer The thickness of the carburizing layer can be shown from the results of the hardness number test. It is indicated by the position where the magnitude of the hardness number does not change. Through interpolation of hardness test results then suspected effective thickness of the Carburizing Layer temperatures of 8500C, 9000C, 9500C were 57.8 μm, 135 μm, and 372 μm, respectively the total of the carburation layer temperature of 8500C, 9000C, 9500C were 450μm,550μm and 650μm. Increased hardness of the carburizing layer occurs due to structural changes into martensite due to rapid cooling of high temperatures (austenite temperature) to room temperature. Martensite is a very hard structure where the carbon previously in the solid solution in the austenite forms a solution in a new phase, but sometimes there is a small amount of unreformed austenite to form martensite, called retained austenite. Specimens with retained austenite of 32% and 35% in carburizing layer showed relatively high hardness. 3.3. Microstructure of Carburizing Layer Results from microstructural observation of carburizing layer for 3 hours at 8500C, 9000C, 9500C after pack carburizing process is given in Fig. 7,8, and 9. Figure 7 Carburizing Process Pack Results on temperature 8500C, 9000C, 9500C, addition of 30% energizer PMSP The total thickness of the carburizing layer is given in Fig.7 and Fig, 8. The carburizing laye rtends to increase as the carburizing temperature increases and percentage of PMSP. The thickness of carburizing layer appears through the discoloration of the dark (high carbon) with the pearlite structure becoming lighter with the ferrite structure, is given in Fig.9. Figure 8 Carburizing Layer on temperature 8500C, 9000C, 9500C, the addition of 30% energizer PMSP Figure 9 Carburizing layer microstructure. a. Raw material before pack carburizing. b. Pack carburizing at temperature 8500C c. Pack Carburizing at temperature 9000C d. Pack Carburizing at temperature 9500C (with addition of 30% energizer PMSP) From Figure 9 is given that ferrite (light-colored and white) and martensit (dark and black) are larger in size than carbides. The carbide will enlarge in case of heat treatment of the workpiece (low carbon steel). The addition of PMSP with a concentration of 30% (% weight) as an energizer accelerates the process of carbon diffusion into the steel so as to form more martensit structures. So the specimen becomes harder than before and also influenced by the rapid cooling process so that it can change the physical properties of steel. 4. CONCLUSION The findings of this study indicated that pack carburizing process with carburizer media corn cob charcoal – pictada maxima shell powder (PMSPp) can increase the hardness number and the carburizing layer from subsoil plow chisel. As the result the rise in carburizing temperature and the percentage of PMSP can increase the hardness number and thickness of the carburizing layer. The highest hardness number rate is 662 kg/mm2, and the effective depth of the carburizing layer reaches a maximum of 372 μm at carburizing temperature 9500C and percentage of PMSP 30% REFERENCES [1] Stachowiak, G. W., Batchelor, A. W. Engineering Tribology, 3rd Edition. Burlington Elsevier Butterworth-Heinemann, 2005. [2] Bayhan Y. Reduction of Wear Via Hardfacing of Chisel Ploughshare, Tribology International, issue 39, 2006, pp. 570-574. [3] Hatirli S, Ozkan B, Fert C. Energy Inputs and Crop Yield Relationship in Greenhouse Tomato Production. Renewable Energy, issue 31, 2006, pp.427-438. [4] Mouazcn A.M. Smoldcrs S. Mcrcsa F. Gcbrcgziabhcr S. Nysscn J. Vcrplanckc H. Dcckcrs J. Ramon H. And Bacrdcmacker J. D. Improving Animal Drawn Tillage System in Ethiopian Highlands, Soil and Tillage Research., issue 95, 2007, pp.218-23. 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