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MORALITY BEFORE KNOWLEDGE

The study of high-density polyethylene (HDPE) waste utilization into particle board

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ABSTRACT
This research discusses related to one of the processing of waste, especially HDPE waste. HDPE waste is another alternative besides wood to make particle board. HDPE particle board takes advantage of these properties to provide a strong and durable alternative. The use of HDPE particle board provides significant benefits in the context of sustainability and the environment. In the manufacture of particle board in this study there were differences in temperature variations, so the variable in this study was temperature. Sample A has a temperature of 130° and sample B has a temperature of 160°. The particle board is pressed for 20 minutes using a hot press machine using 1 x 1 m molding. Testing of this HDPE particle board includes testing of physical properties, namely in the form of Density and chemical testing in the form of Acidity resistance and Alkalinity resistance. The standards in this study refer to SNI 03-2105-2006 regarding Particle Boards, SNI 01-7201-2006 regarding Plywood and block boards with beautiful paper faces, and ASTM D543. The density test showed a value of 0.90 gr/cm3 in the average sample A and 0.75 gr/cm3 in the average sample A. The results of the ANOVA analysis on the Density test showed that there was a significant difference between each sample and each treatment. the results of the t-Test showed that the treatment of sample A did not meet the standard, while the treatment of sample B met the SNI 03-2105-2006 standard. The acidity and alkalinity resistance were tested visually with the results that the temperature at 130° was more susceptible to reaction than the temperature at 160°. Objectives to find out the result of Density test, Acidity, and Alkalinity resistance of HDPE Particle Board is it already fulfill the standard; To determine the temperature that has the most significant impact on the performance of HDPE Particle Board. Method and results: 1) Process of making the Particle Board, the process are include material preparation, material weighing, shredding, cleaning, drying, and pressing. 2) Sample Testing, the treatment that used is about variation of temperature. Variable that be used in this study consist of Density, Acidity, & Alkalinity. 3) Data Analysis, by using ANOVA Single Factor and t-Test. The results of Density test by t-Test analysis showed that the treatment of sample A did not meet the standard, while the treatment of sample B already fulfill the SNI 03-2105-2006. In Acidity and Alkalinity resistance there are indicators according to SNI 01-7201-2006 in the form of softening and open cracks in several samples. Density test results show the variable B (160°) is at 0.75 gr/cm3 and already fulfil the standard. Visual test results of Acidity and Alkalinity resistance show the variable B (160°) is more resistant to the effects of acids and bases. So that the optimal variable is at a temperature of 160°.

KEYWORDS: acidity & alkalinity; density; high-density polyethylene; particle board; temperature

1. Introduction

Condition of plastic waste in Indonesia is a serious environmental issue. Indonesia is one of the countries with the highest level of plastic waste production in the world. Based on data from the Indonesian Ministry of Environment and Forestry, in 2022, Indonesia produces around 19,45 million tons of waste, the majority of national waste generation in

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2022 is in the form of plastic waste with a proportion of 18.55% (SIPSN, 2022). One of the factors causing the high amount of plastic waste in Indonesia is the high consumption of single-use plastic. The use of plastic bags, plastic drink bottles, plastic food containers and other plastic products that do not decompose easily causes a large accumulation of plastic waste. Plastic waste is a material that cannot be decomposed by decomposing microorganisms (non- biodegradable), so that its accumulation in nature is feared to cause environmental problems. The solution to overcome this problem is that it is necessary to intensify efforts to be able to utilize industrial waste both from the wood and non-timber industries to be used as raw material for the composite board or particle board industry (Sari, 2011). One form of effort to reduce the population of plastic waste is to process plastic waste, especially plastic with High-Density Polyethylene (HDPE) type in the form of plastic bottle caps as particle board. By converting HDPE waste into particle board, it adds value to waste that was previously considered waste. HDPE is a type of plastic that is milky white/clean white. Used for tissue bags, detergent bottles, oil, heat-resistant plastic, plastic pipes, shopping bags and ordinary plastic bags for vegetable and soupy foods (Riyadi et al., 2013). HDPE particle board takes advantage of these properties to provide a strong and durable alternative. Particle board is a board made of wood particles joined together by means of adhesives and given cold and hot pressure (Afrilda, 2021). Particle board tends to be stable and does not change its shape easily (Armadi, 2021). Particle board is also easy to cut, shape and drill easily using standard tools (Yulianto et al., 2018). There are several studies that have examined related to particle board, Hj. Noor Mirad (2011) that has reaserched related physical and mechanical properties of particle board from waste plastic type HDPE and rubber twigs/branch. Gun Sudiryanto (2015) that has researched related the effect of temperature and pressing time on the physical and mechanical characteristics of sengon wood particle board.

2. Methods

2.1 Data Collection Method

The data collection carried out in the HDPE Particle Board Manufacture Study is primary data, where the resulting data comes from the results of documentation related to direct research experiments.

2.2 Particle Board Making Process

The material that used in this study is from plastic bottle caps waste. The following below is the manufacturing method from this study, namely particle board from HDPE;

1) Material Preparation
   At this step all materials and tools are prepared, including the main ingredient in the manufacture of HDPE particle board, namely used bottle caps
2) Material Weighing
   The material will be weighed first with a scale, weighed until it reaches 11.5 kg
3) Shredding
   The material in the form of plastic bottle caps is chopped 3 times to make it smaller so that the pressing process can be maximized, then proceed with cleaning the material and drying
4) Cleaning/Washing
   Because this material comes from waste, it is important to carry out a cleaning process
5) Drying
   Drying needs to be done to maximize the particle board pressing process
6) Pressing

At this step the HDPE bottle cap will be placed into a 1 x 1m molding and will be pressed for 20 minutes with temperature variations of 130ºC and 160ºC

7) HDPE Particle Board
HDPE that has been pressed has become HDPE particle board and ready to proceed to the testing process based on related standard..

2.3 Data Analysis Method

2.3.1 Statistic Test

1) ANOVA Test, ANOVA analysis used to test for differences between groups of data, ANOVA will identify differences between one group and other groups data. In this study will
Define the value by using P-value. P-value more than α (0.05) means the hypothesis H0 will accept and rejected the Ha. Meanwhile if the P-value less tha α (0.05) means the hypothesis H0 will rejected and Ha will accepted. The software of ANOVA analysis is from Microsoft Excel.
2) T-Test, The t-test serves to measure the comparison between the results of variable measurements against SNI standards that cover the entire population (Oktaviani and Masjud, 2022) . The results of the T-Test are accompanied by a p-value. If the p-value is lower than a(0.05), it can be concluded that the difference between the two groups is statistically significant.

2.4 Particle Board Testing Method

Table 1. Sample Size

No	Test	Size
1	Density	100 mm x 100 mm
2	Acidity Resistance	75 mm x 75 mm
3	Alkalinity Resistance	75 mm x 75 mm

2.4.1 Particle Board Characteristic

1) Density

Density can be defined as the mass or weight per unit volume. This density describes how dense or heavy HDPE particle board is in each volume unit expressed in grams per cubic centimeter (g/cm^3) or kilograms per cubic meter (kg/m^3). Density is one of the physical properties of a composite board is defined as the mass per unit volume of material, increasing regularly with increasing atomic number in each subgroup (Desi, 2016).

Based on SNI-03-2105-2006 regarding "Particle Board", the Density formula as follows:

$$\text{Density } (g/cm^3) = \frac{B}{I}$$

Description:
B = Mass (g)
I = Volume (cm^3)

2) Acidity and Alkalinity Resistance

Acidity and Alkalinity resistance are two types of tests used to evaluate the extent to which a material or substance can withstand or interact with an acidic or alkaline environment. In a broader context, this test is used to test the resistance of materials to corrosion or chemical degradation caused by acidic or alkaline environments. In a chemical context, acidity and alkalinity refer to the chemical properties of a solution which are related to the concentration of hydrogen ions (H+) and hydroxide ions (OH-) in the solution. Acidity measures the concentration of hydrogen ions (H+) in a solution. The higher the H+ concentration, the more acidic the solution. Basicity is the opposite of acidity. It measures

the concentration of hydroxide ions (OH-) in a solution. The higher the concentration of OH-, the more basic the solution.

Table 2. Standard of indicator testing

No	Characteristic	Unit	Standard
1	Density	gram/cm	0.40 gr/cm3 - 0.90 gr/cm3 (SNI 03-2105-2006)
2	Acidity	-	Visual analysis by directly observe thesampel after the test, if there any open cracks, blister, delamination, softening, discoloration and color fading (SNI 01-7201-2006)
3	Alkalinity	-	

Table 3. Temperature variation level

Sample	Temperature (°C)	Mass (kg)
A	130°C	11.5
B	160°C	11.5

In this study there are two temperature testing treatments for pressing particle board, the first is called treatment A, which is a variation of the pressing temperature at 130 degrees where the test is repeated 5 times so that it has 5 samples called A1, A2, A3, A4, and A5. and the second is called treatment B, which is a variation of the pressing temperature at 160 degrees where the test is repeated 5 times so that it has 5 samples called B1, B2, B3, B4, and B5.

3. Results and Discussion

3.1 HDPE Particle Board Test Result

3.1.1 Density Test

The following below are the results of the Density test

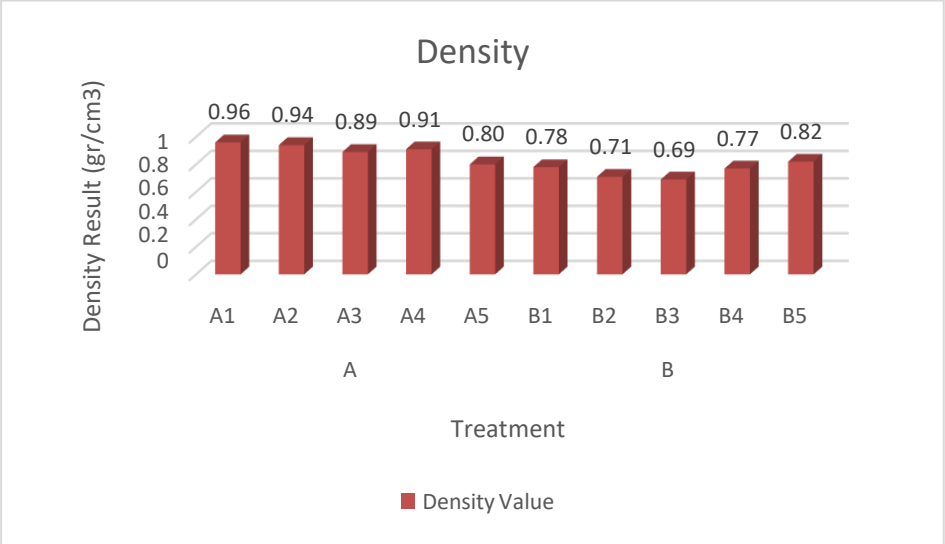


Figure 1. Density test result

There are variance value of the density test. Sample A1 is 0.96 gr/cm3, sample A2 is 0.94 gr/cm3, sample A3 is 0.89 gr/cm3, sample A4 is 0.91 gr/cm3, sample A5 is 0.80 gr/cm3, sample B1 is 0.78 gr/cm3, sample B2 is 0.71 gr/cm3, sample B3 is 0.69 gr/cm3, sample B4 is 0.77 gr/cm3 and sample B5 is 0.82 gr/cm3.

If viewed from the result and compared with the standard, there are samples A1, A2, and A4 that not meet the requirement. However the average value of samples A and B already meets the Density standard by SNI 03-2105-2006.

3.1.2 Acidity Resistance Test

Table 4. Acidity resistance test result (sample A)

Sample	Before	After	Visual Observation Result
A1			Softening & Open cracks
A2			Nothing changes
A3			Nothing changes

A4			Softening & Open cracks
A5			Softening & Open cracks

Table 5. Acidity resistance test result (sample B)

Sample	Before	After	Visual Observation Result
B1			Softening & Open cracks

B2			Nothing changes
B3			Nothing changes
B4	 	 	Softening & Open cracks
B5			Nothing changes

From the visual observation result of the Acidity resistance test, the sample A1, A4, A5, B1 & B4 changes and becoming into Softening and Open cracks, and the sample A2, A3, B2, B3, & B5 did not change. In this case, it can be concluded that a temperature level of 130° is more susceptible to changes than temperature level of 160°.

3.1.3 Alkalinity Resistance Test

Table 6. Alkalinity resistance test result (sample A)

Sample	Before	After	Visual Observation Result

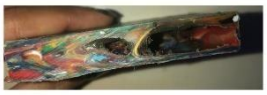
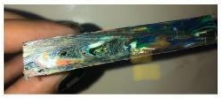
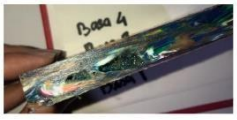
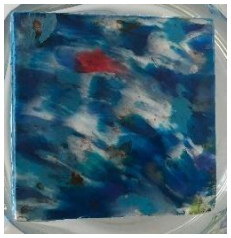
A1			Nothing changes
A2	 	 	Softening & Open cracks
A3			Nothing changes
A4	 	 	Softening, Open cracks
A5			Nothing changes

Table 7. Alkalinity Resistance Test Result (Sample B)

Sample	Before	After	Visual Observation Result

B1			Nothing changes
B2			Nothing changes
B3			Nothing changes
B4			Nothing changes
B5	 	 	Softening, Open cracks

From the visual observation result of the Alkalinity resistance test, the sample A2, A4, A5 & B5 changes and becoming into Softening and Open cracks, and the sample A1, A3, A5, B1, B2, B3 & B4 did not change. In this case, it can be concluded that a temperature level of 130° is more susceptible to changes than temperature level of 160°.

3.1.4 Result of ANOVA Analysis

1) Density

Table 8. Density result by ANOVA analysis

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.05329	1	0.05329	15.95508982	0.003981	5.317655
Within Groups	0.02672	8	0.00334			
Total	0.08001	9				

Based from the table ANOVA analysis above show number of P-value is less than α (0.05), then the hypothesis H0 is rejected and Ha is accepted. So based on this data, there are significant differences between each sample and each treatment.

3.1.5 Result of T-Test Analysis

1) Density

Table 9. Density result by t-test analysis

Density	Treatment A	Treatment B
Mean	0.9	0.754
Variance	0.00385	0.00283
Observations	5	5
Pooled Variance	0.001925	0.001415
Hypothesized Mean Difference	0	0
df	8	8
t Stat	0	-6.13683773
P(T<=t) one-tail	0.5	0.00013899
t Critical one-tail	1.859548038	1.85954804
P(T<=t) two-tail	1	0.00027798
t Critical two-tail	2.306004135	2.30600414

Based from the table Density T-Test above show the P one-tail value in treatment A is more than α (0.05), then the hypothesis Ho is accepted and Ha is rejected. However, the P one- tail value in treatment B is less than α (0.05), then the hypothesis Ho is rejected and Ha is accepted. So, the conclusion from this Density T-Test is treatment A is not fulfill the SNI standard, and for the treatment B is fulfill the SNI standard.

4. Conclusions

1. The physical properties test of particle board is carried out in the form of a Density test and Chemical resistance of particle board in the form of Acidity and Alkalinity resistance. The results of Density test by t-Test analysis showed that the treatment of sample A did not meet the standard, while the treatment of sample B already fulfill the SNI 03-2105-2006. In Acidity and Alkalinity resistance there are indicators according to SNI 01-7201-2006 in the form of softening and open cracks in several samples.
2. Density test results show the variable B (160°) is at 0.75 gr/cm3 and already fulfil the standard. Visual test results of Acidity and Alkalinity resistance show the variable B (160°) is more resistant to the effects of acids and bases. So that the optimal variable is at a temperature of 160°.

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