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The Effect of Adding Plastic Bottle PET Waste in the Making of Sawdust Particleboard

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A B S T R A C T

One of the derivative products from wood processing materials is particle board made from sawmills waste. This research tries to examine experimentally, how the physical and mechanical behavior of particleboard if in its manufacture it is added with plastic beverage bottle waste made of polyethylene terephthalate (PET). This research was conducted with the aim of reusing used plastic bottles which could improve the physical and mechanical behavior of particleboard with the proportion of a mixture of sawdust and plastic bottles 50 : 50; 60 : 40; 70 : 30. PET measuring 1 cm x 5 cm is not used in the mixture, because the results are not good enough, then crushed PET is used, pressing temperature 200 ℃, pressing time 20 minutes, density of all test samples meet the standards, moisture content only C test samples meets the standards, water absorption are not required by the standard, swelling in thickness, samples of B and C tests which meets the standards are, MOE all test samples do not meet the standards, MOR all test samples meet the standards, internal bonding only test sample C meets the standards, screw holding power all test samples did not meet the standards.

Keywords:particleboard, PET, physical, mechanical, reuse

1. Introduction

West Kalimantan is one of the largest producers of processed wood products in Indonesia, one of the products of processed wood products is particleboard, which is the use of wood sawn residue and wood chips mixed with adhesive, then compacted under pressure, and heated to a high temperature, so that the resulting product is solid and strong, but relatively light. This particle board is an alternative material to substitute for plywood (multiplex) because multiplex requires logs, while particle board only utilizes wood processing waste, in addition to the weight of the multiplex which is heavier than particleboard.

To increase the durability of particleboard, it will usually be coated with paint or laminated with veneer with various motifs (decorative) to beautify and improve the quality of the outer surface, as well as increase the resistance of particleboard to weather (humidity) and water. Particleboard is now a material from the type of wood that is most widely used for the manufacture of water furniture because of its relatively cheap price and low weight, because water furniture tends to be moved around frequently.

Other advantages of particleboard compared to multiplex are its ability to withstand nails or screws, its ability to insulate heat (thermo) and sound (acoustics) which is good, so it is widely used for the manufacture of sound systems. In addition to these advantages, problems or weaknesses with moisture and water, a solution must be found, so this research was carried out, by adding waste plastic bottles made of polyethylene terephthalate (PET) for the manufacture of particleboard, with the hope that this plastic will melt and unite with sawdust when heated, and will form a layer that is more waterproof and more resistant to attack by insects such as termites.

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2. Materials and Methodology

2.1 Materials

Particleboard size : 30 cm x 30 cm x 1 cm
Density : 0,8 g/cm^3
UFadhesive (*UF*) : 11% (SC 52%)
Paraffin (*P*) : 1% (SC 52%)
Catalyst (*C*) : 0,1% (SC 52%)
Proportion of ingredients to make 1 piece of particleboard:

Oven dry weight	: UF	: Paraffin	: Catalyst	= Total
100	: 11	: 1	: 0,1	= 112,1

Materials requirements according to the following proportions:
Oven dry weight = length x width x thick x density = 30 cm x 30 cm x 1 cm x 0,8 g/cm^3= 720 g

$$S = \frac{100}{112,1} \times 720\ g = 642,28\ g$$

a. Sample 50% sawdust (S) : 50% PET

$$S_{50} = \frac{100}{112,1} \times 720\ g \times \frac{50}{100} = 321,14\ g$$

$$PET_{50} = \frac{100}{112,1} \times 720\ g \times \frac{50}{100} = 321,14\ g$$

$$UF_{52} = \frac{11}{112,1} \times 720\ g \times \frac{100}{52} = 135,87\ g$$

$$P_{52} = \frac{1}{112,1} \times 720\ g \times \frac{100}{52} = 12,35\ g$$

$$C_{52} = \frac{0,1}{112,1} \times 720\ g \times \frac{100}{52} = 1,23\ g$$

b. Sample 60% sawdust (S) : 40% PET

$$S_{60} = \frac{100}{112,1} \times 720\ g \times \frac{60}{100} = 385,37\ g$$

$$PET_{40} = \frac{100}{112,1} \times 720\ g \times \frac{40}{100} = 256,91$$

$$UF_{52} = \frac{11}{112,1} \times 720\ g \times \frac{100}{52} = 135,87\ g$$

$$P_{52} = \frac{1}{112,1} \times 720\ g \times \frac{100}{52} = 12,35\ g$$

$$C_{52} = \frac{0,1}{112,1} \times 720\ g \times \frac{100}{52} = 1,23\ g$$

c. Sample 70% sawdust (S) : 30% PET

$$S_{70} = \frac{100}{112,1} \times 720\ g \times \frac{70}{100} = 449,60\ g$$

$$PET_{30} = \frac{100}{112,1} \times 720\ g \times \frac{30}{100} = 192,69\ g$$

$$UF_{52} = \frac{11}{112,1} \times 720\ g \times \frac{100}{52} = 135,87\ g$$

$$P_{52} = \frac{1}{112,1} \times 720\ g \times \frac{100}{52} = 12,35\ g$$

$$K_{52} = \frac{0,1}{112,1} \times 720\ g \times \frac{100}{52} = 1,23\ g$$

2.2 Methodology

Particle board is made by pouring sawdust and PET into a plastic container, then stirred so that it is evenly distributed according to the proportions of the mixture above as many as 3 variants, namely 50: 50; 60 : 40; and 70 : 30, with a proportion of 11% UF adhesive (SC 52); paraffin 1% (SC 52); and 0.1% catalyst (SC 52), the amount of adhesive is the same for each variant. The sample that has been mixed evenly is then poured into the mold. The surface of the mixture is leveled with a steel ruler, then pressed with a hot packing press with a load of 25 kg/cm2, which is heated at a temperature of ±200 °C for 20 minutes, then the test sample is dried for 24 hours.

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The sample will be compared with the standard for testing the physical and mechanical properties of particleboard based on Indonesian standard SNI 03-2105-2006 and Japan standard JIS A 5908:2003 as listed in the following table:

Table 1 Physical and mechanical properties of particleboard according to standards:

Num	Properties	JIS	SNI
1	Tolerances on thickness, mm	± 1.0	± 1.0
2	Density, g/cm^3	0.40 – 0.90	0.40 – 0.90
3	Moisture content, %	5 – 13	< 14
4	Swelling in thickness, %	Max 12	Max 12
5	Internal bonding, kgf/cm^2	Min 1.5	Min 1.5
6	MOR, kgf/cm^2	Min 80	Min 82
7	MOE, kgf/cm^2	Min 20,000	Min 20,400
8	Screw holding power, kgf	Min 30	Min 31

3. Result and Discussion

The test results of the test samples are as follows, the letter A indicates the test sample is made of a mixture of 50% sawdust: 50% PET; the letter B indicates the test sample is made from a mixture of 60% sawdust: 40% PET; the letter C indicates the test sample is made of 70% sawdust: 30% PET. First, a test sample A is made, using 1 cm x 5 cm PET and crushed PET, the results are as figure 1 follows:

(a) (b)

Figure 1 Waste plastic bottles PET(a) PET size 1 cm x 5 cm; (b) crushed PET

(a) (b)

Fig. 2 Particleboard (a) made from PET size 1 cm x 5 cm; (b) made from crushed PET

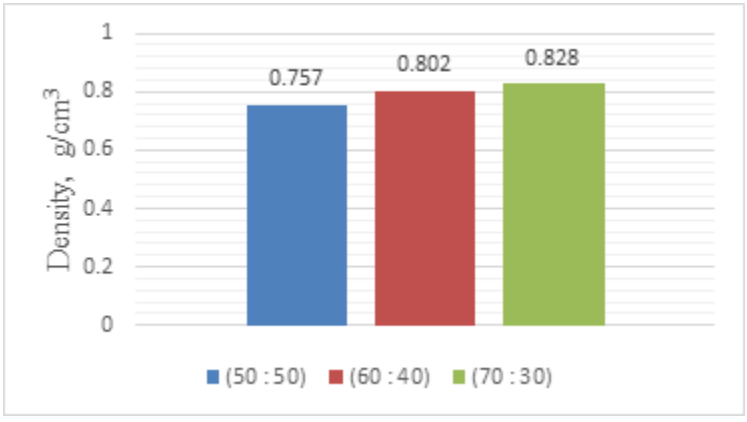

Figure 3 Average density

From the test results listed in Figure 3 above, it was obtained that the average density value met the criteria of SNI 03-2105-2006 and JIS A 5908:2003.

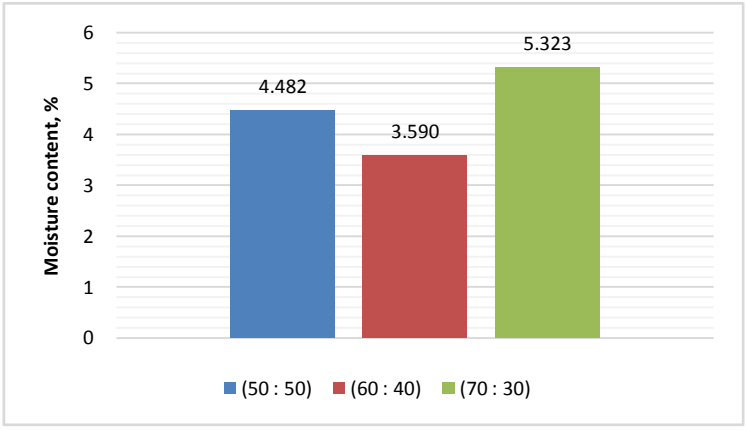

Figure 4 Average moisture content

The average value of water content ranges from 3.6% - 5.3% which meets the criteria according to SNI 03-2105-2006 and JIS A 5908:2003 only sample C, while test samples A and B are below the standard, meaning that PET affects the content of water, that is, lowering the water content with the increasing amount of PET in the mixture, it is necessary to further investigate why test sample B is lower than A.

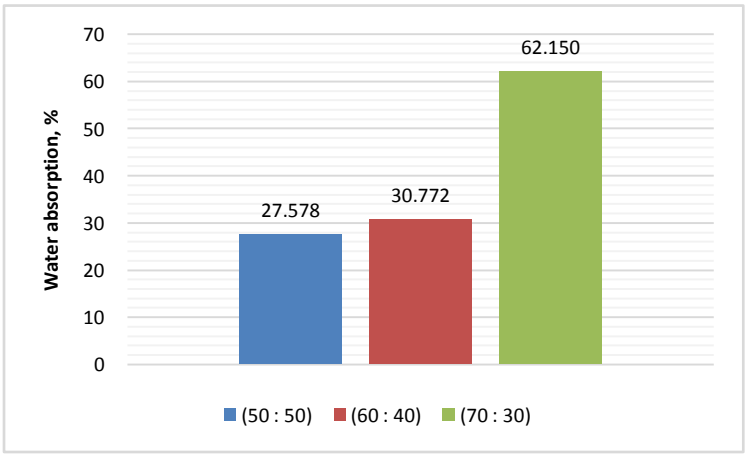

Figure 5 Absorption of water

The water absorption value as shown in Figure 5 ranges from 27.6% - 62.1%, this results indicate that the more PET material in the mixture, the lower the water absorption value of the particleboard.

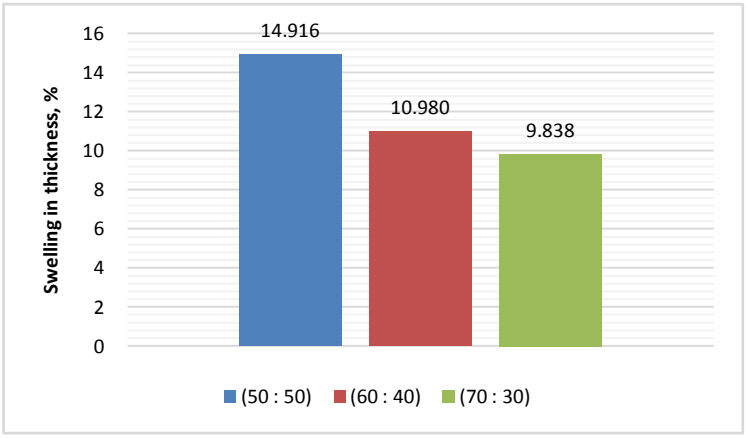

Figure 6 Swelling in thickness

The results show that the test sample A exceeds the limits required in SNI 03-2105-2006 and JIS A 5908:2003, this indicates that the more PET in the mixture, the greater swelling in thickness value, this indicates that the PET has not yet melted,to fill the voids in the particleboard, it is necessary to test by increasing the compression temperature and adjusting the compression time.

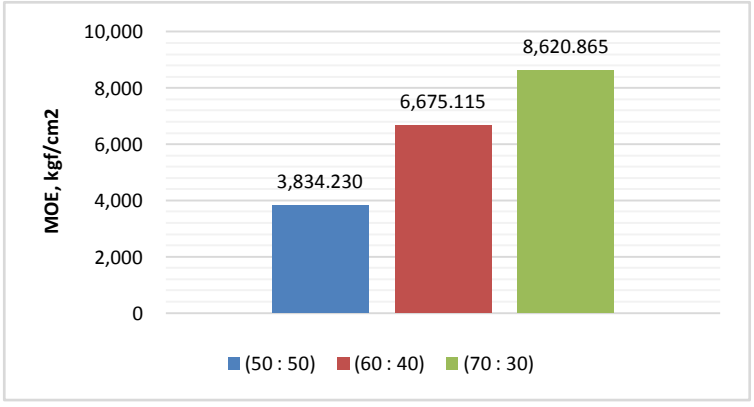

Figure 7 MOE

From the test results, we know that the more PET material in the mixture, the smaller the flexural modulus of elasticity, this also indicates that the PET material in the mixture has not yet melted, so there is no strong bond between the sawdust and PET. The all MOE value is still below the requirements of both SNI 03-2105-2006 and JIS A 5908:2003, further research needs to be done by increasing the compression temperature and adjustcompression time until the PET material melts.

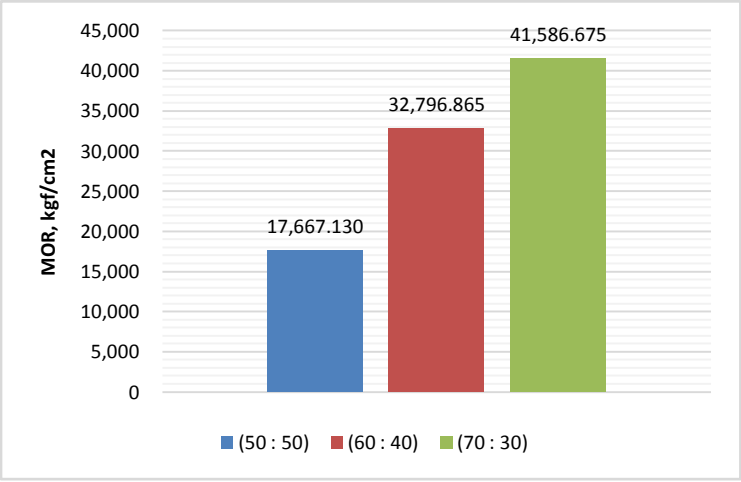

Figure 8 MOR

From the test results, it is found that the more PET added in the mixture, the smaller the MOR value will be. The MOR value meets the standards of SNI 03-2105-2006 and JIS A 5908:2003, this indicates that the PET material is still not fused with the sawdust, it is necessary to do research using a higher temperature and adjust the compression time.

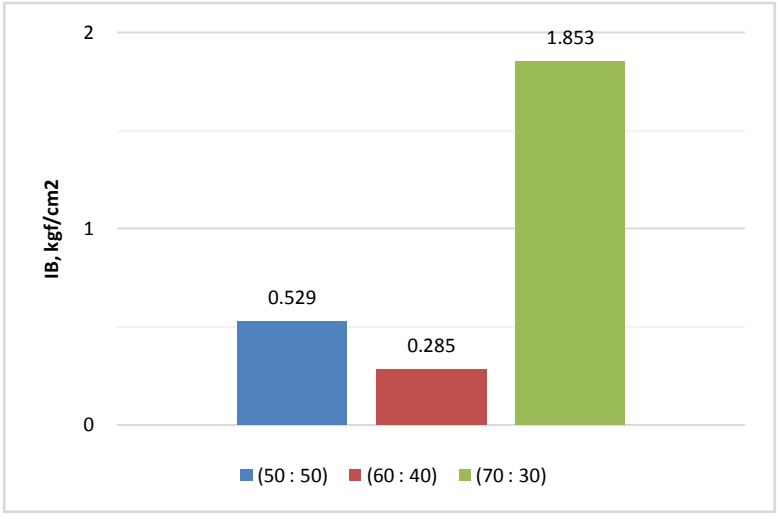

Figure 9 Internal bonding

From the test results above, we can see that the addition of more PET material in the mixture will decrease the value of internal bonding, this indicates that the PET material used has not yet melted, so there has not been a strong bond between PET and sawdust. The internal bonding of the test sample C met the standards of SNI 03-2105-2006 and JIS A 5908:2003, while the test samples A and B were below the standard. The value of test sample B which is smaller than test sample A should be investigated further, and it is necessary to further investigate the internal bonding by increasing the compression temperature and adjusting the compression time.

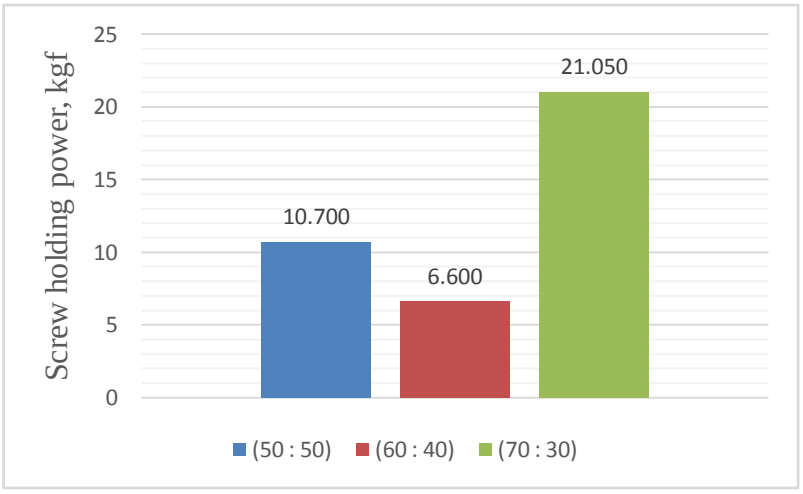

Figure 10 Screw holding power

From the test results, it was found that the more PET material in the mixture, the smaller the screw holding power value. The value of the screw holding power is still below the standard of SNI 03-2105-2006 and JIS A 5908:2003, this indicates that the PET material is not yet fused with the sawdust, so further research is needed to determine the right temperature and compression time. The existence of deviations in the value of the screw holding power of test sample B which is lower than test sample A, should be investigated further.

4. Conclusion

- PET measuring 1 cm x 5 cm is not used in the mixture, crushed PET is used.
- Pressing temperature 200 ℃, pressing time 20 minutes.
- Density ranges from 0.757 g/cm^3 – 0.828 g/cm^3, all test samples met SNI and JIS standards.
- Moisture content ranges from 3.590% – 5.323%, meets SNI and JIS standards, only sample C.
- Water absorption ranges from 27.578% – 62.150%, SNI and JIS are not required.
- Swelling in thickness ranges from 9.838% – 14.916%, which meets the SNI and JIS standards are samples B and C.
- MOE ranges from 3,834,230 kgf/cm^2 – 8,620,865 kgf/cm^2, all test samples did not meet SNI and JIS standards.
- MOR ranges from 17,667,130 kgf/cm^2 – 41,586.675 kgf/cm^2, all test samples meet SNI and JIS standards.
- Internal bonding rangesfrom 0.285 kgf/cm^2 – 1.853 kgf/cm^2, only sample C meets SNI and JIS standards.
- Screw holding power ranges from 6,600 kgf – 21,050 kgf, all test samples did not meet SNI and JIS standards.

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