13. SUGAR INDUSTRY: PRODUCTION, CONSUMPTION, AND WASTE UTILIZATION TO ENHANCE CLEANER PRODUCTION 1 3 IMPLEMENTATION IN INDONESIA

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SUGAR INDUSTRY: PRODUCTION, CONSUMPTION, AND WASTE UTILIZATION TO ENHANCE CLEANER PRODUCTION IMPLEMENTATION IN INDONESIA

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ABSTRACT

Cleaner production is referred to as a technical preventative procedure. Every step, every significance of information process, as well as every procedure and choices made, is analyzed. The Indonesian government has advocated this model in every critical industry, including the sugar industry. This research provides a picture of the sugar industry's environmental impacts. In a sugar refinery, proper technology and management develop in reducing, recycling, and reusing become a zero waste. As a result, the sugar industry is considered an emission-free system. This study implies that sugar processing has issues that require careful management to eager the cleaner production. Environmental impact assessment (EIA) with Life Cycle Assessments (LCA) methodology could be the promising analysis of the solutions to develop the assessment in sugar refinery performances.

KEY WORDS : Sugarcane industry, Promoting cleaner production, By-product, waste

INTRODUCTION

Sugar demand in 2017 reached 3.1 million tons and in 2018 it reached 3.6 million tons (Adhiem, 2018). Meanwhile, sugar production in Indonesia in 2017 only reached 2.3 million tons and in 2018 only reached 2.1 million tons (Badan Pusat Statistik, 2019). Based on these data, domestic sugar products are currently not able to meet the needs of the community. Furthermore, it is necessary to increase production capacity and develop the sugar industry, that domestic sugar needs are fulfilled. However, the sugar processing industry has a large water requirement and generates large amounts of wastewater at all stages of sugar manufacture. Capacity building and industrial development are directly proportional to the environmental impact of an industrial production process. The industrial sector is the third largest contributor to greenhouse gas (GHG) emissions, reaching 26.61% of the total global GHG emissions (Kementrian Energi dan Sumber Daya Mineral, 2016). This study was conducted to analyze the impact that occurs on the environment but also accelerate the beneficial impact on the production process the industry. (Kaab *et al.*, 2019; Nieder-Heitmann *et al.*, 2019). The main objective of this study is to determine the environmental impact and at the same time the potential for utilization by reusing, recycling and minimizing waste from the sugarcane processing industry which has a negative impact on production and processing. This study is a preliminary study in the initial assessment of the identification of the environmental impact of the sugar industry to determine a more integrated cleaner production application.

Production Process Evaluation (Scope of Study)

This study conducted in Sugar Factory in Mojokerto. Sugar Factory produces White Crystal Sugar made from sugar cane with several supporting ingredients such as lime milk, sulfur, phosphoric acid and flocculants. White Crystal Products produced reach ± 80,000 tons/year. Sugar Factory has an independent power plant by utilizing bagasse which is used as an energy source. The Sugar Factory implements a power plant using a boiler that produces steam and will drive a turbine so that it can generate electricity for the energy needs of the sugar production process. The production process of White Crystal Sugar (GKP) passes through several stations, namely a milling station consisting of 5 mills, a purification station, an evaporation station, a crystallization/cooking station, a spin and packing station.

Power Plants

The Sugar Factory has an independent power plant. The power plant is fueled by waste from the sugar production process, namely sugar cane (bagasse). The power plant starts from the Boiler unit which will later produce steam. After passing through the boiler, the steam produced by the boiler will be fed to a turbine to drive it so that it can produce electricity which is used for the sugar production process at the Sugar Factory. In this process produces emissions NO2, SO2, PM (Figure 1).

Mill Station

Before entering the milling station, sugarcane is selected with the qualifications of SBM sugar cane (sweet, clean, fresh) which is a minimum brix content of 17, free from residualand aged less than 24 hours after the harvest. Sugarcane that has passed the qualification will be put into the cane cutter. Cane cutter is a tool used to chop sugar cane into small pieces. After passing through the cane cutter, the cane will be taken to HDHS (Heavy Duty Hammer Shredder). In HDHS the pieces of sugar cane are crushing. With the opening of the sugarcane cells, will be easy to be milked. The bagasse milking process will be continued to mill 3, mill 4 and mill 5 and so on (Figure 2).

Purification Station

In the defecator unit I, phosphoric acid is added. The heated sugar juice will be accommodated in a flash tank to remove gas bubbles in the sugar juice. After passing through the flash tank, the juice will be flowed to the snowballing unit to be added to the flocculant. Then it will be put into a clarifier to settle

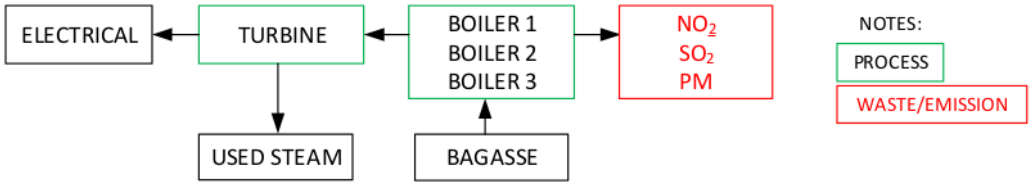

Fig. 1. Electrical Generator

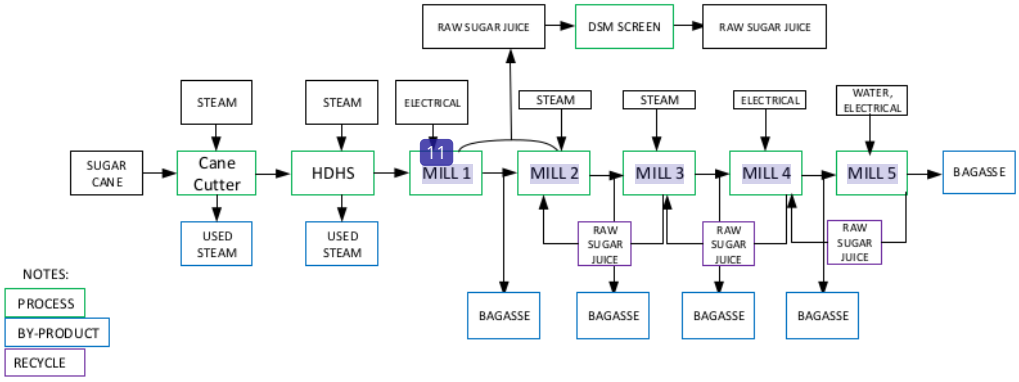

Fig. 2. Mill Station

the dirt. The results of the deposition will produce clear raw sugar juice. Clear raw sugar juice will be accommodated in the clear raw sugar juice tank. The dirty raw sugar juice which will be forwarded to the Rotary Vacuum Filter (RVF) for the separation of raw sugar juice with blotong. The sugar juice that is successfully separated by a Rotary Vacuum Filter (RVF) is known as the raw sugar juice filter. The filter raw sugar juice will be reprocessed and mixed in the raw sugar juice tank. This process produces SO2 air emissions, then waste BOD, COD, TSS, sulfides and fatty oils.

Evaporation Station

The sugar juice that has been freed from impurities will move towards the evaporation process. The evaporation process aims to reduce the water content furthermore it is easy to get sugar crystals. The steam used for the evaporator is used boiler steam. Boiler steam is the result of boiler steam that has been used to turn a turbine. The steam is assisted by a condenser to speed up the evaporation process. The viscous juice that comes out of the evaporator will then be pumped into a sulfitation crate. In the case of thick sugar juice sulfation, SO_2 gas will be added. The sugar juice that has been supplied with gas will be pumped to the waiting crate for the thick sugar juice. The sulfated viscous juice will be processed into crystals at the cooking station. This process produces SO_2 air emissions, then waste BOD, COD, TSS, sulfides, and fatty olis (Figure 3).

Crystallization Station

Sugar mills convert the sucrose in the juice into sugar crystals through a cooking or crystallization process. There is an important term in cooking stations, the liquid separated from the sugar crystals in the first centrifugation. Clare is a liquid that is separated from sugar crystals in the second centrifugation. The cooking process uses 2 main tools, namely a vacuum pan and a spinner. The product of the vacuum pan is called masscuite. In the first stage, the thick sugar juice that has been sulphitured is flowed into a vacuum pan A. In this process there are inputs and outputs with raw juice. This process produces SO_2 air emissions, then waste BOD, COD, TSS, sulfides and fatty oils (Figure 4).

Implementation of cleaner production in the sugar industry

Sugar industry by-products

Bagasse (25–30 percent cane) after crushing, pressmud (3–5% cane) after clarifying, and molasses (3.5–5% cane) after centrifuge are the three primary side products of the sugar production industry. Four alternatives to bagasse use have been proposed:

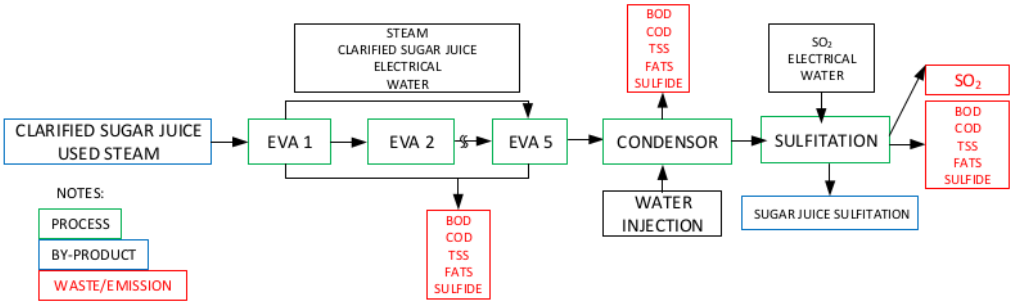

Fig. 3. Evaporation Station

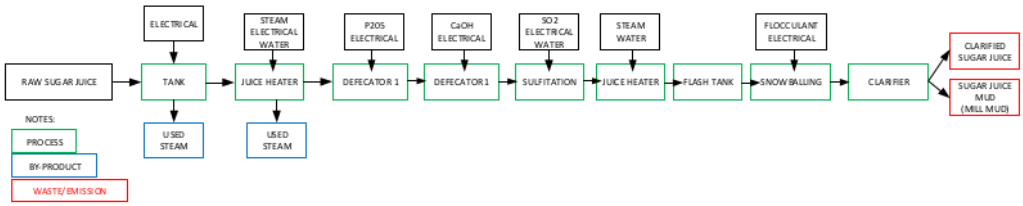

Fig. 4. Crystallizations process

composting to convert into organic manure, burning for steam, digestion for methane gas production, and input for pulp and paper. Molasses is another significant byproduct of the sugarcane processing industry. From one ton of sugarcane, almost 2.5–4% of molasses was generated. Molasses is a valuable raw material used in the production of alcohol, acetic acid, bioethanol, bread yeast, chemical solvents, micronutrients, and cow feed, among other things. Molasses is primarily utilized in the manufacturing of ethyl alcohol in the alcohol industry. Filter cake is made from press mud, which is a byproduct of the sugar industry. It has a moisture content of 75–80%, a sugar content of 2–5%, and a fiber content of 5–10%. It has been used as fertilizer to boost agricultural output due to the enrichment of inorganic material (Sahu, 2018).

Wastes from sugar industry

Waste in sugar industry are unloading sugarcane from a loader releases dust; cutting and shedding of small fibers releases suspended particle matter; burning of discarded sugarcane bagasse releases smoke; and open dumping of solid garbage releases odors are all sources of air pollution. A lot of caution was exercised during all of these activities. Mill house, boiler blowdown, rotary filter and condensate, leakage from pumps and pipes in the evaporators and centrifuge house, as well as frequent floor washings, all contribute to the wastewater generated by the industry. They are natural, organic, and safe. Sugar industry effluent contains oil and grease, as well as cane thread, which must be filtered and skimmed before utilization.

Cleaner production in sugar industry

Cleaner production on the basis of sustainable development is now an activity and several stakeholders to implement production that can minimize emissions or waste (Farahdiba *et al.*, 2021). The implementation of clean production needs to be followed by a study at every stage of the production process.Indonesia has implemented this study by integrating the EIA study with LCA analysis in the national environmental rating assessment which is called PROPER (Farahdiba *et al.*, 2021). In several previous studies, environmental impact assessments were conducted to achieve cleaner production using the life cycle assessment (LCA) method (Iswara *et al.*, 2020; Nieder-Heitmann *et al.*, 2019; Renouf *et al.*, 2018). The LCA is included to find out the ingredients, products, and residues generated from each production process (Standard, 2000; The International Standards Organisation, 2006). Previous study conducted that the biggest energy lies in the sugar production process of 113167.05 MJ/1 tonne of sugar (97%) while the biggest global warming impact category lies in the sugar production process with 1072808 kg CO_2eq/1 ton cement (96.4%)(Gunawan *et al.*, 2019).

Regarded as some of the most essential environmental protection processes, EIA and Cleaner Production ought to be optimally strengthened in sugar indsutry. They have many characteristics, such as principles, objectives, and procedures, as well as formal/legal links that are almost the same, which cause them to be correlated or integrated in practice. (Salvador *et al.*, 2000).

CONCLUSION

This study reveals a brief picture of the sugar industry's environmental effects. Proper technology and management that utilize the reducing, recycling, and reusing in sugar refinery, will become the promising zero waste industry. This study stated that sugar processing faces numerous problems and necessitates good management to provide cleaner production systems. Otherwise, it has a significant environmental impact.

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REFERENCES

Adhiem, M. A. 2018. Kebijakan Impor Gula/: Potensi Dampak. *Kajian Singkat Terhadap Isu Aktual Dan Strategis*. *X*(17): 19-23.

Badan Pusat Statistik. 2017. Statistik Tebu Indonesia. In *Katalog BPS*. BPS RI.

Farahdiba, A. U., Adefitri, W., Yulianto, A., Putra, A. H., Qonita, A. Z. and Oktavitri, N. I. 2021. Sustainable sanitation assessment of settlements close to a landfill: A case study of Piyungan landfill, Yogyakarta, Indonesia. *Pollution Research*. 40(1) : 88-92.

Farahdiba, A. U., Qonita, A. Z., Ramadhanti, Z. L., Juliani,

F. E. K. A., Amalia, A. and Iswara, A. P. 2021. Environmental impact assessment for promoting cleaner production: Qualitative process analysis in cement plants. *Pollution Research*. 40(1) : 63-66.

Gunawan, Bantacut, T., Romli, M. and Noor, E. 2019. Life Cycle Assessment of Cane-sugar in Indonesian Sugar Mill: Energy Use and GHG Emissions. *IOP Conference Series: Materials Science and Engineering*. 536(1). https://doi.org/10.1088/1757-899X/536/1/012059

Iswara, A. P., Farahdiba, A. U., Nadhifatin, E. N., Pirade, F., Andhikaputra, G., Muflihah, and Boedisantoso, R. 2020. A Comparative Study of Life Cycle Impact Assessment using Different Software Programs. *IOP Conf. Series: Earth and Environmental Science* 506 : *012002*. https://doi.org/10.1088/1755-1315/506/1/012002

Kaab, A., Sharifi, M., Mobli, H., Nabavi-Pelesaraei, A. and Chau, K. Wing. 2019. Combined life cycle assessment and artificial intelligence for prediction of output energy and environmental impacts of sugarcane production. *Science of the Total Environment*. 664 : 1005-1019. https://doi.org/10.1016/j.scitotenv.2019.02.004

Kementrian Energi dan Sumber Daya Mineral. 2016. *Data Inventory Emisi GRK Sektor Energi*.

Nieder-Heitmann, M., Haigh, K. F. and Görgens, J. F. 2019. Life cycle assessment and multi-criteria analysis of sugarcane biorefinery scenarios: Finding a sustainable solution for the South African sugar industry. *Journal of Cleaner Production*. 239: https://doi.org/10.1016/j.jclepro.2019.118039

Renouf, M. A., Poggio, M., Collier, A., Price, N., Schroeder, B. L. and Allsopp, P.G. 2018. Customised life cycle assessment tool for sugarcane (CaneLCA)–a development in the evaluation of alternative agricultural practices. *International Journal of Life Cycle Assessment*. 23(11) : 2150-2164. https://doi.org/10.1007/s11367-018-1442-z

Sahu, O. 2018. Assessment of sugarcane industry: Suitability for production, consumption, and utilization. *Annals of Agrarian Science*. 16(4): 389-395. https://doi.org/10.1016/j.aasci.2018.08.001

Salvador, N. N. B., Glasson, J. and Piper, J. M. 2000. Cleaner Production and Environmental Impact Assessment: A UK perspective. *Journal of Cleaner Production*. 8(2) : 127-132. https://doi.org/10.1016/S0959-6526(99)00317-0

Standard, I. 2000. Environmental management – Life cycle assessment – Life cycle interpretation Management environnemental – Analyse du cycle de vie – Interprétation du cycle de vie. *Reference Number ISO*. 14043(14043). https://doi.org/10.1109/IEEESTD.2007.4288250

The International Standards Organisation. 2006. *INTERNATIONAL STANDARD assessment – Requirements and guilelines* (Vol. 2006). https://doi.org/10.1007/s11367-011-0297-3

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