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Application of Boiler Fly Ash for Oil Palm Kernel Separation in Claybath

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ABSTRACT

The burning of shells and fiber as boiler fuel in palm oil mills produces waste in the form of ash which is not utilized and managed optimally, resulting in environmental damage. Based on the chemical compounds contained in fly ash, its abundant availability, its cheap price and easy-to-obtain, fly ash can be used as a cheap raw material in claybaths as a substitute for clay and calcium carbonate. This study aims to determine the effective weight of boiler ash in reducing kernel and shell production losses at the kernel processing station. This study used variations in the weight of boiler fly ash, namely 3000 g, 3500 g, 4000 g, 4500 g, and 5000 g which were tested first in the laboratory. The application of boiler ash variations that were close to the norm was tested directly in the claybath. The best weight parameter for using fly ash is found in the weight variation of B5 (5000 g) with a loss of production in the sample of 3.98% or 0.159% of the oil palm fresh fruit bunches. At the time of application, boiler fly ash should be mixed with water at a ratio of 1:2 (fly ash to water) to result the best effect.

1. INTRODUCTION

Oil palm fruit processing is one of the factors that determine success in the palm oil industry. The main products of oil palm fruit processing are crude palm oil (CPO), palm kernel, shells, fiber (Setyawan, 2014). Generaly, Palm Oil Mill (POM) has several processing stations, namely sortation station, sterilization station, threshing station, pressing station, clarification station, and kernel station (Denur *et al*., 2020). The mixture of dregs (fiber) and kernel that comes out of the screw press will be processed to produce shells and fiber as boiler fuel materials and palm kernel which is further processed to produce palm kernel oil (PKO) (Suandi *et al*., 2016). Shell is the outer part of the seed which is cracked to produce the kernel and shell (Subramaniam *et al*., 2008).

Palm kernel is a by-product of the CPO processing process with a high selling value. Indonesia produces 3.78 million metric tons (MMT) of palm kernel oil and 4.55 MMT of palm kernel cake (Nugraheni. *et al*., 2017). The process of separating the shells from the seeds occurs in a claybath based on the difference in density between the objects separated by a calcium carbonate solution (Nugroho, 2019). Claybath is a tool that functions to separate large broken shells and kernels of palm oil which weigh almost the same (Sari, 2013). Whole kernel is one of the quality determinants to produce quality palm kernel oil (Prastyo, 2017).

The results of the ripple mill are a mixture of half broken kernels, round kernels, broken kernels, and shells. The mixture is separated through a two-stage dry separation system to obtain kernels, both round and broken (Mahmud, 2012). The separation process results in a change of specific gravity, which causes an increase in suspended matter from the broken seeds having a different weight than the clay. This resulted in a failure in the core and shell separation process (Hikmawan *et al*., 2020). The maximum permissible loss of kernel production is 0.25% of fresh fruit bunches (FFB) (Effendi, 2017).

Wet kernel originating from the kernel hopper is fed using an air lock to control feeding in the ripple mill. Cracked kernels, namely kernels and shells, are called cracked mixtures (Syam *et al*., 2011). The separated shells and core are transported by the Cracked Mixture Conveyor and then enter the Cracked Mixture Elevator and are processed to obtain palm kernel (Hikmawan *et al*., 2021). The process of separating kernels and shells is carried out in a conical tub equipped with a mixing knife. Liquid movement due to circulation will carry the core to the vibrating sieve to be cleaned and then sent to the kernel silo (Riswan, 2016).

Palm biomass as a sustainable fuel is a recommendation aimed at increasing the value of environmentally friendly boilers (Ferryno *et al.*, 2017). Boiler ash is a material that can be used as an adsorbent. Adsorbents are able to absorb certain components from a fluid, but before application they need to be activated using chemicals so that the absorption effectiveness increases (Rangkuti *et al.*, 2021). Boiler ash is solid waste originating from fuel processing in boilers derived from fiber and palm shells. This ash has a coarse texture and is usually in the form of a very fine crust. The application of boiler ash which is used as a substitute for calcium carbonate and boiler ash ex-dust collector at a ratio of 1:1 can save calcium carbonate consumption of 0.2 kg/ton FFB, and is estimated to generate an annual margin of IDR 88,600,000 (Saraswati, 2012). Each tonnage of palm fruit bunches produces around 4 kg – 6 kg of boiler ash (Asadullah & Rathnasiri, 2015).

The limited supply of chemicals ($CaCO_3$) will of course disrupt kernel processing and will cause losses. On the other hand, inventory, which is a company asset with a large proportion, must be managed efficiently. Calcium carbonate is a fast-moving material, so its management needs to be considered in detail (Hudori, 2019). As an adsorbent, boiler ash has good performance because it contains 31.45% silica, 15.2% calcium oxide and 1.6% dialuminium trioxide (Al_2O_3). Based on the chemical compounds in the form of silica and dialuminium trioxide contained in oil palm shell fly ash and their relatively large abundance and cheap price, easy to obtain, fly ash can be used as a low -cost adsorbent material (Triawan *et al*., 2017). This study aims to determine the effective weight variation of palm oil mill boiler ash as a separator material in clay baths as a substitute for calcium carbonate and termite clay and its application in clay baths.

2. MATERIALS AND METHODS

2.1. Materials and Tools

The material used in this research is boiler fly ash collected from Palm Oil Mill (POM) of PT. Perkebunan Negara (PTPN) I Tanjung Seumantoh, Aceh Province. Other materials include termite soil, water, ripple mill output in the form of cracked mixture and claybath losses in the form of broken kernels, whole kernels. The tools used are a ripple mill, a clay bath with a length of 6,000 mm and a width of 2,006 mm, and a centrifuge.

2.2. Research design

This study used an experimental method with quantitative data analysis. This research was conducted at the PTPN I Tanjung Seumantoh using boiler ash to test its effectiveness in separating the core and shell at the seed processing station, namely in the clay bath. The variations in the weight of boiler fly ash used in the study were B0 = 2500 g, B1 = 3000 g, B2 = 3500 g, B3 = 4000 g, B4 = 4500 g, and B5 = 5000 g which was carried out with 15 repetitions.

2.3. Research Stages

2.3.1. Sampling

Sampling of the main raw materials, namely boiler fly ash, termite clay, and samples of ripple mill output and losses from claybath (wet shell) were taken from POM of PTPN I Tanjung Seumantoh. Analysis of the effectiveness of fly ash, namely analysis of the concentration of boiler fly ash and termite clay in the laboratory. The analysis was carried out to determine the material weight norms when applying boiler fly ash into claybaths. Boiler fly ash is weighed with various weights to be tested. After that the boiler ash is soaked in 10 liters of water and stirred for ± 10 min. The stirred material is then ready to be used to be mixed with the sample. The output sample from the ripple mill or sample losses from the clay bath/wet shell is added as much as 1000 g. Then stirred and observed the results obtained.

2.3.2. Boiler Fly Ash Application in Claybath

The application of boiler fly ash was carried out to determine the success of the concentration analysis carried out referring to the norms of losses in the POM Tanjung Seumantoh, namely 4.00% based on sample, and 0.16% based on fresh fruit bunch (FFB).

2.3.3. Kernel Loss Analysis

The analysis of kernel loss is measured by two indicators, namely losses on sample (loss of core in sample) and losses on ffb (core loss counted in palm fruit bunches). How to calculate kernel losses (NL) is

$$NL = (ML/MS) \times 100\%$$

where ML is the mass of kernel loss, and MS is the mass of the sample (Arham, 2017).

3. RESULTS AND DISCUSSION

3.1. Concentration of Boiler Fly Ash and Termite Soil

The factor of losses in the nut and kernel station is caused by the damper setting being too large causing the suction power to produce air to be too large, so that the nut is also sucked in and the screw press is strong enough to cause the nut to break so that the fiber cyclone also sucks in (Syam *et al.,* 2011). The weight of the separator material used, namely B0, still has losses that are far from the normal kernel losses at the nut separation station, which is 4.76%. Treatments B1 and B2 do not yet have results that are in accordance with the norms of losses at POM Tanjung Seumantoh. Variations in the weight of B5 fly ash obtained values below the standard losses norm at POM. The average loss results from variations in the weight of the different boiler ash mixtures are presented in Table 1.

Table 1. The average kernel loss from the weight variation treatment of boiler fly ash mixture

No	Boiler Fly Ash Treatment (gram)	Average Kernel Losses (%)	
		on Sampel	on FFB
1	B0 (2500)	8.76 [a]	0.35
2	B1(3000)	7.90 [a]	0.31
3	B2(3500)	6.79 [b]	0.27
4	B3(4000)	5.80 [c]	0.23
5	B4(4500)	4.78 [d]	0.19
6	B5(5000)	3.93 [e]	0.15

Note: Numbers followed by same superscript letters are not significantly different at a = 0.05.

Table 1 shows the results of several variations in the weight of separator material (in this case boiler fly ash) applied to the claybath resulting in different losses. The resulting loss value tends to decrease along with the amount of boiler fly ash material that is applied to the kernel and shell separation process. Variations in the weight of B5 boiler fly ash resulted in losses in accordance with the norms at POM, namely 4.00% (On Sample) and 0.16% (On FFB). The results of variance indicated that the boiler fly ash application treatment showed significant differences. The higher the amount of fly ash used significantly reduces kernel losses. Further tests using the Tukey test showed that the treatment using 5000 g of fly ash resulted in the smallest kernel losses compared to other treatments. The use of boiler fly ash used when applying in the clay bath is 5000 g using 10 liters of water for 1 kg of sample.

The higher the specific gravity of the separating solution, the greater the separation between the core and the shell. This is caused by the difference in specific gravity in each ratio of clay and water in the clay solution. If the solution gets thicker, the specific gravity increases and if the solution gets thinner, the specific gravity decreases (Hikmawan *et al*., 2020). The separating solution used in the clay bath must have a density between the shell and the kernel to be separated (Muhammad *et al*., 2022). According to (Saraswati, 2012) the simulation is done by entering the cracked mix, which will become a floating material while the shell will become a sinking material. the level of impurities caused by ash and calcium which is entrained in the floating material is quite small.

3.1. Application of Boiler Fly Ash in Claybath

The application of the separator material was carried out on Monday 10 August 2020 by applying it to the claybath line II. The first application is carried out in a clay bath condition that still contains termite clay. The operator enters ± 900 liters of water so that the mixture (termite soil and boiler ash) becomes dilute so that there are losses in the sample. After it was known that there was core loss, 450 kg of boiler fly ash was added and adjusted to 900 liters of water.

Table 2. First application on clay bath

Materials	Kernel Losses (%)	
	On sample	On FFB
Termite clay + 450 kg boiler fly ash + 900 L water	3.97	0.158

Table 2 shows that the separating material formulated with the mixture (termite soil and boiler fly ash) resulted in losses of 3.97% (on sample) and 0.158% (on FFB). When compared with the standard norm of losses in PKS, which is On Sample: 4.00%, On FFB: 0.16%, the data presented above is sufficient to meet the indicators for handling losses at POM Seumantoh.

The second application is carried out using boiler fly ash (fly ash) thoroughly without any admixture. The operator enters ± 2000 liters of water with a separating agent, namely 1000 kg of boiler fly ash.

Table 3. Second application of boiler fly ash (1000 kg) on clay bath

Material	Kernel Losses (%)	
	On sample	On FFB
1000 kg boiler *fly ash* + 2000 L water	3.91	0.156

Table 3 shows that 1000 kg of boiler fly ash as a separator using 2000 liters of water produces losses on sample of 3.91% and on FFB of 0.156%. When compared with the standard norm of losses in PKS, which is On Sample: 4.00% , On FFB (fresh fruit bunch: 0.16%) the data above fulfills the core losses indicator at the seed processing station. The use of boiler ash and water is proportional (1:2) for obtain results in accordance with established norms.

This was confirmed by research (Saraswati, 2012) which stated that the highest value in the use of calcium carbonate and ash with a ratio of 1:1 was tested on clay baths. The specific gravity of the palm kernel is 1.07 g/ml and the specific gravity of the palm kernel is 1.15-1.20 g/ml, therefore to separate the shell and the kernel of the palm a solution is formulated with a specific gravity between the two (Hikmawan *et al*., 2020).

The ability of the clay bath to separate the kernels from the shells is greatly influenced by the degree of saturation of the solution (Sari, 2013). The greater the weight of activated carbon added, the higher the absorption rate obtained, the longer the adsorption time, the higher the resulting absorption rate (Meriatna *et al*., 2020).

4. CONCLUSION

Based on the research, it can be concluded that the best weight variation in the use of boiler fly ash (fly ash) is found in B5 with losses at on sample 3.98% and on ffb 0.159%. When applied to claybath boiler ash as a core and shell separator material with a ratio of 1:2 (boiler ash: water) is the best ratio in reducing loss of core and shell production.

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