Study of Generation, Composition, Characteristics, and Recycling Potential of Industrial Food Waste in Padang City

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Abstract. The purpose of research to measure and analyze the generation, composition, characteristics, and potential recycling industrial food waste in Padang City. The sampling and determination of samples based on SNI 19-3964-1994, which was carried out for eight consecutive days with sampling from 35 food industry consist of large industrial, medium industries, and small industries. The average quantities of food waste generated from the large, medium, and small industries in Padang City were 0.005 kg/d, 0.083 kg/d, and 0.262 kg/d, respectively. The composition of food waste consists of 94.01% organic waste, 5.97% plastic waste, 0.01% paper waste, and 0.01% other waste. The potential for recycling of industrial food waste was 75.20% plastic, 100% nonferrous metal, and 97.38% organic waste. The characteristics of the waste based on parameters average density, water content, volatile content, ash content, fixed carbon, C/N ratio, calorific value, and biodegradability fraction were 13.32 kg/l, 13.77%, 26.75%, 45.39%, 14.09%, 13.77, 1,798 kJ/kg, 38.87%, respectively. The generation, composition, characteristics, and potential recycling industrial food waste is very important for proper waste management.

Keywords: characteristics, composition, generation, industrial food waste, recycling potential

1. Introduction
Waste management is an important factor in supporting urban infrastructure development because every community has the right to get sanitation facilities. Mismanagement of waste leads not only degrade environment but also can damage urban infrastructure. Technological and industrial advances in today’s globalization, have a high impact on all sectors of life. One of them is increased environmental pollution as a result of growing population and growing and diverse industries, one of the food industry. Data from the United Nations Food Agency (FAO) in the year 2016 in Indonesia food waste reaches 13 million tonnes annually. Based on FAO, food waste means the amount of waste generated during the food manufacturing process as well as after eating-related activities with the seller and consumer behaviour [8]. The prevention and recycling of food waste management contribute to urban infrastructure.

According to the Head of the Environment Agency in Padang City The food industry sector in Padang City ranks second after tourism objects as a contributor to the increase in waste generation in Padang City [1]. Data from the Department of Industry and Labor Padang in 2015, Padang city, has 1,213 food industries. Food industries increase waste generation in Padang city because of the waste mixed with municipal waste and deliver to the landfill directly without any separation.
The purpose of this study was to analyze the waste generation, composition, recycling potential, and characteristics of the industrial food waste in Padang City. The data of waste generation, composition, recycling potential, and characteristics of industrial food waste in Padang City useful for planning waste management systems, such as determining storage, collection, transportation, design of processing facilities, and design of landfills [2]. The data of waste generation, composition, and potential of recycling of industrial food waste in Padang City, can be utilized by the government of Padang City to the planning of management industrial food waste. On the other hand, management industrial food waste can reduce waste to the landfill.

2. Methodology
The food waste sample was taken daily for eight days based [5]. According to data from the Department of Industry and Labour, there are 1,213 units food industry registered in Padang City. The number of sample points obtained 35 samples were taken from 35 food industry, covering large industries, medium industries, and small industries. The palm oil industry represented the large industry, the only large industry in Padang. For the medium industries, there are 3 sample points based on the category of food products; they were two dried fish industries and bread industry. While, from 1,196 small industry in Padang City, 31 industries were used as the location of sampling point based on the food product category, they were meat processing industries & poultry, fish, chips, Tempe, tofu, sponge cakes, food & processed cuisine, rice and ice cream. For total, 35 industries as samples represented 1,213 total food industry in Padang city.

3. Result and Discussion
3.1. Industrial food waste generation rate
Calculation of the generation unit industrial food waste in Padang City is done in units of weight. Estimates in weight units are based on the average daily production of food produced, which is used to obtain the total generation of industrial food waste. Industrial food waste generation in Padang city per day in the weight unit of each product can be seen in Table 1.

| Industry       | Units weight (kg/product/day) |
|----------------|-------------------------------|
| Large Industry | 0.005                         |
| Medium Industry| 0.083                         |
| Small Industry | 0.262                         |

Table 1 shows that the maximum generation unit of industrial food waste in Padang City was a small industry at 0.262 kg/production/day. In general, the small industry carries out a simple production process, low production efficiency, which results in a large amount of waste generated. On the other hand, a large industry generated lower waste at 0.005 kg/production/day. The introduced high processing technology increased production efficiency, subsequently less waste generation. In addition to technology, the amount of waste generated by industry depends on the raw material used.

The composition of the food industry waste depends on the type of industry. The results of the composition study of the industrial food waste in Padang City showed that the highest composition was an organic waste with a percentage of 94.01%, while the rate of plastic waste was 5.97%. The composition of food industry waste plays role for selection treatment method [4]. Data calculation of the average composition of the Padang City food industry waste can be seen in Table 2.
Industrial food waste recycling potential in Padang City is 68.15%, while the industrial food waste non-recycling is 31.86%. Nonferrous metal has recycling potential 100%, organic waste has recycling potential is 97.38%, and plastic waste has to recycle possible 75.20%. Industrial food waste recycling potential can be seen in Table 3.
3.3. Characteristics Industrial Food Waste Padang City

Characteristics Industrial Food waste consisted of physical characteristics (density, water content, volatile content, ash content, fixed carbon), chemical characteristics (C/N ratio), and biological characteristics (biodegradability). The characteristics waste depending on the composition of the waste that useful to estimate the utilization of materials. The result of the analysis density of industrial food waste, proximate analysis, C/N ratio, biodegradability rate can be seen on Table 4-7.

Table 4. Density industrial food waste.

| Industry     | Density (kg/liter) |
|--------------|--------------------|
| Large Industry | 0.61               |
| Medium Industry | 0.06              |
| Small Industry | 0.64              |
| Average      | 0.44               |

Based on the density, the highest density waste was from the small industry because it dominated by fruit and vegetable waste containing high water. The lowest was waste from the medium industry because of the content dominated by fishbone waste from the fishing industry and plastic packaging from the bakery industry.

Table 5. Proximate analysis industrial food waste.

| Proximate Analysis | Large Industry | Medium Industry | Small Industry | Average |
|--------------------|----------------|-----------------|----------------|---------|
| Water Content (%)  | 4.19           | 31.08           | 62.00          | 32.42   |
| Volatile Content (%) | 16.02      | 27.34           | 53.24          | 26.75   |
| Ash Content (%)    | 21.09          | 21.84           | 20.95          | 21.29   |
| Fixed Carbon Content (%) | 2.74     | 3.40            | 36.13          | 14.09   |

Water content is depending on the waste composition. In this study, a small industry has high water content because it consists of organic waste. The small industry has high volatile content and fixed carbon because the waste contains organic matter. Higher ash content of industrial food waste it can be realized that it is difficult to burn and has effects on the efficiency of combustion.

Table 6. C/N ratio industrial food waste.

| Sample          | C (%) | N (%) | C/N ratio |
|-----------------|-------|-------|-----------|
| Large Industry  | 4.78  | 0.47  | 10.19     |
| Medium Industry | 0.69  | 0.38  | 1.83      |
| Small Industry  | 17.46 | 0.60  | 29.29     |
| Average         | 7.64  | 0.48  | 13.77     |

Elemental analysis of industrial food waste is mostly used to determine C/N ratio for biological conversion process and important to design selected tecnology treatment. Based on the results study obtained, an average C value is 7.64%, N value is 0.48%, and C/N ratio is 13.77. The composting and biodigester design criteria for the C/N ratio parameter is 20-50 [9]. The potential industrial food waste for composting was small industries.
Tabel 7. Biodegradabilitas industrial food waste.

| Sample       | Lignin Rate(%) | Biodegradability Fraction (%) |
|--------------|----------------|------------------------------|
| Large Industry | 24.19          | 15.28                        |
| Medium Industry | 14.46          | 42.52                        |
| Small Industry  | 8.64           | 58.81                        |
| Average       | 15.76          | 38.87                        |

The results show an average of the lignin value content of 15.76%, and the average value of the biodegradability fraction of industrial organic food waste in Padang City is 38.87%. The right amount of waste biodegradability fraction if it exceeds 50% [7]. The food waste from small industries was easier to decompose for composting and biodigester because most of the contents were organic materials.

4. Conclusion

The average generation rate of industrial food waste in Padang City was 0.005 kg/production/day for large industries, 0.083 kg/production /day for the medium industry, and 0.262 kg/production/day for small industry. The industrial food waste was containing 94.01% organic waste, 5.97% plastic, 0.01% paper, and 0.01% other waste. The potential for recycling was 75.20% for plastic, 100% for non-ferrous metal, and 97.38% for organic waste. The average density of waste was 13.32 kg/l with containing 13.77% water, 26.75% volatile compound, 45.39% ash, and 14.09% fixed carbon. The C/N ratio and biodegradability fractions were 13.77 and 38.87%, respectively.

5. References

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