Preliminary Study: Conversion of Organic Fractions in Municipal Waste in Samarinda City into Value-added Products

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Keywords: Inorganic Waste, Municipal Waste (MSW), Organic Waste, Subcritical Water Technology.

Abstract: In line with economic and population development, currently cities in Indonesia are facing increasing waste management problems with the area of land to buy continues to decrease. As the population increases, the amount of waste generated will also increase. Based on data from the Ministry of Environment and Forestry (KLHK) in 2020, the amount of waste in Indonesia in 2020 reached 67.8 million tons per year with the composition of waste dominated by organic waste, contributing 60% of the total waste. Plastic waste ranks second with 14%, followed by paper waste at 9% and rubber at 5.5%. This initial study aims to characterize waste in the Samarinda City area and pay attention to Organic Waste in Municipal Waste (MSW) so that it becomes a value-added product using subcritical water technology. With a research method that refers to the type and characterization of waste in the city of Samarinda and the potential for organic waste to be converted into energy or products by reading organic waste in municipal waste into value-added products using the subcritical water method and analyzing the environmental impact of technology to convert organic waste into waste city. Studies from other researchers, most researchers only use conventional technology methods, namely composting, biogas and incineration. Other researchers also conduct special research with certain types of samples. This is different from research that uses the subcritical water technology method.

1 INTRODUCTION

Garbage is residual material from human activities that has no use, serial must be managed. Without proper and proper management, waste can cause losses because it will cause flooding, climate management, cause bad smells, disturb beauty, worsen environmental sanitation and threaten various diseases (Sri, 2015).

In line with the development of the economy and population, currently, cities in Indonesia are facing the problem of handling the waste problem which continues to increase with large areas of land to cancel the end which continues to decline. Indonesia is the largest archipelago in the world with an area: 1.905 million km² consisting of 17,504 islands. With a population of nearly 270,054,853 people in 2018, it is projected that in 2020 it will increase by 271,066,000 people (Badan Pusat Statistik Kota Samarinda, 2020).

From the increasing population, it will also increase the amount of waste produced. Based on data from the Ministry of Environment and Forestry (KLHK) in 2020, the amount of waste in Indonesia in 2020 reached 67.8 million tons per year with the composition of waste dominated by organic waste, accounting for 60% of the total waste. Plastic waste is in second place with 14%, followed by paper waste at 9% and rubber with 5.5%. Other waste consists of metal, cloth, glass and other types of waste (Badan Pusat Statistik Kota Samarinda, 2020).

From this increase, both the population and the amount of waste will also occur in every island in Indonesia such as in East Kalimantan, especially in the city of Samarinda in 2020 according to data from DLH Samarinda, the daily waste production of Tepian City is 800 tons. Within a year, garbage in the city of Samarinda can reach 292 thousand tons per year (Badan Pusat Statistik Kota Samarinda, 2020).

Where the composition of waste in the city of Samarinda is food waste 59.30%, plastic 17.90%, paper 12.93%, yard waste 3.19%, cardboard 2.17%, diapers 2, 04%, hazardous and toxic waste 0 , 80%,

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0.43% cans, 0.41% glass, 0.40% wood, 0.28% textiles, 0.11% rubber, 0.03% metal and 0% leather, while based on the variation it is dominated by waste organic 62.90%, inorganic waste around 36.30% and hazardous and toxic waste around 0.8% (Juli, 2017).

The size of the waste problem grows along with the population growth in the city (Sucipto, 2012). Based on data from the (Badan Pusat Statistik Kota Samarinda, 2020), Samarinda City has an increasingly rapid population growth. Waste is a problem in big cities, both in terms of quantity and type, and the composition of the waste will have an effect and have a big impact on the waste management system (Sumantri, 2013).

Solid waste management systems, especially for urban areas, must be implemented appropriately and systemically. Solid waste management activities will involve the use and utilization of various waste infrastructure and facilities which include container, collection, transfer, transportation, processing and final disposal. The problem of waste is closely related to the lifestyle and culture of the community itself. Therefore, waste management is not only a government affair, but its handling requires broad community participation (Jailan, 2016).

Thus, the need for efforts to reduce waste from the source to reduce the burden of processing waste at the TPA. The concept of waste management by reducing waste at the producer and consumer levels, waste handling which includes sorting, collecting, transporting, and final processing has not yet optimally resolved these problems. Currently, the level of solid waste services has only reached 79.80%, while the universal target of access to sanitation is 100% in 2019. (Kementerian PUPR, 2019),

2 LITERATURE REVIEW

Samarinda City is the capital of the province of East Kalimantan, as well as the largest city in the whole of Kalimantan Island with a population of 812,597 people. Samarinda has an area of 718 km² with a hilly geographical condition with altitudes varying from 10 to 200 meters above sea level. The city of Samarinda is divided by the Mahakam River and becomes the gateway to the interior of East Kalimantan by river, land and air. The population growth reaches 2,000 people per year or 1.9% and vehicle growth reaches 4.46%(Badan Pusat Statistik Kota Samarinda, 2020), the progress of industry and trade directly affects the condition of the city itself, causing social impacts that are not easily resolved thoroughly, such as the problem of sampad and waste management in the city of Samarinda (Fitriyati, 2020).

Garbage is solid which is no longer used and thrown away. Garbage can come from our daily activities or come from industry, commercial places, markets, parks and gardens, etc. From the material content, waste is classified into two types, namely organic waste (waste originating from animal, plant and human parts) and inorganic waste (waste originating from mineral materials such as metal, glass, plastic, and so on). Organic waste contains various substances such as carbohydrates, proteins, fats, minerals, vitamins, etc. Naturally, these substances are easily decomposed by physical, chemical influences, the enzymes contained by the waste itself and the enzymes released by the organisms living in the waste.

The uncontrolled decomposition of organic waste generally takes place anaerobically (without oxygen). From this process, gases such as H_2S and CH_4 arise, which smell so strong that this process is known as the process of decay. From this process leachate (leachate) also arises which can cause ground and surface water pollution. Decomposing waste is also a source of diseases such as bacteria, viruses, protozoa, and worms. Judging from the sanitation and environmental aspects as described above, organic waste needs serious handling or attention because the amount it generates is quite large, around 70 - 80% of the total waste. City (Wahyono, 2011).

The issue of waste is constantly being discussed, because it is related to the lifestyle and culture of the community itself. Therefore, waste management is not only a matter for the government, but also requires the participation of the public at large. In terms of waste handling, it can be assumed that the rate of waste production is not proportional to the handling process. This certainly spurs local governments to think earlier about how efficient strategies are in overcoming solid waste problems. In the capacity of the city as a source of meeting human needs, it is appropriate to provide adequate facilities and infrastructure to preserve the environment through good solid waste management. If the waste problem is not handled properly, it can cause various problems, to the risk of human health and other creatures. Good solid waste management is a series of activities that include collection, transportation, management and disposal. Each of these activities is related to one another and is mutually related.

The development of waste production every day

has increased quite sharply. He hopes that its management will also be carried out effectively and efficiently. However, based on empirical observations, it can be seen that the waste production and the ability to manage this waste are not balanced. The cause is the limited means of collecting and transporting waste. This problem will not only be a short-term problem, but will become a long-term problem, so it needs to be addressed with local government policies, so that the handling will be more integrated with maximum results. Solid waste problems occur partly due to chaotic settlement patterns and the rapid increase in population. So one aspect that is being pursued is adequate facilities and infrastructure as the main media for solid waste management (Mohamad, 2011).

Waste management of a city aims to serve the waste generated by residents. Currently, solid waste management is facing a lot of pressure, especially due to the increasing source of waste from waste producers. This is made even harder by the old paradigm of management that relies on collection, transportation and disposal activities. This condition requires a larger budget from time to time and if a suitable system for waste management is not available it will cause many operational problems such as waste not transported, facilities that do not meet requirements, how to operate facilities that do not comply with technical requirements.

Based on the explanation of Law Number 18 Year 2008 concerning Waste Management. It is time for the waste management paradigm that relies on the final approach to be abandoned and replaced with a new paradigm of waste management. The new paradigm views waste as a resource that has economic value and can be utilized, for example, for energy, compost, fertilizer or for industrial raw materials.

Waste management is carried out with a comprehensive approach from upstream, from before a product that has the potential to become waste is produced, downstream. , that is, at the stage the product has been used so that it becomes waste, which is then returned to environmental media safely. Waste management with this new paradigm is carried out by reducing and handling waste activities. Waste reduction includes limitation, reuse, and recycling activities, for waste handling activities including sorting, collection, transportation, processing, and final processing (Reni, 2017). One interesting option is the conversion of organic waste in municipal waste (MSW) into value-added products using subcritical water technology (SBCWT).

3 RESEARCH METHODOLOGY

The research method refers to identifying the type and characterization of waste in the city of Samarinda and evaluating the potential of organic waste to be converted into energy or products by converting organic waste in municipal waste into value-added products using the subcritical water method and analyzing the environmental impact of conversion technology. organic waste in municipal waste. Studies from other researchers, most researchers only use conventional technological methods, namely composting, biogas and incineration. Other researchers also specifically conducted research with certain types of samples. This is different from research using subcritical water technology methods The research that will be carried out begins with formulating the problem from the background problem so that it is expected to achieve the expected results and conclusions. To follow up the problems that have been formulated, a literature study was carried out to find out information and the theoretical basis of problem solving. Furthermore, research and data collection will be carried out with procedures and variables based on the literature study that has been conducted. This research is expected to be able to answer smapah problems which often become environmental, social and cultural problems. However, the problem can be overcome with a conversion technology approach, namely converting waste into high value products.

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The issue of waste continues to be discussed, because it is related to the lifestyle and culture of the community itself. Therefore, waste management is not only a matter for the government, but also requires the participation of the public at large. In terms of waste handling, it can be assumed that the rate of waste production is not proportional to the handling process. This certainly spurs local governments to think earlier about how efficient strategies are in overcoming solid waste problems. In the capacity of the city as a source of meeting human needs, it is appropriate to provide adequate facilities and infrastructure to preserve the environment through good solid waste management. If the waste problem is not handled properly, it can cause various problems, to the risk of human health and other creatures. Good solid waste management is a series of activities that include collection, transportation, management and disposal. Each of these activities is related to one another and is mutually related.

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The data obtained from the research will be collected and processed, then analyzed in order to obtain results and conclusions. There are several stages of data collection, namely primary and secondary data with a data approach using a qualitative description method, namely to analyze previous research on the conversion of organic waste into municipal solid waste. The reference of this research data uses reliable reference sources, which can be traced to the google scholar index, to identify relevant academic literature.

3.1 Proposed Method

The method used in this study is a qualitative description method, namely to analyze previous research on the conversion of organic waste into municipal solid waste. The reference of this research data is to use reliable reference sources, which can be traced to the google scholar index, to identify relevant academic literature.

The activities carried out in this study were to collect data about waste and how to handle it in the city of Samarinda. The data collected is in the form of primary data. Primary data is data obtained directly from the field or research location through observation and questionnaire methods.

Researchers use this data to obtain direct information about the characteristics of the area, the condition of the area and the management system garbage in the Samarinda area. Primary data used include:

a) Waste generation
b) Solid waste management, consisting of collection, transportation and disposal.
c) Factors that affect the waste management system.

4 RESULTS AND DISSCUSION

The method that will be used in this study is a qualitative description method, namely to analyze previous research on the conversion of organic waste in municipal waste. The reference for this research data is to use trusted reference sources, which can be traced to the Google Scholar Index, for identification of relevant academic literature.

The activity carried out in this research is to collect data on waste and how to handle it in the city of Samarinda. The data collected in the form of primary data and secondary data. Primary data is data obtained directly from the field or research location through observation and questionnaire methods. And secondary data is data obtained from the literature and an overview of accurate data information.

4.1 Primary Data

Researchers use this data to get direct information about the description of the characteristics of the area, the condition of the area and the waste management system in the Samarinda region. The primary data used include:

a) Garbage Generation

Based on SNI 19-2454-2002 concerning Procedures for Urban Waste Management, waste generation is the amount of waste that arises from the community in units of volume and weight per capita per day, or expand buildings, or lengthen roads.

It is very important to know waste generation data to determine the facilities of each waste management unit and its capacity, for example equipment facilities, transport vehicles, transportation routes, recycling facilities, area and type of landfill.

The data in the table below is primary data obtained on April 7, 2021 at the Samarinda City Environmental Service. This was carried out during a direct interview with the Head of the DLH Section (Kasi) of Samarinda City, Mr. Zainal Abidin. Primary data is data obtained directly from the research location, as well as respondents who provide information to researchers.

Table 1: Calculation of the minimum service standard of Samarinda city transportation services per year period.

No	Description	Unit	Years					
			2015	2016	2017	2018	2019	2020
1	Total Population	Soul	913655	936669	769632	85893	872769	886806
2	Waste Generatiomn Volume	M^3/day	3133.83	3212.66	2640	2311.81	2349.06	2386.84
3	Volume of Waste Handled	M^3/day	1938.58	2002.34	2288.5	1909.27	1709.63	1749
4	Persentace and Processing of Waste Generation in TPA	%	61.86	62.33	86.96	82.59	72.78	73.26
5	Total TPS	Unit	317	317	254	255	251	250
6	Total TPS Capacity	M^3	1518	1518	1429	1569.5	1522	1521
7	Ratio of TPS Caoacity per 1000 Population	Ratio	1.66	1.62	1.86	1.83	1.74	1.72

b) Waste Management, Consisting of Collection, Transportation, and Disposal.

c) Factors Affecting the Waste Management System.

Table 2: Waste management, consisting of collection, transportation, and disposal.

Number and Capacity of Garbage Collection Fleet

I. Number of Garbage Collection Fleet
OPD : Dinas Lingkungan Hidup Samarinda
Tahun : 2021

No	Description	Fleet Type	Total Driver	Production Year										Total Fleet	Trash volume/Unit/m3	Information
				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020			
1	Container Garbage Transport	Area Rool	20	2		2	2	6				1			19	8 Unit	
2	Garbage Transport	Dump Truck	56	3	1	2	4	6				1	9	1	34	8 Unit	
3	Ditch and sewage transportation		9									3			6	4 Unit	
4	Sand Transport		12												7	4 Unit	
5	SATGAS worker transportation	Pick Up	5										1		5		
6	TPS/Container Spraying		1												1		
7	Garbage Patrol Car And Counseling		2							1				1	2		
8	Transport of trench workers	Engkel Truck	5												3		
	Transport of spraying of TPS/containers	Tank Truck	2												2	3000 Liter	
9	Vacuum Cleaner	Sweeper	1						1					1	2	4 Orang	
	Total	Fleet	113	5	1	4	6	12	1	1		5	10	3	81		

Sumber: Dinas Lingkungan Hidup Kota Samarinda tahun 2021.

Obstacles for the Samarinda city government in dealing with waste problems in the city of Samarinda or the obstacles faced by the Department of Hygiene and Parks in the city of Samarinda in efforts to overcome waste in handling waste in the city of Samarinda, such as the lack of TPS/containers in the city of Samarinda and causing high piles the garbage in the container as well as the lack of public awareness in complying with the rules of time and place in disposing of waste which causes the landfill to always look full.

Even though in the container area the Sanitation and Parks Office of Samarinda City has put up a banner to always throw garbage into the container. With the increasing population of Samarinda City, the volume of municipal waste also increases. If the TPS and the waste collection fleet are not balanced with the increasing volume of waste, it will be difficult to create a clean and healthy city environment. Moreover, there is no waste processing technology that can process waste into goods of economic value, namely the conversion technology from municipal waste (MSW) into high-value goods.

In the Samarinda City Regulation Number 02 of 2011 concerning Waste Management, it has been explained that the provision or procurement of TPS, transporting waste from TPS to TPA, including providing garbage carts in certain places where TPS is not possible to build is the obligation of the Regional Government and is the responsibility of the Office of Hygiene and Parks. Samarinda city in providing services to the community, especially in the field of services. This indicates that the Sanitation and Parks Office of the City of Samarinda has not been maximal in fulfilling its obligations to serve the community in the waste sector because cleanliness is a shared responsibility that should be realized by all parties, both from the community and authorized agencies, as stated in the Regional

Regulation of the City of Samarinda No. 02 of 2011 Article 45 Paragraph 2 states that the Head of the Neighborhood Association (RT) as the person in charge of residential areas is responsible for the order and cleanliness of the environment in his area.

Based on these regulations, in other words, every citizen is obliged to maintain the cleanliness of his environment without being separated from the monitoring and direction of the Head of the Neighborhood Association (RT) and the Village Head as the leader of the administration of government affairs in the working area of the Village. So basically the obstacles in handling waste problems in the city of Samarinda are: a. Lack of discipline in the city of Samarinda, there are still many who do not understand and are not aware of the cleanliness of the city b. Age of old facilities and facilities c. And budget.

Besides the above constraints, there are also other factors, namely the separation of waste based on its composition or type of waste. The Samarinda city government only separates its waste based on 2 major groups, namely organic waste and inorganic waste. The current problem in Samarinda City for handling waste is that the waste composition group has not been implemented. However, research on the composition of waste has been carried out by (Juli, 2017) but the government has not implemented a waste classification system based on its composition. The following data was carried out (Juli, 2017), the composition of waste in the city of Samarinda is 59.30% food waste, 17.90% plastic, 12.93% paper, 3.19% yard waste, 2.17% cardboard, 2 diapers , 04%, hazardous and toxic waste 0.80%, cans 0.43%, glass 0.41%, wood 0.40%, textile 0.28%, rubber 0.11%, metal 0.03% and leather 0%, while based on the variation, it is dominated by organic waste 62.90%, inorganic waste around 36.30% and hazardous and toxic waste around.

4.2 Secondary Data

Data from reliable reference sources regarding waste both on a national scale and on a local scale (Samarinda city scale) obtained from the reference http://SIPSN.MenLHK.go.id/SIPSN/ (Badan Pusat Statistik Kota Samarinda, 2020) are as follows:

- National Scale

Waste Management Performance Achievement is the Achievement of Reduction and Handling of Household Waste and Waste Similar to Household Waste. The achievements below are the achievements in 2020 consisting of 283 regencies/cities throughout Indonesia.

Waste Generation: 35,476,875.59 (tons/year)
Waste Reduction: 16.19% i.e. 5,744,379.16 (tons/year)
Waste Handling: 37.92% i.e. 13,451,297.67 (tons/year)
Managed Waste: 54.11% i.e. 19,195,676.83 (tons/year)
Unmanaged Waste: 45.89% i.e. 16,281,198.76 (tons/year)

- Samarinda City Scale

The East Kalimantan Environment Agency (DLH) shows the percentage of waste that is managed and utilized (Semester 1) from January to June 2020 in 10 regencies and cities throughout East Kalimantan. Specifically for data on managed waste, waste generation amounted to 703,664.26 tons. A reduction of 102,290.48 tons. Handling amounted to 443,178 tons, and managed as much as 545,468.64 tons per year. Meanwhile, for the utilization of waste throughout East Kalimantan, there was as much as 703,664.26 tons of waste generated. The amount of waste reuse is 11,176.87 tons, the amount of waste recycling is 58,269 tons, processing is 16,442.20 tons and the waste is utilized as much as 85,887.79 tons. The data is taken from the regional strategic policy document (Jakstrada) for the management of household waste and similar household waste.
And for the amount of waste from both the national and local scales are as follows:

¬ TOTAL WASTE IN INDONESIA

KLHK: 2020 National Waste Amount Reaches 67.8 Million Tons per year Based on data from the Ministry of Environment and Forestry (KLHK), the composition of waste is dominated by organic waste, which reaches 60% of the total waste. Plastic waste occupies the second position with 14%, followed by 9% paper waste and 5.5% rubber. Other waste consists of metal, cloth, glass, and other types of waste.
(https://www.idntimes.com/news/indonesia/aldzah-fatimah-aditya/klhk-nomor-sampah-nasional-2020-men reach-678-juta-ton/3)

¬ TOTAL WASTE IN EAST KALIMANTAN

The East Kalimantan Environmental Service (DLH) shows the percentage of waste that is managed and utilized from January to June 2020 in 10 regencies and cities throughout East Kalimantan. For data on managed waste, waste generation is 703,664.26 tons per year. A reduction of 102,290.48 tons. Handling amounted to 443,178 tons, and managed as much as 545,468.64 tons per year. 20Environment%20Life%20(DLH)%20Kaltim,waste%20amount%20703.664%2C26%20tons).

¬ TOTAL WASTE IN SAMARINDA

According to data from DLH Samarinda, the daily waste production of Tepian City is 800 tons. In a year, the waste can reach 292 thousand tons per year. 17 to 19 percent is plastic waste. With this estimate, in a year Samarinda's plastic waste reaches 49,640 to 55,480 tons per year. (https://rri.co.id/samarinda/government/689980/dlh-dari-800-ton-sampah-di-samarinda-17-19-persen-sampah-plastik)

¬ TPS AND TPA DATA

Data In 2020, waste collection sites (TPS) in the city of Samarinda totaled 269 TPS and 2 TPA or Final Shelters (http://e-journals.unmul.ac.id/index.php/JAR/article/view/570). And Data In 2021 the Waste Shelters (TPS) in the city of Samarinda amounted to 102 TPS and there were 2 TPAs or Final Shelters.

Solid Waste Management Service Chain in Samarinda City

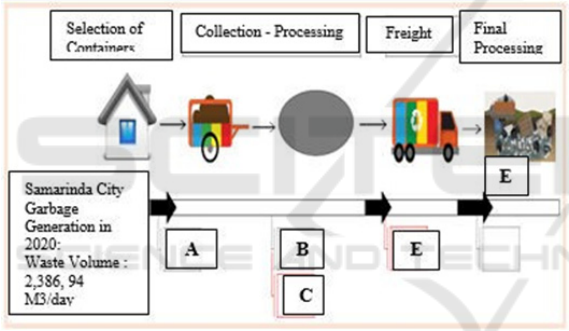

Figure 1: Solid Waste Management Service Chain in Samarinda City.

Garbage Type

A	Waste Reduction With Takakura/Composter/Waste Bank
B	Waste Reduction With 3R TPS / Main Waste Bank / Communal Biodigester / Collectors / TPST
C	Not Collected To TPS/TPS 3R/TPST
D	Not transported to landfill
E	Waste Reduction in TPA Composting/Economical Value Waste Collection by Scavengers Plastic Counter/Biodigester

Types of Waste by Source

Based on the source, waste is divided into 6 types, including:

1. Trash from humans
2. Trash from nature
3. Consumption waste
4. Nuclear waste/radioactive waste
5. Industrial waste
6. Mining waste
7. Animal litter

Types of Waste Based on Characteristics

1. Organic Waste
   Organic waste is waste that can be decomposed or processed into compost.
   Types of waste that are considered as organic include food scraps, dry leaves, vegetables, and so on.
2. Inorganic Waste
   Inorganic waste is waste that is difficult to decompose and cannot be decomposed.
   If not managed properly, this waste can damage the ecosystem of animals and humans.
   However, the existence of this waste can be tricked by looking for recycling.
   Examples of inorganic waste include plastic, cardboard, metal, and so on.
3. B3 Garbage
   This type of waste is usually the residue from processing hazardous chemicals.

Types of B3 waste itself include the following:

- Unspecified sources: Waste originating from equipment maintenance activities, descaling, washing, and others.
- Specific sources: Waste originating from industrial
- processes (main activity).
- Other sources: Waste originating from unexpected sources such as expired products, packaging residue, and product odors that do not meet specifications.

Types of Garbage Based on Shape

Figure 2: Types of Waste Based on Characteristics.

Types of waste described above, namely the types of waste based on their source and based on their nature, that has been implemented by the local government of Samarinda city, but the type of waste based on its form has not been fully implemented in the city of Samarinda. Therefore, from the initial study of municipal waste conversion (MSW) this will emphasize the separation of waste based on its shape. From the results of previous studies, the composition of waste in the city of Samarinda is as follows:

Table 3: Percentage of Municipal Solid Waste Composition in the City Samarinda.

No	WasteTypes	waste Component	Percentage(%)	
			waste types	waste Composition
1	Organic	Leftovers	62,90	59,30
		Junk pages		3,19
2	Inorganic	Wood	36,30	0,40
		Paper		12,93
		Cardboard		2,17
		Plastic		17,90
		fabric		0,28
		rubber		0,11
		skin		0,00
		glass		0,41
		Cans		0,43
		Metal		0,03
		Diapers		2,04
3	B3	B3	0,80	0,80

Garbage Handling

The current waste management in the city of Samarinda uses the 3P method (Collection, Transport and Disposal) as in the waste management service chain in the city of Samarinda above, while the technology for handling organic waste that is currently used in the city of Samarinda are: Sanitary Landfill, Incineration, Composting, Briquetting, Anaerobic Digester and animal feed pellets. For technology for handling organic waste, researchers will emphasize the technology for converting municipal waste organic waste into added value, namely using subcritical water technology (hydrothermal technology).

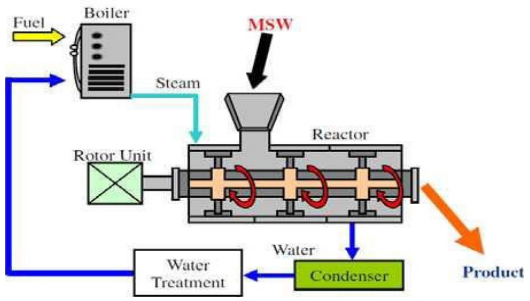

Figure 3: Pilot Plant Waste treatment with hydrothermal technology (Panji, 2012).

From the above, this is a preliminary study of the conversion of organic fractions in municipal waste in the city of Samarinda into value-added products.

5 CONCLUSION

1. From the types of waste described above, namely the types of waste based on their source and based on their nature, that has been implemented by the local government of Samarinda city, but the type of waste based on its form has not been fully implemented in the city of Samarinda. Therefore, from the initial study of municipal waste conversion (MSW) this will emphasize the separation of waste based on its shape.
2. For technology for handling organic waste, researchers will emphasize the technology for converting municipal waste organic waste into added value, namely using subcritical water technology (hydrothermal technology).

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