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Development of Waste Cooking Oil Strengthens Biodiesel-Based Derivative Products

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Abstract:
The consumption of cooking oil in the Special Capital Region of Greater Jakarta is 12-16 million liters per month and its waste (used cooking oil) reaches 6-8 million liters / month, from studies it found that more than 95 percent of the people dispose of the waste into waterways, trash cans and soil with the potential to cause environmental damage. The Life cycle assessment (LCA) method is used to identify and evaluate the value of the life cycle and emissions from the disposal of the waste to become a derivative product of used cooking oil recycling (gate to gate), then entered into inventory data as quantitative data and the results of emission inputs and outputs such as acidification and eutrophication. Identification and recommendations to determine processes that have a significant effect on the environment, one alternative solution is through strengthening biodiesel-based end derivative products.
Some studies that have an effect on biodiesel-based balance are unifying various esterification methods and analyzing the application of the circular economy concept of used cooking oil waste in overcoming environmental pollution problems and influencing the policy of developing used cooking into biodiesel that is beneficial to the community in the future.

Keywords: used cooking oil, transesterification, life cycle assessment, green technology, and circular economy, environmentally based products and biodiese product development

Introduction

The government is determined to encourage the optimization of the Domestic Component Level (TKDN) for manufacturing production in Indonesia. This effort is to spur the productivity and competitiveness of the national industry in the midst of dynamic world trade conditions. Several regulations related to the implementation of TKDN, including Government Regulation Number 29 of 2018 concerning Industrial Empowerment, Presidential Decree No. 24 of 2018 concerning the National Team to Increase the Use of Domestic Production, and Regulation of the Minister of Industry No. 29 of 2017 concerning Provisions and Procedures for Calculating the Value of Domestic Component Levels (TKDN) for Cellular Phone Products, Handheld Computers, and Tablet Computers.
Optimization of the Domestic Component Level (TKDN) for manufacturing production in Indonesia will accelerate with a strong industrial cluster. An industrial cluster is a production network for closely interdependent companies (including specialized agents), knowledge-generating agents (universities, research institutes, engineering companies), intermediary institutions (brokers, consultants), and customers associated in the value-added production chain. The Center for Sustainable Production System Research and Life Cycle Assessment as a work unit in research institutions, namely the National Research and Innovation Agency in supporting Optimization of the Domestic Component Level (TKDN) also examines the circular economy of several products produced by the industry. With the Optimization of the Domestic Component Level (TKDN) and a strong industrial cluster and the application of this circular economic concept, several studies were carried out as follows The Economic Mapping of Used Cooking Oil Waste based on biodiesel.

One of the important aspects of sustainable development is the sustainable production process using appropriate, efficient and environmentally friendly methods and inputs. The concept is also known as green technology . The influence of consumption on sustainable environmental issues, one of which is related to the production process of consumer goods. All stages of the production process emit greenhouse gases (GHGs) that contribute to climate change.

The activities that will be carried out to increase carbon sequestration in green technology use several simulation models of measuring carbon emissions and improving and reducing the impact on the environment by conducting significant identification of the environment, and analysis of alternative improvements that allow it to be applied.

The Study of the Domestic Industrial Cluster & Component Level Research Group (TKDN) is one of the programs of the Center for Sustainable Production System Research and Life Cycle Assessment in support of Optimization of the Domestic Component Level (TKDN) as well as assessing the circular economy of several products produced by the industry. One of the implementations of circular economy activities and life cycle assessment of used cooking oil waste in overcoming environmental pollution problems and applying LCA methodology and database systems to evaluate the value of the life cycle and emissions of used cooking oil products. This activity will result in mapping the circular economy concept of used cooking oil waste and identifying input data (raw materials, additives, and energy) used and outputs (products, by-products, emissions, and waste) resulting from the process of recycling used cooking oil waste into biodiesel-based derivative products.

The circular economy concept is used to help reduce waste by utilizing return, reuse, repair and recycle, in contrast to the recycle economy, it only utilizes recycle and distinguishes it from linear econoy without using a recycle system and so on.

Environmental pollution can be caused by solid waste or liquid waste generated from: health service activities or activities (hospitals, puskesmas and health clinics), waste from domestic activities (hotels, offices, flats, houses in DKI Jakarta, from various studies on 13 existing rivers, the problem of B3 waste and household waste is declared acute (Zaenal, 2017). The average river is degraded and heavily polluted.

This condition causes a danger to the level of health, so that the river, which is one of Jakarta's water sources, is not used. In PP No. 20/1990 concerning Water Pollution Control, water pollution is defined as the entry or inclusion of living things, substances, energy, and or other components into the water by human activities so that the quality of the water drops to a certain extent which causes water to be no longer useful in accordance with its designation. Each household consumes an average of 2-5 liters of cooking oil every month. With the population of DKI Jakarta reaching more than 10 million people, the consumption rate of cooking oil can reach 12-16 million liters per month and used cooking oil waste reaches 6-8 million liters per month.

From the study, it was found that more than 95 percent of people in DKI Jakarta dispose of used cooking oil into waterways, trash cans and soil, so that every month there are millions of liters of used cooking oil that has the potential to pollute the environment (KSBB Persampahan DKI Jakarta).

As for used cooking oil waste, some people are still considered liquid waste that is easily discharged into the waterways of the dishwasher, without realizing the risks. And it is sad if this is done not only by households but by food stalls, of course, there is quite a lot of waste used cooking oil. Even though the oil absorbed into the soil can coagulate and close the pores of the soil so that the texture of the soil will be hard. When the rainy season comes, the soil cannot absorb water properly, so it has the potential to cause flooding. While throwing used cooking oil into the waterways of the dishwasher, in addition to being able to clog waterways or drainage, it also has the potential to become a place for bacteria to grow and develop. Plants that live inside marine ecosystems can be endangered because they cannot get enough sunlight for the process of photosynthesis due to being blocked by floating oil. Overcoming this, the DKI Jakarta government issued

DKI Jakarta Governor Regulation Number 167 of 2016 concerning Cooking Oil Waste Management, which is aimed at producers, collectors and utilizers of cooking oil waste so as not to cause negative impacts on public health and the environment and encourage the use of Cooking Oil Waste as an alternative fuel in the form of biodiesel for the transportation sector and or other industrial sectors in the regions.

However, small-scale used cooking oil producers, such as stalls and communities, still dump used cooking waste into waterways and soil.

These programs are quite good, because in addition to providing knowledge and making people aware that disposing of used cooking oil is bad for the environment, it also teaches that used cooking oil still has economic value. Through the use of this recycling, waste, emissions, and wasted energy can be minimized. Utilization of Cooking Oil Waste as an alternative fuel for biodiesel-based products for transportation and or other industrial sectors in the regions. Biodiesel is an alternative fuel as a substitute for environmentally friendly petrodiesel.

In this study, we will explore the environmental impact of the used cooking waste recycling process with the Lifecycle Assessment (LCA) method to identify the amount of potential emissions produced from recycled production activities from used cooking oil.

At the same time analyzing the application of the circular economy concept of used cooking oil waste in overcoming environmental pollution problems. And apply the LCA methodology and database system to evaluate the life cycle value and emissions of used cooking oil products.

Drawing of the Circular Economy Roadmap of Used Cooking Oil Waste and the formulation of problems and competitiveness of the used cooking oil waste-based biodiesel industry cluster, as well as contributions in sustainable development and development of the LCI Dataset for Industry and National Products This research is useful for determining the life cycle of used cooking oil waste products . The input and output data obtained in this study will be able to complement the development of the LCI Indonesia dataset For the government, the results of this study provide important information so that policies can be formulated to reduce environmental damage. Sustainable Process and Manufacturing Systems This research is part of the Sustainable Process and Manufacturing System, because the focus of this research explores data about the life cycle of a product (in this case: used cooking oil) which is part of a development process system to maintain sustainability .

The Waste Recycling Process supports the Circular Economy The Circular Economy that is explored in this research is the circular economy of used cooking oil waste, starting from assessing its circular flow to assessing its life cycle.

The success factor in conducting LCA on used cooking oil waste recycling products is to get a way or combination of ways to optimize carbon sequestration measurement methods so that they can be categorized as a sustainable production system. one important aspect in sustainable development is One of the sustainable production processes using appropriate methods and inputs, efficient and Environmentally friendly.

Adjusting the methodology related to the scope of research objectives and using several model simulations in optimizing carbon emission measurements and improving and reducing the impact on the environment by identifying to determine processes that have a significant effect on the environment, then an analysis is carried out to provide several alternative improvements that are possible to be applied.

Goals:

Conducting preliminary research related to the circular economy of used cooking oil waste as well as a study of the calculation of the environmental impact of the LCA's life cycle and recommendations for its management into biodiesel-based derivative products.

Method

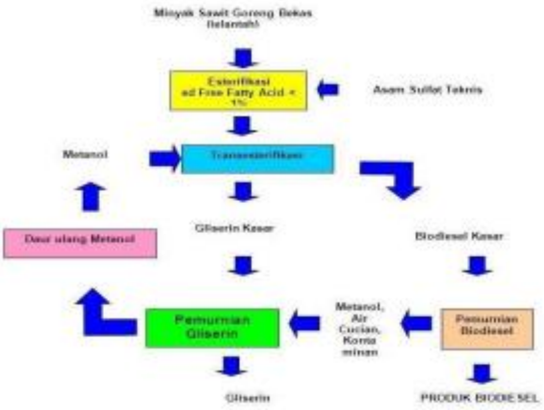

Figure 1 : Methodologi

Research The data collection method is carried out by the field survey method, collecting data related to the flow of processes that occur in the sector. In addition to primary data collection, this activity also carries out secondary data collection through literature studies and existing industrial databases that have been owned by R & D agencies and private industries.

the next step is to carry out data processing and analysis. The method of processing and data analysis is carried out by separating process data with product data from recycling used cooking oil waste Input / output data in the production process of recycling used cooking oil waste is obtained from various sources.

verified through discussions with relevant experts. The verification is carried out by the method of consignment and focus group discussion (FGD). Competitiveness analysis is carried out with the Diamond Porter Industrial Cluster Competitiveness approach, the life cycle assessment is carried out by the LCA method.

Results And Discussion

The success factor in conducting a Life cycle assessment (LCA) on recycled products of used cooking oil waste is to get several ways to optimize carbon sequestration measurement methods so that they can be categorized as a sustainable production system.

One of the important aspects of sustainable development is the sustainable production process using appropriate, efficient and environmentally friendly methods and inputs. The concept is also known as green technology. Activities that will be carried out to increase carbon sequestration in green technology in Indonesia in the future are: 1. Adjusting methodologies related to the scope of research objectives 2. Using several model simulations in optimizing carbon emission measurements 3. Improve and reduce the impact on the environment by identifying to determine the processes that have a significant effect on the environment, then an analysis is carried out to provide several alternative improvements that are possible to be applied.

Model Life Cycle Assessment (LCA)

According to ISO 14040 in the World Business Council for Sustainable Development (2002), the definition of LCA is a technique developed to understand and deal with the impact of products when they are produced and when consumed. This LCA consists of 4 main phases which can be seen in Figure 2.

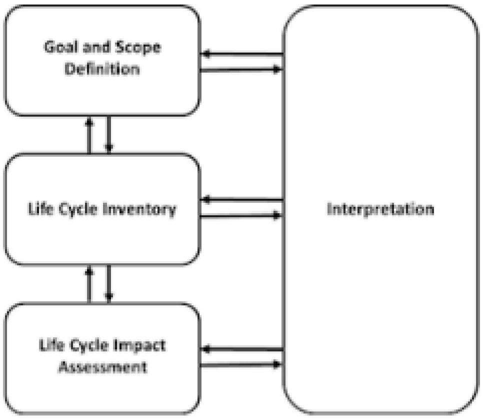

Figure 2 : Fase Life Cycle Assessment (LCA)

1. Goal and Scope

formulate and describe the objectives, the system to be evaluated, the limitations and assumptions related to the impact throughout the life cycle of the system.

2. Life Cycle Inventory (LCI)

shows the environmental influence per-part of the life cycle. This stage is a process of quantification of energy and material needs, air emissions, solid waste and all outputs discharged into the environment during the product life cycle.

3. Life Cycle Impact Assessment (LCIA)

grouping and assessment of the effects caused to the environment based on the data obtained at the LCI stage.

a. Classification and characterization. identify and group substances that contribute to the category of impact.

b. Normalization. The procedure required to show the relative contribution of the characterization value to the normal value.

c. Weighting. Weighting is obtained by multiplying the impact category by the weighting factor and adding to get the total value.

d. Single score. Used to classify impact category values by activity or process. The single score value will show which activities contribute to environmental impact.

4. **Interpretation.** Is an integration of life-cycle inventory and life cycle impact assessment used to review, draw conclusions and recommendations In accordance with the revision of the Minister of LH Regulation Number 3 of 2014 concerning PROPER, new criteria have been added, from which the application of Life Cycle Assessment (LCA) has been added. The application of this life cycle assessment (LCA) aims to identify, calculate the sustainability of the use of natural resources, disposal in the environment and evaluate and Life Cycle Assessment refers to the ISO 14040: 2006 standard which has been adopted into SNI ISO 14040: 2016 and ISO 14044: 2006 or has been adopted into SNI ISO 14044: 2017. apply possible environmental improvements.

Biodiesel Processing

The breakdown of the double bond in its unsaturated fatty acids, only saturated fatty acids are left. Cooking oil that is heated at temperatures above 160 degrees Celsius is then oxidized, can trigger cancer cells in the liver organs and damage its function can also increase cholesterol levels in the blood which has the potential to trigger heart disease. The used cooking oil into biodiesel processing equipment unit called 'One Pot Reaction' which is easy to apply by the community and can produce biodiesel to the maximum", Holistically, the process of processing used cooking oil into biodiesel can be beneficial for environmental conservation, as well as developing renewable energy. The main advantages of producing biodiesel using used cooking oil feedstock are

1) the percentage of its CO2 emission reduction is the highest, reaching 86%, compared to ordinary diesel and 2) the price of feedstock is very cheap.

Through transesterification, triglycerides in used cooking oil react with alcohol (accelerated by catalysts) and produce biodiesel or FAME (fatty acid methyl ester) which can be used as alternative energy instead of diesel (Manurung, 2006). In addition to biodiesel, the reaction will also produce by-products in the form of glycerin (Jaichandar and Annamalai, 2001).

Biodiesel can also be processed through esterification reactions using acid catalysts (Aziz, 2011) and esterificationtransesterification (Berrios, et al., 2010). The selection of reactions depends on the content of free fatty acids (ALB) in the raw material. Freedman et al. (1984) stated that the ALB of raw materials for biodiesel should not exceed 1%. Another researcher stated that a direct transesterification reaction can be carried out if the ALB inside the material is less than 3% (Ribeiro,et al.) or 5% (van garpen, 2005)

The high ALB content will result in a lathering reaction (saponification), which can affect the biodiesel purification process (Ma and Hanna, 1998).

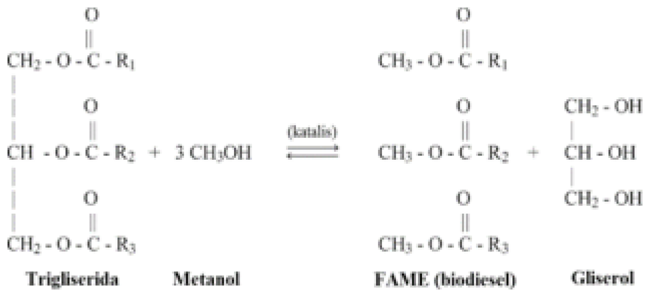

Figure 3 : Biodiesel Transesterification

Transesterification reactions are preferred over esterification because they are faster and require less alcohol (van Gerpen, 2005).

The transesterification of biodiesel is influenced by various factors, including reaction time (Yuniawati and Karim, 2009; Aziz, 2011), temperature (Kwartiningsih et al., 2007; Aziz, 2011), catalytic type, and ratio of molar ratio of triglycerides to alcohols (Jagadale and Jugulkar, 2012; Satriana et al., 2012.

The conventional production of biodiesel is generally carried out at high temperatures with an external heat source. Heat transfer takes place less effectively because it occurs by conduction and convection. This kind of heating requires a large amount of energy and a long enough time (Motasemi and Ani, 2012).

Used cooking oil was tested to determine the density, acid number, free fatty acid number (ALB). The methanol and NaOH catalysts used in this study are of technical quality (technical grade). Other chemicals are aquades, PP indicators, isopropyl alcohol, and KOH.

Other equipment includes glassware, electric stirrers, spatulas, burettes, falling ball viscometers, analytical balances, picnometers, and heaters. 1:6 (Jagadale and Jugulkar, 2012). A total of 100 ml of used cooking oil is mixed with 20 ml of methoxide solution (NaOH in methanol) in an erlenmeyer.

Next the mixture of oil and methoxide is heated in an electric stirred microwave oven. The resulting biodiesel is allowed to stand for approximately 24 hours to precipitate glycerol. After being separated from glycerol, biodiesel is washed using aquades three to four times until clear.

Because it concerns the expected biodiesel, the LCA concept is expected to eliminate the inputs, processes and outputs produced from the processing of biodiesel from used cooking oil because the type and raw materials are from waste oil and the energy needed is not much.

Meanwhile, the process of concentrating biodiesel is simple with the use of basic chemistry by mixing with NaOH which balances its formula and LCA content, the process of removing used cooking oil should only be used as biodiesel fuel, but it needs to be careful because it still contains a slight corrosion.

Characteristics of Used Cooking Oil

The calculation results show that the total molecular weight of fatty acids is 280.8 g / mol so that the molecular weight of used cooking oil is 880.4 g / mol. The test results showed that the number of catalysts required for the transesterification reaction was 5.5 g/L of used cooking oil.

Biodiesel Amendment

The yield and characteristics of biodiesel resulting from the treatment of microwave power intensity and reaction time. minute.

Acid Numbers

The amount of acid in the resulting biodiesel ranges from 2.98 mgKOH/g to 4.20 mgKOH/g. When compared with the acid number of used cooking oil raw materials, which is 5.6 mgKOH / g.

Density of Biodiesel

The standard density of biodiesel allowed by SNI ranges from 0.85–0.9 g/mL. The density of biodiesel obtained from the transesterification reaction by conventional heat exertion at the same molar ratio ranges from 0.85– 0.86 g/mL. Density of Biodiesel.

Biodiesel Viscosity

The resulting biodiesel has a viscosity value between 1.9 cSt to 2 cSt. This value is not much different from the viscosity of biodiesel obtained from transesterification of 1.65–1.85 cSt.

Capillarity Test and Flame Test

Biodiesel was also tested for ignition using a simple lantern and the results showed that the lantern could ignite properly.

The treatment of making biodiesel from used cooking oil waste is carried out in accordance with esterification because used cooking oil still contains FFA of 1 percent which is then given technical sulfuric acid so that transesterification is processed and the results are obtained coarse glycerin and coarse biodiesel, then biodiesel purification is carried out and the results are obtained biodiesel as expected. Here, sulfuric acid and laundry methanol are obtained by the percentage expected according to the initial formulation, for example 10 liters of used cooking oil, then sulfuric acid is half the amount of used cooking oil. Because the environmental impact is not large because the sulfur content is not large, the grave is considered small.

The results of the interpretation of transesterification results by looking at the biodiesel results obtained from the experimental results, here the source of origin of the cradel can be eliminated by controlled disposal and the biodiesel results obtained from the calculation system with the density and fiscosity of the biodiesel can be calculated how much proximity it is to the B30 or B 100 system... depending on the results obtained.

Conclusions

Implementation of Circular Economy and Life Cycle Assessment of Used Cooking Oil Waste in overcoming environmental pollution problems and applying LCA methodology and database systems to evaluate the value of the life cycle and emissions of used cooking oil products. This activity will result in mapping the circular economy concept of used cooking oil waste and identifying input data (raw materials, additives, and energy) used and outputs (products, by-products, emissions, and waste) resulting from the process of recycling used cooking oil waste into biodiesel-based derivative products.

According to ISO 14040 in the World Business Council for Sustainable Development (2002), the definition of LCA is a technique developed to understand and deal with the impact of products when they are produced and when consumed. The SO2 levels contained in used cooking oil are obtained non-existent so that the sulfurization of the development of greenhouse gas emission levels can be eliminated.

In the analysis of the development of biodiesel products carried out through the transesterification process, triglycerides in used cooking oil react with alcohol (accelerated by catalyst) and produce biodiesel or FAME (fatty acid methyl ester) which can be used as alternative energy to replace diesel.

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