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Plastics Waste Of Asset 3 PT Pertamina EP Subang Field As A Potential Raw Material For Refuse Derived Fuel (RDF)

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ABSTRACT

The main objective of this study is to determine the characteristics of plastic waste of Asset 3 PT Pertamina EP Subang Field. The characteristics were then used to analyze plastic waste as potential raw material for Refuse Derived Fuel (RDF). The company is located in Purwakarta, West Java, Indonesia. There were two areas as sampling location; they were SP. Cilamaya and SPG. Subang and CO_2 Removal. Parameters to be analyzed were solid waste generation, composition of plastic waste and density (SNI 19-3964-1994) as well as combustible characteristics including moisture content (ASTM D 3173), ash content (ASTM E 830-87), volatile matter content (Standard Method 2540 E), and Low Heat Value/LHV (ASTM D 5865-03). The results indicated that the rate of solid waste generation in the SP. Cilamaya and SPG. Subang and CO_2 Removal was 2.170 kg/day and 6.990 kg/day with composition of plastic waste by 10% or 0.28 kg/day and 37% or 1.18 kg/day. Plastic waste density in the area was 32.24 and 20.67 kg/m3. In SP. Cilamaya, the value of combustible parameter showing the potential of plastic waste as RDF raw material including water content, ash content, volatile matter content, and LHV was 0.63 to 4.19%; 1.02 to 12.66%; 87.34 to 98.98% sequentially. Meanwhile, in SPG. Subang and CO_2 Removal the value was 5142 to 9627 kcal/kg and 0.50 to 2.61%; 0.12 to 10.44%; 89.56 to 99.88%; and from 6154 to 8650 kcal/kg. Compared with the standard RDF in several countries, the values showed the potential of plastic waste as raw material of RDF, yet not massive.

Key words: Asset 3 PT Pertamina EP Subang Field, Indonesia, material, plastics, potential, Refuse Derived Fuel (RDF), waste.

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INTRODUCTION

Solid waste management is one of world's countries concerns including Indonesia for disposed material or materials disposed as useless or unwanted are considered solid waste. As definition of solid waste is the material arising from human and animal activities that is normally solid and is discarded as being either useless or unwanted (Shah, 2000; Peavy et al., 1986). One of the pressing problem today in all solid waste sources is efficient disposal on a long-term basis and safe for environment. Only one realistic option are available to achieve that is application of the reduce, reuse, recycle (3R) principles. One of sources industrial waste in Indonesia is Asset 3 PT Pertamina EP Subang Field. This company was engaged in business activities in the upstream sector of the oil and gas fields, including exploration and exploitation (Pertamina, 2014).

Table 1. Waste sampling areas.

No	Location	Number of staff (capita/day)	Total area (m^2)
1	Cilamaya collecting station area (SP. Cilamaya)	20	18100
2	SPG. subang and CO_2 removal areas	57	52000

Source: Study (2014).

There are two general sources of solid waste at this company: the commercial and institutional component, and the process solid waste (Consulting, 2012; Shah, 2000). Commercial and institutional component arising from office activity support industrial and public infrastructure activities (Consulting, 2012). These waste are include in the category of municipal waste and generally so called garbage (Shah, 2000; Peavy et al., 1986). In this company, the highest waste component is organic waste. The highest components of inorganic waste are paper waste and followed by plastic signed waste (Consulting, 2012). As a company that cares about the environment, Asset 3 PT Pertamina EP Subang field also intends to recycle plastic waste whose characteristic is difficult to degrade. Some literatures report that plastic waste possesses great energy potential. On 2012, analysis result of water content, ash, volatile content, C organic content, nitrogen and phosphate content in the waste of Asset 3 PT Pertamina EP Field Subang sequentially were 41.78% of wet weight; 51.26% of dry weight; 0.79% of dry weight; 40.68% of the dry weight; 0.64% of dry weight, and phosphates was 1.049.65 mg/kg of dry weight.

These characteristics indicate that the waste in Asset 3 PT Pertamina EP Subang Field has potential as a fuel raw material due to its good fuel power. Because its water level is still high, direct burning of the waste is not recommended, instead, the waste is better to be treated as packaged or fuel product, for example is ECO-Briquette (Consulting, 2012). There are multiple choices of technology for the application of the 3Rs. The technology chosen should pay attention to the generation, composition, and character of existing waste (Stessel, 1996). Trend world of waste management is the concept of waste to energy, including the use of waste as a raw material inorganic alternative fuels to replace fossil fuels such as coal. This technology called Refuse Derived Fuel (RDF), resulting from the mechanical separation of the combustible fraction (combustible fraction) and the hard burned (non-combustible fraction) of garbage (McDougall et al., 2001). Advanced waste-to-energy technologies like RDF production for energy recovery from solid waste is well established in many developing and developed countries (Saiki et al., 2007).

In Germany, more than 54% of the industry's heat demand are met using RDF, and some plants now operate with "zero fuel costs" or even earn money through their ability to offer environmental friendly utilization of MSW (Kara et al., 2009). Many other countries in Asia and Europe have been utilizing waste as RDFs. For industry, RDF users in Indonesia are PT Indocement and Indonesian Cement Group (SMIG). In PT Indocement, the use of RDF for kilns cement is 5% (Bimantara, 2012). Indonesian Cement Group (SMIG) learns to apply RDF from waste obtained at Ngipik final disposal, Gresik, East Java, Indonesia for it has calorie value of 3500 to 5000 kcal/kg (SMIG, 2014). The main objective of this study is to determine the characteristics of 3 PT Pertamina EP Asset Subang Field plastic waste. Then, the characteristics were used to analyze the plastic waste as a potential raw material for RDF. The characteristics include composition of waste generation particularly for plastic waste, density, and combustible characteristics including moisture content, volatile matter, ash content and calorific value. Then, the characteristics were used to analyze the potential of RDF production from plastic waste. Plastic is chosen because it is non-degradable and possess the highest energy potential.

This is the first study of how to recycle the waste of Asset 3 PT Pertamina EP Subang Field, especially on the principle of waste to energy. This effort is a form of environmental awareness of Asset 3 PT Pertamina EP Subang Field and in accordance with regulations in Indonesia. Therefore, according to the Government Regulation Number 81 of 2012 on the management of household waste and household waste, waste reduction and handling is mandatory for every person and business entity (Government Regulation, 2008).

MATERIALS AND METHODS

Sampling Locations

The waste was collected from the collecting bin of Assets 3 PT Pertamina EP Subang Field. The company is located in Purwakarta, West Java, Indonesia. There were 2 sampling areas in this location. Areas of data collection are shown Table 1, while Figures 1 and 2 show the condition of the source of waste. Sampling was conducted in November 2014, in rainy season.

Sampling Design

Sampling points were determined by the pattern of waste collection in each sampling area. At SP. Cilamaya, waste

Figure 1. SP. Cilamaya Area, Source: Study (2014).

(a) (b)

Figure 2. (a)SPG. Subang and CO_2 Removal Areas: CO_2 removal (a), (b) Office of SPG. Subang area . Source: Study (2014).

collection activities were carried out when the garbage was dumped into the transfer station so that the point of sampling was carried out directly on the containers location. There were two sampling points in SP. Cilamaya, from garbage containers in front of management office and nearby the garden. Those locations were taken for the high staff on duty activities. The location of sampling points is shown in Figure 3. At SPG. Subang and CO_2 removal, waste collection activities of each location of containers were carried out every day. The waste was then placed in trash bags of ± 660 L or 0.66 m^3 in size that there was only one selected sampling point, which was at the trash location. The location and containers is shown in Figure 4.

Generation And The Composition Of Solid Waste

The total weight of all samples collected during 8 days with unit weigth (kg). And then, the composition of garbage mass can be determined by the percentage of waste component. It involves the weighing of individual components of the volume of garbage in selected samples and determine their percentage. Based on the results of the analysis it will be possible to determine the

(a)

(b)

Figure 3. Point Sources at SP. Cilamaya: (a) Sampling Point I-in front of Office Building (b), Sampling Point II-in front of Garden. Source: Study (2014).

potential of waste into the recycling, that is, as a raw material for RDF (Diaz et al., 1993; Tcobanoglous et al., 1993).

Density Of Solid Waste

Waste density was analyzed in accordance with the procedures in the Indonesian National Standard (SNI) 19-1964-1994. The box is filled with the representative sample so that the sample is heaped above the top box, but does not spill on the floor. The sample is then made to settle by lifting the box to 30 cm above the floor and dropping it three times. Then, a straight-edge is used to sweep those parts of the sample still protruding above the box onto the floor, yielding a known volume as sample. The box is then weighed, and its tare weight subtrated. That mass, divided by the volume of the cube, is the bulk density (Stessel, 1996; Peavy et al., 1993, Tcobanoglous et al., 1993).

Combustible Characteristics

The combustible characteristic was used for determination of plastic waste potential as a raw material of RDF. Waste properties are important to determine the material handling properties of the material. Combustible analysis consist of moisture content, ash content, volatile matter content, and Caloric value or Low Heat Value (LHV) determined by put the selected sample to different range of the temperature, between 100 to 950°C. The laboratory methods to measuring the combustible analysis of samples in this study were crried out based on ASTM standard.

Moisture Content

The percent moisture of the waste samples was determined by weighing 1 kg of the samples into a pre weighed dish and drying the samples in an oven at 105°C to a constant weight (ASTMD 3173; Stessel, 1996; Peavy et al., 1993). The percent moisture content (MC) was calculated as a percentage loss in weight before and after drying. Equation (1):

$$\%\,Moisture\ content = \left[\frac{(Wet\ weight - Dry\ weight)}{Wet\ weight}\right] \times 100\% \qquad (1)$$

Ash Content

Ash content of waste is the non-combustible residue left

Figure 4. Container Collector of SPG. Subang and CO_2 Removal. Source: Study (2014).

Table 2. Solid waste generation at SP. Cilamaya and SPG. subang and CO_2 removal on 2014.

No	Location	Generation (kg/day)	Generation (kg/capita/day)
1	Collection station of Cilamaya (SP. Cilamaya) area	2.170	0.051
2	Collection Station of SPG. subang and CO_2 removal	6.990	0.054

Source: Study (2014).

after waste is burnt, which is represents the natural substances after carbon, oxygen, sulfur and water. Procedure analysis for ash content used methods in ASTM E 830-87. As an alternate method use the dried analysis sample from the residual moisture determination. See Test Method E 790. Place the uncovered container containing the sample in the furnace at low temperature and gradually heat to ignition at such a rate as to avoid mechanical loss from too rapid expulsion of volatile matter. Finish the ignition to constant weight 96 ± 0.001 g/h) at 575±25°C. It may be determined that a constant weight can be routinely established by allowing a sample to ash within the prescribed.

Volatile Matter Content

Procedure analysis for volatil matter content used methods in Standar Test Method for volatil matter in the analysis sampel of RDF (ASTM, 2004[c]). Heating for a total of exactly 7 min. on 950° C zone. Then, remove the crucible from the furnace and, without disturbing the cover, allow it to cool on a metal cooling block. Weigh as soon as cold (Note 2: To ensure uniformity of results, the cooling period should be kept constant and should not be prolonged beyond 15 min.). The percentage loss of weight minus the percentage moisture in accordance with Test Method E 790 is the volatil matter. Equation (2).

$$\% VS = \left[\frac{(Dry\ sample\ \ weight - Ash\ weight)}{Dry\ sample\ \ weight}\right] \times 100\% \quad (2)$$

Caloric Value or Low Heat Value (LHV)

Procedure analysis for caloric value used methods in ASTM 5865-03. The instrument of the analysis is Bomb calorimeter.

RESULTS AND DISCUSSION

The potential of waste, especially plastic waste of Asset 3 PT Pertamina EP Subang field as raw material of RDFs can be determined by the following characteristics.

Solid Waste Generation in SP. Cilamaya and SPG. Subang and CO_2 Removal

Potency of RDFs was determined also by the rate of generation due to the availability of waste in the form of quantity and continuity role in the sustainability of the production of RDF. Solid waste generation in SP. Cilamaya and SPG. Subang and CO_2 Removal on 2014 is shown in Table 2. Daily waste generation rate at SP. Subang and CO_2 Removal was higher than that at SP. Cilamaya by 6.990 and 2.17 kg/day. However, the

Table 3. Density of plastic waste in SP.Cilamaya and SPG. subang and CO_2 removal.

Sampling location	Density (kg/m^3)
SP. Subang and CO_2 removal	20.67
SP. Cilamaya	32.24

Source: Study (2014).

amount of waste generated per person was nearly the same of 0.054 and 0.051 kg/capita/day. This value was influenced by the activities being carried out in both areas sampling. In SPG Subang and CO_2 Removal, project work to improve the infrastructure was carried out that the average number of active staff was 128 people per day. Meanwhile at SP. Cilamaya, there was no project activities carried out that the number of active staffs was 42 people. This shows that the more people with a variety of activities, the higher the amount of waste generated. Therefore, waste generation was defined as the amount of waste generated by an activity within a certain time or in other words the amount of waste generated in units of weight (kilograms) gravimetri or volume (liters) volumetric (Peavy et al., 1993; Tchobanoglous et al., 1993). The amount of the waste generated the sampling site was very low compared to the need for waste management technology such as RDF. Hence, to utilize the waste as raw material of RDF, Pertamina should perform it communally from various waste sources across the sampling areas to meet the requirement of efficient processing cost.

Composition of Solid Waste in SP. Cilamaya and SPG. Subang dan CO_2 Removal

Figure 5 shows that the largest inorganic waste composition at SP. Subang and CO_2 Removal was plastic by 37%, while SP. Plastic Cilamaya placed the second position of 10%. Plastic components waste is classified into 3 types which were subsequently coded as 1, 2 and 3 based on the existing plastic materials with code 1 for packaging and bottle cap, code 2 for bottles, and code 3 for plastic bag. At SPG. Subang and CO_2 Removal, composition percentage of plastic waste from highest to lowest was 37% for code 1, 36% for code 2, and 27% for 3. Meanwhile percentage composition of SP. Cilamaya was 46% for code 1, 27% for code 2, and 27% code 3. The high percentage of plastics due to the increased amount of use of plastics as packaging. The selected waste type to be used as RDF was plastic waste, considering that the use of plastics has been increasing because it is durable. However, long-lasting property creates problems in the environment due to its accumulation, increasing number and low degradation ability. Some problems have also existed, including shorter landfill operation duration and many mangrove estuaries die from root rot as they are closed by plastic debris from the the land.

The presence of large amount of plastic waste affects the quantity and continuity of RDF production. The analysis results of plastic waste composition in SPG. Subang and CO_2 Removal sampling areas was 37% or 1.18 kg/day while at SP. Cilamaya was 10% or 0.28 kg/day. These value cannot be used as raw materials of large scale of RDF. Thus, if the Asset 3 PT Pertamina EP Subang Field intends to produce RDF, it should consider the source of viable plastic waste as raw material of RDF production in terms of quantity and continuity.

Density of Plastics Waste SP. Cilamaya and SPG. Subang and CO_2 Removal

Density is one of waste characteristics used to determine the potential of RDF. Density value at SP. Cilamaya and SPG. Subang and CO_2 removal is shown in Table 3. The density of plastic waste in SP. Cilamaya amounted to 32.24 kg/m^3 and in SPG. Subang and CO2 Removal was 20.67 kg/m^3. SP. Cilamaya plastic density is higher density value of the SPG. Subang and CO2 Removal due to the type of waste that is put into the bin when the measurement volume, more of this type of waste plastic than the bottle. Waste density values in both locations can be improved with treatment, such as destroyed to reduce the size of the volume of waste.

Plastic Waste as a Potential Raw Materials of RDF

Table 4 shows the results of comparison of the characteristics of the plastic waste in the SP. Cilamaya and SPG. Subang and CO_2 removal with the quality standards of RDF in some countries as Finland, Italy, etc. (Gendenbien et al., 2003). The result is at the SP. Cilamaya and SPG. Subang and CO_2 removal has the highest LHV value, low moisture content and ash content lower. Then, in the SP. Cilamaya and SPG. Subang and CO_2 removal has a value almost equal to the volatile material ISTAC Co (Turkey). So the conclusion of this value, plastic waste from Asset 3 Pertamina has potential as a raw material RDF. The use of RDF made from plastic waste as a fuel provides advantages, such as high heating value, the homogeneity of the physical-chemical composition, take easy of storage, handling, and transfer of, the fewer emissions of

Table 4. Comparative of caracteristic of plastics waste at SP. Cilamaya and SPG. subang and CO_2 removal with standar quality of RDF.

Parameter	Unit	Finlandi	Italia	Inggris	European standard	ISTAC Co.	Lechteberg	SP. subang dan CO_2 removal			SP. Cilamaya		
								1	2	3	1	2	3
LHV	kCal/kg	3.107-3.824	3.585	4.469	3.585	3.500	-	8.650	8.520	6.154	9.627	9.192	5.142
Moisture content	(%w)	25-35	Max. 25	7-28	<25	25	<20	2.61	1.89	0.50	4.19	3.53	0.63
Ash content	(%dry)	5-10	20	12	<5	7,7	8-12	8.95	10.44	0.12	5.55	12.66	1.02
Volatile content	(%dry)	-	-	-	-	92.3	50-80	91.05	89.56	99.88	94.45	87.34	98.98

Sources Gendenbien et al. (2003), Kara et al. (2009).

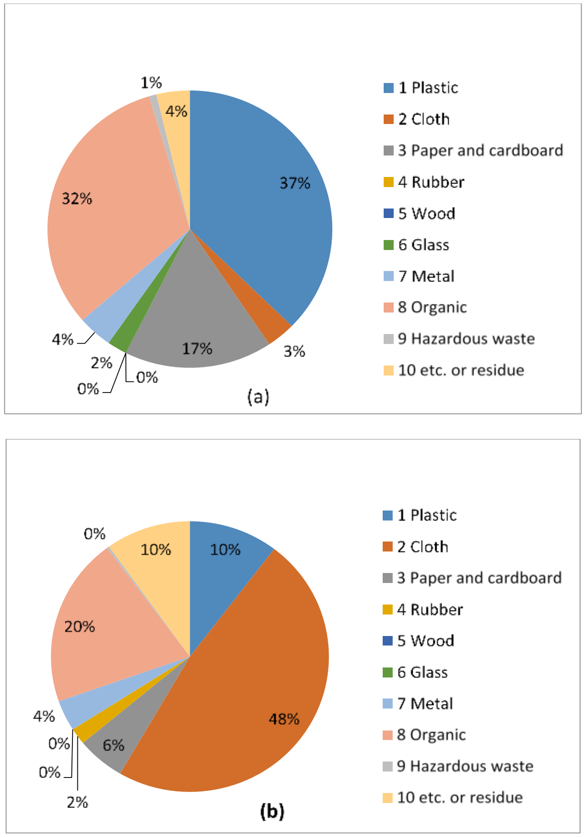

Figure 5. Composition of Waste: SP.Cilamaya (a), SPG. Subang and CO_2 Removal (b) Source: Study (2014).

pollutants generated and reduced air needed for combustion processes (Nitikhul, 2007).

CONCLUSIONS

Based on the results presented earlier, the rate of waste generation at SP. Cilamaya and SPG. Subang and CO_2 Removal was 2.170 and 6.990 kg/day with the composition of the plastic waste by 10% or 0.28 kg/day and 37% or 1.18 kg/day. The density of plastic waste in the area reached 32.24 kg/m3 and 20.67 kg/m³. The value of the combustible parameter showing the potential of plastic waste as raw material RDF including water content, ash content, volatile matter content, and LHV sequentially was 0.63 to 4.19%; 1.02 to 12.66%; 87.34 to 98.98%; and 5142-9627 kcal/kg at SP. Cilamaya. At SPG. Subang and CO_2 Removal the value was 0.50 to 2.61%; 0.12 to 10.44%; 89.56 to 99.88%; and from 6154 to 8650 kcal/kg at SPG. These values, compared to the standard RDF in several countries, have shown the potential of plastic waste as a raw material of RDF, yet not massive.

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