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The Life Cycle Assessment Method Used to Predict the Rubber Industry's Environmental Impact Research

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Abstrak

. Karet alam merupakan salah satu produk pertanian yang kebutuhan bahan industrinya sangat tinggi. Di Indonesia, karet merupakan tanaman perkebunan utama yang tumbuh di seluruh negeri. Penelitian ini mencoba menggunakan teknik LCA, namun tujuan utamanya adalah untuk menguji konsekuensi dari industri karet remah. Menggunakan asam sulfat menyebabkan emisi sekitar 11,94705 kilogram setara dengan gas sulfur dioksida ke lingkungan. Sebaliknya, penggunaan isoprena sebagai bahan dasar menyebabkan emisi sekitar 1090 kilogram, setara dengan gas karbon dioksida. Energi yang berasal dari batu bara menyumbang hingga 719.748 MJ, atau 199.930 kWh, dan merupakan fokus penting dalam pencarian energi alternatif. Pasalnya, macerator, creeper, hammer mill, dan mesin pengering membutuhkan listrik 199,93 kilowatt jam untuk beroperasi.

Kata kunci: Karet, LCA, Dampak Lingkungan

Abstract

Natural rubber is one of the agricultural products in exceptionally high demand for industrial materials. In Indonesia, rubber is a major plantation crop grown all across the country. This research seeks to use the LCA technique, but its primary objective is to examine the consequences of the crumb rubber industry. Using sulfuric acid causes the emission of roughly 11,94705 kilograms equivalent of the gas sulfur dioxide into the environment. In contrast, using isoprene as a base material causes the emission of approximately 1090 kilograms, equivalent to the gas carbon dioxide. Coal-derived energy accounts for up to 719,748 MJ, or 199,930 kWh, and is the critical focus in the quest for alternative energies. Because the macerator, creeper, hammer mill, and drying machine take 199.93-kilowatt hours of electricity to operate.

Keywords: Rubber, LCA, Environmental Impact

INTRODUCTION

Following Thailand's total annual production, Indonesia is the world's second-largest rubber producer. Natural rubber and synthetic rubber make up the majority of rubber traded on both the local and international markets (Raju, 2016). Most of the rubber produced in Indonesia is in the form of natural rubber, and around seventy percent of the natural rubber produced in Indonesia is processed into crumb rubber. Natural rubber that has undergone further processing to assure the product's quality is called "crumb rubber." Because of its role as a raw material in the production of tires, crumb rubber is in high demand worldwide. This need is growing in tandem with the expansion of the global automotive industry. Because of the tremendous rivalry among producers of crumb rubber throughout the world, it is necessary for Indonesia to compete with other producers of crumb rubber. For this reason, exported crumb rubber must compete with crumbs from other nations' production, both in terms of the quality of the product and the number of sales.

The most important types of raw materials are lump and brown crepe (BRCR), both obtained from national enterprises and smallholder plantations. During the manufacturing process, the dry lump material is combined with other ingredients to form a combination. The liquid waste has measurable amounts of pH, COD, BOD, and TSS. It also has NH3 levels. In the crumb rubber business, wastewater is the primary source of wastewater. In certain processes, such as the breaker process, there is an odor generated by raw materials and water waste. This stench is also released during the hammer mill and drying process. Rubber effluent comprises contaminants (Mokhtar et al., 2015), organic materials, and particles that are either

suspended or dissolved and will go through changes due to chemistry, biology, and physical processes.

The consequences brought forth by the rubber industry. An increase in the number of organic materials presents causes the disturbance of biotic life due to wastewater pollution (Afifah et al., 2020; Prajati et al., 2021). During the degradation process, a significant amount of the waste oxygen is used up. Ammonia, hydrogen sulfide, carbon dioxide, and methane are the by-products of decomposition that might arise if the concentration of organic pollutants is high enough and anaerobic conditions are present (no oxygen). Anaerobic conditions occur when there is a lack of oxygen. Wastewater may also be a source of contaminants; thus, if it is not handled effectively, it can create water pollution, resulting in unpleasant scents and poor sight. This can occur if it is not adequately controlled (I. Suryawan et al., 2021).

An acid bath produces high levels of COD and BOD5 because there is a procedure of adding oxalic acid that increases product quality. Oxalic acid can be added to the bath. On the other hand, a high TSS cadence can be attributed to the washing process in the shredder during dry lump washing, which leaves behind a significant amount of residual dirt. In addition, the drying process, which results in trash being released into the chimney and then sprayed with water, contributes to high amounts of ammonia. Due to the lack of study on this subject, it is necessary to investigate its influence. A life cycle analysis is one approach that may be taken with this examination (LCA). Although this study aims to utilize the LCA methodology, the focus of this investigation is to investigate the effects that the crumb rubber business has.

METHOD

The objective of life cycle assessment (LCA) aims to assemble and analyze the environmental repercussions of various possibilities to perform a given function or reach a quality standard. The goal is the purpose of LCA. Characterizing the product or process system that is the subject of the research, detailing all of the assumptions, and defining the technique used to build up the production system are all part of the scope. An explanation of Analysis of a product's life cycle inventory, also known as life cycle inventory analysis or LCI analysis, is described by the International Organization for Standardization (ISO) as the "phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle." In reality, inventory analysis refers to the collection and interpretation of data. The process of collecting data entails capturing the significant inputs and outputs that occur during the life cycle of a product or activity (Chairani et al., 2021; Rahmalia et al., 2021; I. W. K. Suryawan, Rahman, Lim, et al., 2021; I. W. K. Suryawan, Rahman, Septiariva, et al., 2021). For example, an industry that processes things requires input, which might be raw materials, extra materials, or even energy. In contrast, output refers to what is created from an industrial operation. This might take the shape of significant goods, by-products, liquid, and solid waste (packing materials), and several other pollutants that are harmful to the environment.

RESULT AND DISCUSSION

To carry out a Life Cycle Inventory Analysis, the inputs and outputs gathered at the LCI must first be submitted into the open LCA program. The influence of the actions of the crumb rubber sector may be seen in the input and output data that has been entered. In addition, the open LCA application has an option for performing an impact study, where one may view the impact. Figure 1 displays the outcomes generated by putting the open LCA application through its paces.

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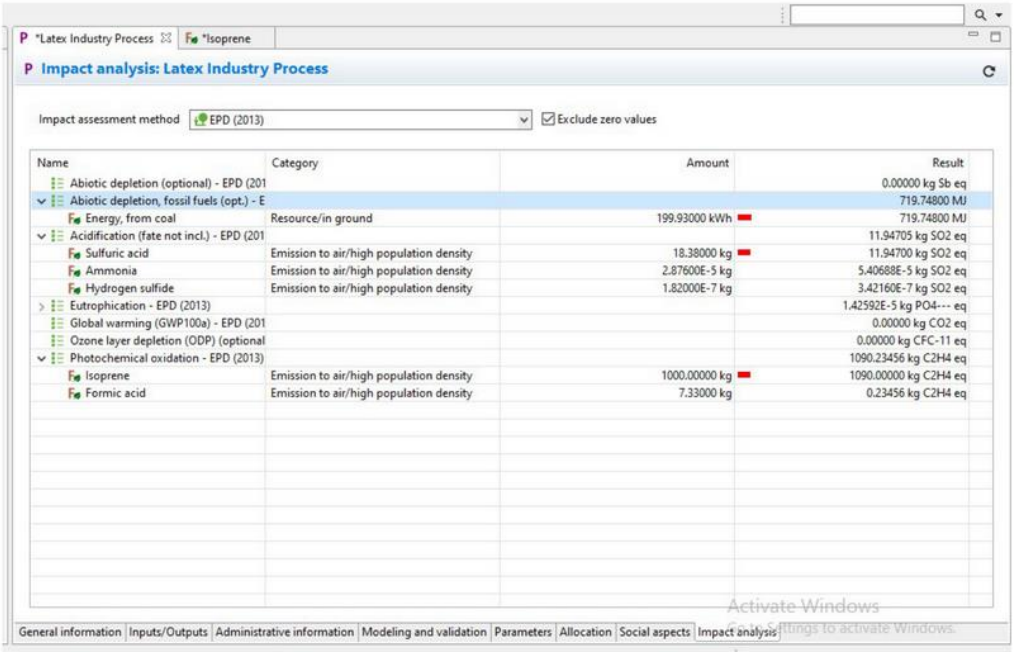

Figure 1. Results of openLCA impact analysis

According to the simulation's findings, the effects of the activities carried out by the crumb rubber business include the abiotic depletion of a total of 719.75 MJ, the acidification of an equivalent amount of 11.95 kg SO2, and the photochemical oxidation of a total of 1090,234 kg C2H4 eq. The enormous amount of energy used by the crumb rubber sector is the root cause of abiotic depletion. The presence of sulfuric acid, ammonia, and hydrogen sulfide are the primary contributors to acidification's detrimental effects. The use of isoprene, the chemical word for the raw material used in the production of rubber, and the use of formic acid contribute to the process of photochemical oxidation. Photochemical oxidation of isoprene occurs via a process that deviates significantly from standard thinking (Zhang et al., 2022). Because abiotic depletion is one of the impacts that contribute the most to pollution, it is necessary to make an effort to lessen the severity of this impact at the interpretation stage.

The use of sulfuric acid results in the emission of approximately 11.94705 kilograms equivalent of the gas sulfur dioxide into the atmosphere, while the use of isoprene as a base material results in the emission of approximately 1090 kilograms equivalent of the gas carbon dioxide into the atmosphere. The utilization of energy derived from coal accounts for as much as 719,748 MJ, equivalent to 199,930 kWh, and is the primary emphasis in searching for other alternative energies. Because of the 199.93 kilowatt hours of power required to run the various pieces of equipment, such as the macerator, creper, hammer mill, and drying machine. The energy consumed the most by the equipment is by the dryer, followed by the hammer mill and the presses (Mega Muitiara Sari et al., 2023; Mega Mutiara Sari et al., 2022). As a result, increased focus is necessary to ensure that energy is utilized most effectively.

CONCLUSION

Based on the example of the crumb rubber business in Semarang, it is clear that every process must have some kind of effect, either on people or the environment. Therefore, a number of options can be utilized to lessen the impact, one of which is switching the fuel used in the manufacture of rubber to renewable fuels. One example of this would be turning coal fuel into wood pellets. Because of the presence of abiotic depletion, which is brought on by the use of a significant amount of energy, the alternative has been selected.

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