Utilization of Fly Ash and Bottom Ash as a Filler in the NPK Plant at Petrokima Gresik Ltd

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Abstract. Coal is a rock composed of organic compounds (C, H, and O), inorganic or mineral impurities, and ash content. Burning coal produces waste in fly ash and bottom ash (FABA). FABA that accumulates for a long time can cause environmental problems, such as pollution. Petrokimia Gresik Ltd. Produces FABA in large quantities, so it must be managed by external parties who have a permit to manage it. With the regulatory changes, FABA can be utilized for various products. This study aims to utilize FABA as a filler substitute for raw materials for NPK fertilizer and find the right proportion so that utilization can be carried out optimally. This study applied the Plan-Do-Check-Act (PDAC) method to achieve continuous improvement. The results show that the most optimal FABA ratio is 3:1 with the addition of ZA raw materials with a specific ratio. After analyzing the test product on NPK 15-10-12 plus fertilizer, it is found that the NPK 15-10-12 plus fertilizer using FABA as a filler complies with SNI 2083:2012 about NPK fertilizer. The effectiveness test results on paddy plants at the Experimental Garden of Petrokimia Gresik Ltd. Show that FABA as a fertilizer filler does not affect the effectiveness of NPK fertilizer. This study shows that FABA can be used as a filler substitute for raw materials for NPK fertilizer.

Keywords: Fly ash · Bottom ash · Filler · Fertilizer · NPK

1 Introduction

Coal is a rock composed of predominantly organic compounds (C, H and O), inorganic or mineral impurities, and ash content [1]. Ash content in coal is known as fly ash and bottom ash (FABA). Fly ash and bottom ash are produced by burning coal in a boiler, with a composition of 75% fly ash and 25% bottom ash [2]. Fly ash is ash particles carried by exhaust gases, while bottom ash is ash that is left behind and removed from the bottom of the furnace [3]. In Indonesia, fly ash and bottom ash are one type of hazardous waste category [4]. In 2021, the Indonesian government classified fly ash and bottom ash as nonhazardous waste [5]. With the change in the classification of fly ash and bottom ash as nonhazardous waste, FABA can be managed internally as a filler substitute for raw materials in accordance with the requirements set by the Indonesian government [6]. Petrokimia Gresik Ltd. Produces hazardous waste consisting of fly ash and bottom ash and uses a catalyst and other hazardous waste. From Table 1, it can be seen that in 2018–2020, the most hazardous waste generated was fly ash and bottom ash.

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Table 1. Hazardous Waste of Petrokimia Gresik Ltd.

Waste	Waste Amount (Ton)/Month			Average (Ton)
	2018	2019	2020	
FABA	513.61	644.04	690.00	615.88
Catalyst	15.22	8.48	4.75	9.48
Others	6.74	4.98	4.44	5.39
Total	535.57	657.51	699.19	630.75

So far, no technology utilizes fly ash and bottom ash waste into products with economic value in the fertilizer industry. This study aims to provide innovation in the utilization of fly ash and bottom ash waste in the fertilizer industry in Indonesia. This study focuses on fly ash and bottom ash waste produced by Petrokimia Gresik Ltd.

2 Research Methods

This research applied the Plan-Do-Check-Act (PDCA) method which refers to ISO 14001 concerning Environmental Management Systems [7].

The first step was to establish environmental objectives and processes necessary to deliver results in accordance with the environmental policy.

The second step was to implement the processes as planned. The trial was conducted on a small scale to measure the results as planned. (1) Determine the FABA mixing ratio, with various ratios of fly ash: bottom ash, including 1:0, 1:1, 1:2, 2:1, and 3:1. (2) Calculate the formulation for the consumption of raw materials in the NPK plant, where the maximum dose of NPK tested was 5%. (3) Determine the FABA feeding method in which the FABA was mixed with ZA raw material with a certain ratio. (4) Coordinate with related units. (5) FABA sent to the raw material warehouse at the NPK fertilizer plant. (6) Conduct trials on the use of FABA at the NPK plant with a predetermined dose and perform analysis on the product. The third step was to monitor and measure processes against the environmental policy, including its commitments, environmental objectives, operating criteria, and report the results. At this step, the effectiveness of fertilizer was tested on paddy plants with 6 treatments, including: A without fertilization, B Phonska 15-10-12 300 kg/ha, C NPK 15-10-12 Plus 5% Fly ash 300 kg/ha, D NPK 15-10-12 Plus 5% bottom ash 300 kg/ha, E NPK 15-10-12 Plus 1% fly ash + 0.5% bottom ash 300 kg/ha, F NPK 15-10-12 Plus 3% fly ash + 0.5% bottom ash 300 kg/ha. The last step is take actions to improve continually.

3 Results and Discussion

Table 3 exhibits the results of the tested NPK fertilizer application on paddy plants that meet the SNI 2803: 2012 about NPK solid fertilizer. Table 2 shows that the parameter values contained in NPK fertilizer with FABA filler meet the SNI values for fertilizers.

Table 2. Study Planning

Activity Plan	Place and Time	Advantage
Engineering		
Determine the FABA mixing ratio	Environment Department Office, 3–6 May 2021	1. Fly ash and bottom ash can be used as a filler in the NPK fertilizer plant. 2. The percentage of fly ash and bottom ash used is 100%.
Calculate the formulation for the consumption of raw materials in the NPK plant	Environment Department Office, 3–6 May 2021	
Determine the FABA feeding method	Environment Department Office, 3–6 May 2021	
Coordinate with related units	Environment Department Office, 3–6 May 2021	
Procurement		
FABA sent to the raw material warehouse at the NPK fertilizer plant	Coal Unit, 7 May 2021	Fly ash and bottom ash can be used as a filler in the NPK fertilizer plant.
Construction		
Conduct trials on the use of FABA at the NPK plant with a predetermined dose	NPK Plant, 17 May – 31 August 2021	Fly ash and bottom ash can be used as a filler in the NPK fertilizer plant.
Perform analysis for the trial product	NPK Plant, 17 May – 31 August 2021	
Collect the data	NPK Plant, 17 May – 31 August 2021	
Perform application test on a paddy plant	NPK Plant, 17 May – 31 August 2021	

Fig. 1. Paddy Planting

Table 4 presents the results of the effectiveness trial. Phonska fertilization is not significantly different from fertilization on type 15-10-12 NPK fertilizer using FABA filler on paddy plants. Furthermore, the addition of FABA as a fertilizer filler does not affect the effectiveness of NPK fertilizer. Figures 1 and 2 present the effectiveness analysis of NPK fertilizer with filler of FABA.

Fig. 2. The Analysis of Paddy Plants

Table 3. The Analysis of Fertilizer using FABA as Filler

Ind	Unit	May 2021			SNI
		1	2	3	
H_2O	%	1.98	1.77	1.88	Max. 3
N	(adbk)%	14.94	15.40	15.56	Min 13.8
P_2O_5	(adbk)%	11.32	11.73	11.73	Min 9.2
K_2O	(adbk)%	11.42	12.53	12.53	Min 11.04
Mesh	(adbk)%	95.76	94.22	90.60	-

Table 4. The Results of the Effectiveness Trial

No	Indicator	GKP (ton/ha)		GKG (ton/ha)		R/C Ratio
1	A	4.45	a	3.97	a	1.04
2	B	7.15	ab	6.33	ab	1.52
3	C	9.06	b	8.06	b	1.92
4	D	7.79	ab	6.86	ab	1.66
5	E	8.35	ab	7.66	b	1.77
6	F	6.41	ab	5.63	ab	1.36

* GKP: Gabah Kering Panen (Harvested dry grain).
* GKG: Gabah Kering Giling (Milled dry grain).

4 Conclusion

FABA can be used as a filler material in the NPK fertilizer plant. The quality of the product tested is proven to be good and meets the Indonesian National Standard (SNI) 2803:2012 concerning NPK solid fertilizer. We are grateful to some friends and colleagues for encouraging us to start the work, persevere it, and finally publish it. We also acknowledge the support from Petrokimia Gresik Ltd. and our family. They all kept us going, and this paper would not have been possible without them.

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