Study of Mechanical Properties of Palm Oil Pulp Sheet based Empty Fruit Bunches

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Abstract: Nowadays, cellulose derived from natural wood still dominates the raw materials for pulp and paper manufacturing in Indonesia. As a result, there are concerns that the rate of deforestation will continue to increase. This study aims to examine the use of oil palm empty bunches (OPEFB) in paper making. The results of the mechanical pulping show that the steam process will open larger OPEFB pores so that it contributes to lowering the crack index value even though it makes a good contribution to the Bendtsen roughness value. The yield from this OPEFB pulp can be used as a base pulp in duplex cardboard making.

1 INTRODUCTION

Palm oil is a commodity in the plantation sector which is growing rapidly in Indonesia. However, the palm oil processing process also produces waste, both solid waste and liquid waste. One of the solid wastes produced is empty fruit bunches. Oil palm empty fruit bunches (OPEFB) have considerable potential to be reused. The lignocellulose content in OPEFB can be used as a raw material for making paper. Currently, cellulose derived from natural wood still dominates the raw material for pulp and paper manufacture in Indonesia. As a result, it is feared that the rate of deforestation will continue to increase. This study aims to examine the use of oil palm empty fruit bunches (OPEFB) in paper making. The results showed that the mass density of OPEFB varied around 0.7 – 1.55 g/cm^3 and had a fiber angle of 46° (Mohamad et al, 1985; Law and Jiang, 2001; Bismarck, 2005; Amar, 2005; Zulkifli et al, 2009). ; Khalil et al, 2008; Hassan et al, 2010). According to Hassan et al (2010) the length of this EFB fiber is between hardwood and softwood. The higher the length of the fiber to the diameter of the fiber, the higher the value of felting power. Microfibril angle, cell dimensions and fiber chemical composition are important variables that will determine the overall properties of a fiber (John and Thomas, 2008). The value of the flexibility ratio will affect the final properties of the composite material. Fibers with thick cell walls have high resistance to collapse and do not contribute to inter-fiber bonding (Reddy and Yang, 2005). Although a higher Muhlstep ratio value indicates a lower quality class, the high Muhlstep ratio is an indication of a large fiber surface area so that the potential for bonding between fibers is also greater when making paper sheets. The lower the Runkel ratio value, the thinner the cell wall and the larger the fiber diameter. On the other hand, the thicker the cell wall, the more bulky sheets will be produced with low tensile, bursting and tear resistance (Mishra et al, 2004). Therefore, OPEFB pulp fiber has the potential to be used as raw material for medium liner paper and molded pulp for both food packaging and other packaging materials such as electronic goods, etc. The mechanical properties of OPEFB are tensile strength of 50 – 400 MPa, Young's modulus of 0.57 – 9 GPa and break length of 2.5 – 18% (Sreekala et al, 2004; Bismarck, 2005; Kalam et al, 2005; Bakar et al, 2006).

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2 METHOD

The first stage is conditioning so that the water content is uniform. Furthermore, the determination of the chemical composition by means of OPEFB is powdered using a wiley mill, then filtered using a sieve shaker to obtain a powder that passes a 40 mesh sieve and is retained on a 60 mesh sieve. Analysis of chemical components was carried out according to the Indonesian National Standard (SNI), covering the levels of holocellulose, alpha cellulose, lignin, pentosan, ash, silicates, extractives (alcohol-benzene extract), solubility in cold water, hot water and 1% NaOH. Before making sheets, the pulp is decomposed using a disintegrator. After that, sheets were made and physical properties were tested for the pulp consisting of stiffness index, bursting index, tensile strength and roughness index. Furthermore, EFB is pulped mechanically using a Masher for 4 cycles using variations of 2.5% and 5% NaOH with varied operational times (short and long) and variations in the use of steam and without using steam. The OPEFB pulp was then refined, filtered, ground to 300 mL CSF and disintegrated to decompose the fibers and then the suspension was diluted to a consistency of 2.5%. After that it is formed into a pulp sheet).

3 RESULT AND DISCUSSION

In this study, OPEFB was pulped mechanically using Masher for 4 cycles using variations of 2.5% and 5% NaOH with varied operating times (short and long) and variations in the use of steam and without using steam. OPEFB pulp that has been produced mechanically using a masher was prepared as the basis for the manufacture of duplex paper in the next year's research phase. This pulp sheet is tested with parameters such as stiffness, pullout resistance, roughness and crack index. The first test parameter is stiffness. The stiffness parameter is needed to determine the potential of OPEFB as a raw material for making pulp. The higher the stiffness value, the better it is as a pulp raw material for duplex paper. However, a stiffness value that is too high will cause low bending resistance or poor creasing folding properties. However, the poor folding properties can be overcome by adding a paper coating or coating material in the next research stage. Figure 1 shows the highest stiffness in the mechanical pulping process using steam, 2.5% NaOH and a short processing time, namely the addition of NaOH in the 20 minute, then followed in the same process the addition of 2.5% NaOH in the 30 minute.

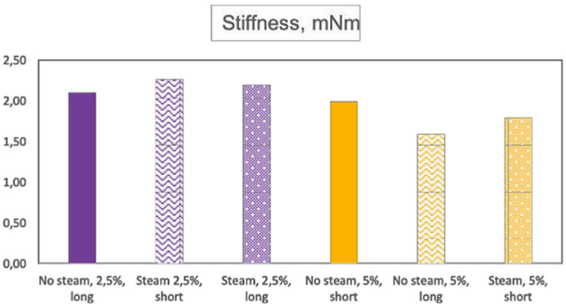

Figure 1: OPEFB mechanical pulp sheet stiffness.

Next is the pull out resistance test. The pullout resistance value was obtained by the IGT method. The value of pullout resistance is important to be tested because it will affect the use of the next duplex coating material. The IGT pullout resistance value for duplex paper according to SNI specification 123:2019 is at least 800 pm/s. All variations of the pulping process carried out in this study in Figure 2 show good pullout resistance rates, which are above 800 pm/s. The pulping process, both with 2.5% NaOH and 5% NaOH, both without using steam, showed the highest value for this pullout resistance parameter.

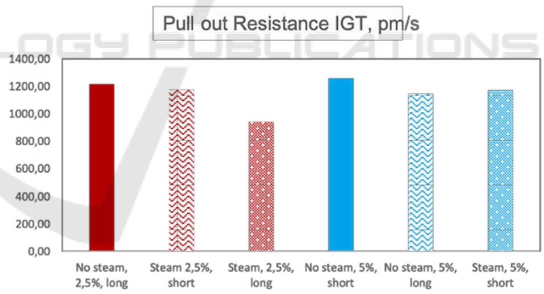

Figure 2: OPEFB mechanical pulp sheet pull out resistance.

Next test the Roughness parameter. The roughness value was tested by the Bendtsen method. This Bendtsen roughness value is not required for duplex paper but is required for medium liner paper. Generally, paper mills that produce duplex paper also use the same raw materials as medium liner paper production. This parameter is still needed because the OPEFB raw material is known to have a high roughness so that it will affect the value of water absorption and oil penetration. In SNI medium liner paper SNI 8053.1:2014, the Bendtsen roughness value is set to a maximum of 1500 mL/minute. Figure 3 shows the low Bendtsen roughness values found in the mechanical pulping process using 2.5% NaOH either with the help of steam or without steam, both in short and long processing times. The use of steam will open the pores of the OPEFB fiber surface so that it will absorb more air bubbles used in testing pulp sheets using the Bendtsen method.

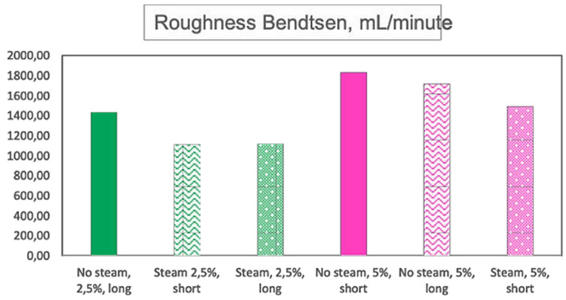

Figure 3: OPEFB mechanical pulp sheet roughness.

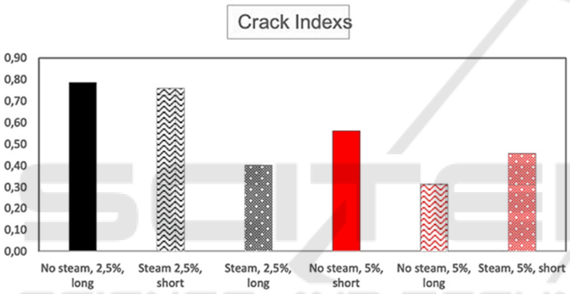

Figure 4: OPEFB mechanical pulp sheet crack index.

Finally, the OPEFB pulp sheets were tested for crack index. As a result, the crack index on the EFB pulp sheet in Figure 4 is quite low. The higher the crack index, the better the paper properties.

4 CONCLUSIONS

The results of mechanical pulping show that the steam process will open the OPEFB pores larger so that it contributes to lowering the crack index value even though it makes a good contribution to the Bendtsen roughness value. The results of this EFB pulp can be used as a base pulp in the manufacture of duplex cartons. Suggestions for the next stage of research, OPEFB pulp needs to be added with additives in the form of dry strength and wet strength to help increase the value of the crack index. In addition, coating materials also need to be added to help increase the value of folding or creasing.

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