Laundry Effluent Environmental Impact Potential Analysis using Life Cycle Assessment Approach

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Abstract. This study aims to analyze the significant environmental impact caused by laundry activities and the selection of a wastewater treatment unit to overcome the effluent that exceeds the quality standard. Life Cycle Analysis (LCA) is one of the methods to analyze the significant environmental impact and can be used in decision-making. This study will use LCA as a method to determine the significant environmental impacts resulting from laundry activities and to select the best wastewater treatment unit that can be applied. Based on the results of the Life Cycle Impact Analysis (LCIA) using OpenLCA, especially EPD 2013 to analyze the impact, the significant environmental impact of laundry activities is the eutrophication potential.

Keywords: Laundry, Wastewater, LCA, Detergent, Eutrophication

1 Introduction

Population growth and increasing safe development are directly proportional to the increase in the need for goods and services, including the laundry business which is engaged in services. The high activity of the population and the increasing level of the economy have an impact on the laundry business which is growing rapidly to support the needs of the population. Laundry is one of the businesses engaged in services and households to clean various clothes, carpets, and so on using detergent. This laundry business will produce liquid waste due to washing activities which contain residual detergents, fragrances, and softeners. The results of the chemical analysis of effluent from laundry activities that the pH, Phosphate, COD, andBOD values exceed the threshold or quality standards that have been set [1]. The BOD, COD, and Phosphate content in laundry wastewater exceeds the quality standard set with TDS 346.94 mg/L (21.15 %); TSS 11.25 mg/L (88.88 %); BOD 31.86 mg/L (63.68 %) [2]. The quality standard that regulates the quality of laundry waste effluent is the Minister of Environment Regulation No.5 of 2014 concerning Wastewater Quality Standards. Almost all laundry businesses do not have a wastewater treatment unit before being discharged into water bodies.

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Laundry wastewater continuously discharged directly into water bodies without any treatment will result in water pollution and have a new negative impact on aquatic life. Laundry X is one of the laundry services that does not yet have a processing unit to handle the effluent produced. The results of the effluent in laundry X are known to have levels exceeding the specified quality standards, so they have the potential to pollute the environment. In overcoming these problems, it is necessary to analyze the environmental impacts that could potentially occur due to laundry waste effluent, which is directly discharged into water bodies, and select the wastewater treatment unit to handle the effluent before being discharged into water bodies.

One method for analyzing environmental impacts and selecting processing units is Life Cycle Analysis (LCA). Life Cycle Assessment (LCA) is a method used to analyze and calculate the environmental impact of a product or activity at every stage of its life cycle. The use of this LCA can be used as a tool for decision making and product quality improvement. The use of the LCA method will focus on the environmental aspects of a product or activity and not related to economic, social and cultural characteristics [3], [4]. This study was conducted to analyze the environmental impact of the laundry process and determine the processing unit from several existing scenarios.

2 Method

In this study, in determining the significant environmental aspect and impact is to use the Life Cycle Assessment (LCA) method. LCA stands for Life Cycle Assessment and is a system for analyzing and calculating the environmental effect of a product at every stage of its life cycle. From raw material preparation to manufacturing operations, sales and transportation, and product disposal (ISO 14040:1997). Goal and Scope, Life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA), and Interpretation are the four processes that are followed when adopting LCA [3], [4]. The LCA method will evaluate environmental impacts through quantitative calculations of the inflow/outflow (exchange flow) of the system to the environment in each stage of the system's life. Some of the main elements of an LCA are identifying and quantifying all the materials involved, evaluating the potential impact of the materials used, and assessing options for dealing with the resulting impacts.

The LCA method will be used in this study to determine the significant environmental impact and to select the unit treatment to reduce the impact resulting from laundry activities. The data that will be used are sourced from literature data on a laundry business. The software we use is OpenLCA. OpenLCA is an opensource database software that is used to process LCA and Sustainability Assessment. OpenLCA is easily accessible, legal, simple to operate, and the application is free [5], [6]. Therefore, in this study, we will use the LCA method with OpenLCA software to analyze the significant environmental impact and choose the unit treatment in the laundry business.

3 Result and Discussion

Laundry operations can lead to water pollution, primarily when they involve the use of detergents and fragrances. Using non-environmentally friendly detergents can result in the release of pollutants such as phosphates, BOD, COD, and TSS. Laundry X, which runs from

Monday to Saturday, discharges wastewater that doesn't meet the set quality standards. The specific effluent data from Laundry X can be found in Table 1.

Table 1. Effluent Data Laundry X

Parameter	Effluent Data (mg/L)	Quality Standard (mg/L)
BOD	96.1	75
COD	307	180
Phosphate	29.15	2

The data shows that Laundry X's effluent exceeds the quality standard set by the Minister of Environment and Forestry Regulation Number 5 of 2014 concerning Wastewater Quality Standards. The environmental aspect in the form of using detergent in the washing process will have an impact on water pollution if it is carried out continuously without any processing. For this reason, it is necessary to analyze the significant impact caused by laundry activities on the environment. The system boundaries used in this study are gate to gate. The process of laundry activities is as **Figure 1**.

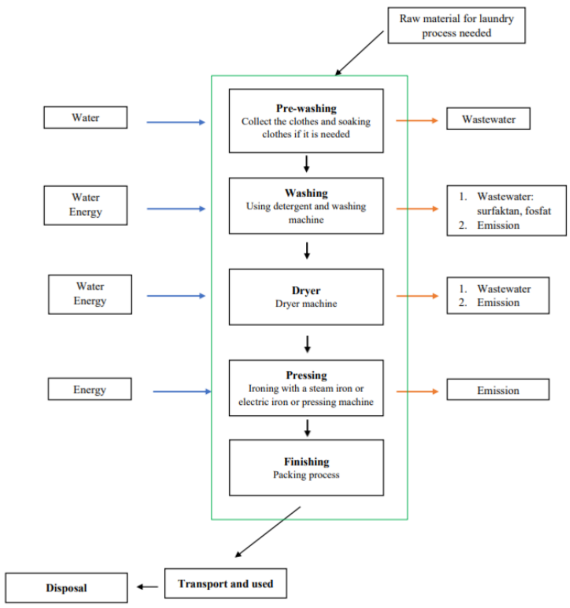

Fig. 1. Laundry Process in Laundry X

Based on the flow diagram, the effluent produced, namely BOD, COD, and Phosphate, seems to exceed the specified quality standard. BOD, COD, and Phosphate levels that exceed the quality standard are discharged into water bodies without any treatment in the long term and will certainly have an impact on water bodies. This excess BOD and COD content will cause aerobic organisms to require more oxygen to actively break down or oxidize organic materials contained in wastewater. This can cause anaerobic conditions so that it can make the water smell bad, disrupt the life of aquatic biota, cause aesthetic problems, reduce oxygen content, and so on [4], [7]. Excess phosphate content in the water will also cause eutrophication [8], [9]. In laundry services, especially in Indonesia, there are still many that have not been equipped with laundry wastewater treatment but are directly discharged into water bodies without any filtering or processing beforehand. If this condition continues, it will result in the condition of water bodies getting worse. Therefore, there is a need for laundry wastewater treatment technology to overcome pollution due to the effluent produced.

Laundries should be encouraged, if not mandated, to use eco-friendly detergents and washing products. This can significantly reduce the environmental impact, especially in terms of eutrophication potential. Organize workshops and training sessions for laundry business owners to make them aware of the environmental impacts of their operations and teach them best practices to mitigate these impacts. Educate the general public on the environmental impacts [10], [11]of laundry effluents, urging them to choose eco-friendly laundries, and encouraging them to demand transparency from businesses about their environmental practices.

4 Conclusion

An environmental impact analysis of a laundry process with a daily capacity of 20 kg/day revealed that its most significant environmental concern is eutrophication potential. This analysis was conducted using openLCA software, drawing on data from existing literature. To address this, three potential wastewater treatment scenarios have been identified. These scenarios aim to reduce the eutrophication potential and ensure the effluent meets quality standards.

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