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THE USE OF BAGASSE SYNTHETIC SURFACTANTS AS MATERIAL FOR ENVIRONMENTALLY FRIENDLY POLICIES TO IMPLEMENT ENVIRONMENTAL MANAGEMENT

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ABSTRACT

Aims: The aim of this research study is to show that the use of synthetic surfactant from bagasse is Environmentally Friendly Policies. Various human and industrial activities surely have affected the environment. Environmental management should include a number of groups from different varieties such as academics, policy makers, non-governmental organizations, corporations' employees, government's employees and related multidisciplinary groups. Methodology and Results: Environmental management will produce an ecological process and shapes industrial ecology which consists of four components namely; production, consumption, waste/by-products and raw materials. Bagasse as one of industrial solid wastes involved in environmental management will also produce ecological process. Bagasse which is produced from sugarcane processing can be further reprocessed into SLS surfactant that is useful for oil companies as injection fluid on reservoirs to improve oil recovery level. Conclusion, significance and impact of study: Environmental management can be applied between two industries that have mutualism symbiosis relationship through secondary production. Waste minimization can be achieved through bagasse processing. Sugarcane bagasse reprocessing into surfactant is a sustainable program that supports sustainable material management effort. The action to reprocess natural waste into a valuable economical material can also alter human behavior into a more environmental friendly type of behavior.

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- Bagasse
- Environmental friendly
- Environmental management
- Surfactant

1. INTRODUCTION

Environmental management has become an essential activity with the emerging industrial activities. Generally, there is a significant potential of waste pollution in industrial sectors due to 2% of activity escalation level each year (Yogaswara *et al.,* 2019; Bah and Artaria, 2021). There are numerous research results that identify several weaknesses regarding green public procurement/GPP which is related to sustainable environmental responsibilities (Lazaroiu *et al.,* 2020). Environmental management acts as a safeguarding policy to protect the nature from potentially environmental damages businesses by establishing an economically and environmentally profiting situation. On a common ground, we can say that environmental management is an effort to manage human impacts on the environment (Barrow, 2020).

The definition of environment is a spatial unity that includes all objects, state forces, and living things including humans and their behavior. Environmental management is an integrated effort to utilize, organize, maintain, supervise, control, recover, and develop the environment (Martadila, 2020; Nugroho & Utomo, 2016). The goal of this effort is to achieve a sustainable relationship between human and their environment as a way to build human as a whole, to maintain resources utilization on a prudent scale, to place human as environment caretaker, and to conduct environmentally-friendly development for the sake of the present and future generations (Das, 2018). With the increasing environmental awareness in the society, manufacturers should educate their engineers and technicians to pay attention to the environmental aspects of manufacturing to improve their competitiveness. The principle of manufacturing and environmental support have already included in curriculum offered by universities (Ghodatri *et al.*, 2016).

Environmental management is related to the understanding about earth's structures and functions, and the effort to adjust to the management itself. Because it contains numerous aspects, environmental management possesses a number of perspectives regarding environmental changes in the future and create maximum benefit whilst also minimize environmental damage. On this condition, decision making and its political aspects play a massive role in environmental management (Barrow, 2020). From previous research in the petroleum sector, there is the use of surfactants made from petroleum (Negin, 2017). Several studies on the use of surfactants have begun to be directed at using raw materials synthesized

from nature by utilizing bagasse (Setiati, 2017; Setiati *et al.*, 2021). In addition to bagasse, research on the use of surfactants from palm oil waste has also been carried out (Prakoso, 2018). This activity is still in the form of sectoral research, which needs to be managed properly in order to achieve good environmental management. Environmental management includes a number of different groups such as academics, policy makers, non-governmental organizations, corporations' employees, government's employees and related multidisciplinary groups. Because it's a multidisciplinary step, it also means that the activities it contains are involving a number of parties. Environmental management is an integrated effort to preserve environmental function that includes environmental structuration, utilization, development, maintenance, recovery, supervision, and control policies (Abu-Rahma, 2019).

2. RESEARCH METHODOLOGY

According to Abu-Rahma & Jaleel (2019), environmental management process includes several stages; starting from the identifications of expected environmental result, physical, economic, social, cultural, politic, and technological obstacles, consideration of the best options to achieve the expected result while also anticipate, avoid, and solve environmental and conservational problems. The government has already established policy regarding the environment through the making of Environmental Law (Wati, 2018; Wiharja, 2018). The law includes the following criminal rights, obligations, authorities and provisions:

- Everyone has an equal right to a good and healthy environment.
- Everyone has an equal right to environmental information related to their role on the environmental management effort.
- Everyone has an equal right to play their part on environmental management in accordance with the applicable law.
- Everyone is obliged to maintain environmental functions and prevent pollutions and damages on the environment.
- Everyone that practice commercial activities and/or general activities is obliged to provide correct and accurate information regarding environmental management.
- The society has an equal chance to play their role on environmental management.

Environmental management system on all human activities will produce impacts on the environment. Because of that, we need to alter our attitude and behavior into a more environmental-friendly ones, which can be identified by three simple ways namely:

- By practicing management and supervision instruments which aim to reduce business options into the ones that support environmental management such as zonation, prescription, certain technological requirements, and prohibition of specific activities that has the potential to damage the environment and drives people to be more environmental friendly (Ferdian *et al.*, 2016).
- By practicing economic instrument that aims to change perspectives on profit and loss by providing economic disincentives and incentives.
- By practicing persuasive instrument that aims to persuasively drive the society to change their perceptions on human-environment relationships.
- The actual recommended environmental management step is to manage oneself. The government still has the power to supervise and manage (Ferdian *et al.,* 2016). To achieve the goal of business profiting environmental internalization cost, Otto Sumarwoto developed two implementation instruments that are related to each other namely financial administration instrument and technological instrument which includes eco-efficiency and ecological industry (Wibisana, 2019; Zheng, 2019).

The application of environmental management that produces ecological process is illustrated in the following Figure 1.



Figure 1 Industrial ecology processes (Celik, 2013)

Through the scheme we can see the industrial symbiosis where the result of production process will be consumed by the society. The waste of the consumption process can be reused by secondary consumption and recycled on secondary production. The waste of secondary consumption can also be recycled on secondary production. The result of society consumption, secondary consumption, and secondary production will be able to minimize wastes. In principle, environmental management will shape industrial ecology that includes four main components namely production, consumption, waste/by-product, and raw materials (Anderson, 2016). Products will be consumed by society, and in the process produce wastes that can also be utilized as materials to produce different useful products.

The method used in this study refers to the concept of the ecological process in Figure 1. The focus of this research is the policy of using surfactant which is synthesized from bagasse. Research starts from activity of sugar factory.



Figure 2 Research flow chart

Activity of the research start from:

- 1. The existence of sugar production, which will be consumed by the community.
- 2. Bagasse waste generated can be used for secondary production, by processing bagasse into lignosulfonate surfactants
- 3. The lignosulfonate surfactant synthesized from this bagasse will be used in the petroleum industry to increase crude oil recovery.
- 4. The crude oil obtained will be processed into a refinery factory to produce fuel products that will be used by the community.

The concept of Ecology Processes can be applied on every industrial activity that creates wastes. Reprocessed wastes will leads to decent environmental preservation situation. Sustainable utilization will simplify sustainable development measurement and create positive contributions towards the identification of optimum solution design and facility operation

(Khorasanizadeh, 2019). Sustainable management is a defined concept consistent to sustainable development which basically represents holistic approach of waste and resource management effort (Khairunisa, 2015).

3. RESULTS AND DISCUSSION

Bagasse as solid waste shows good performance in the Enhanced Oil Recovery (EOR) process. Lignin from bagasse has the potential to become a surfactant which turns out to have the ability to form emulsions which causes a decrease in interfacial tension (Setiati *et al.*, 2021). In this study, we apply environmental management by producing ecological processes as shown in Figure 3. The four components that are in accordance with the principles of environmental ecology in this study are; The product is sugar (1) which will be consumed by the community (2) which produces bagasse during the process (3) can be used as a raw material (4) to produce Surfactant Lignosulfonate which is used by oil companies as injection fluid in reservoir oil to increase recovery oil. Bagasse produced from sugarcane processing is known as sugar factory waste. If we don't recycle this waste, it will pollute and disturb the environment. Bagasse still contains lignin which has the potential to be reprocessed into a new product known as Surfactant Lignosulfonate. This product is produced by isolating lignin through a sulfonation process (Setiati, 2017). Surfactant synthesized from bagasse can be used as an injection fluid in oil reservoirs to increase the oil recovery.

Surfactants can be used to form mid-phase emulsions and reduce interfacial tension in the oil system in the reservoir. Under these conditions, oil droplets trapped in rock formations can be more easily removed and produced at the surface. The results of this study indicate that the surfactant can reduce the interfacial tension from 12.01 mN/m to 2.73 mN/m. The interfacial tension can be reduced because the Surfactant Lignosulfonate has the ability to form a mid-phase emulsion from 1.25% - 10%. Table 1 below shows the results of the surfactant injection that act as the main component of the performance of Surfactants Lignosulfonate in the Enhanced Oil Recovery process. Based on the results of the injection test, it is proven that the use of Surfactant synthesized from bagasse can increase oil recovery by 1.80% - 9.25%. This shows that waste can be reduced and processed into more useful products. The increase in oil recovery with surfactant injection can theoretically be achieved by an increase of 10% (Ragab, 2021). So the results of this study are in accordance with applicable references.

Table 1	. The	results o	of su	urfactant	flooding	g in	the	laborator	y test
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No.	Salinity (ppm)	Middle Phase Emulsion (%)	Recovery Factor (%)
1.	5,000	1.25	7.00
2.	10,000	10.00	9.25
3.	20,000	5.00	8.55
4.	40,000	6.00	1.80

Based on that, we can produce the relationship concept symbiotic scheme between sugar industry and oil industry as shown in the following Figure 3.



Figure 3 Implications of the concept of ecological processes in the petroleum industry

Symbiosis mutualism is occurred between sugar and oil industries. The existence of bagasse produced by sugar factories can be reprocessed into Surfactant Lignosulfonate that can be utilized on oil industry. Surfactant is a result of secondary production activity. With this secondary production, we can reduce waste and create a cleaner and less polluted environment, which would benefit the society.

Sugarcane bagasse processing into Surfactant is a sustainable program that would be helpful on the achievement of sustainable material management effort. This sustainable

process is able to alter human attitude and behavior towards a more environmental friendly, by processing natural waste into a product with high economic value. This sustainable process is able to change human attitudes and behavior towards being more environmentally friendly, by processing natural waste into products of high economic value. This eco-friendliness is shown from the raw material for the synthesis of surfactants using vegetable waste. Previously, for petroleum sulfonate surfactants, crude oil was used as raw material. This raw material is not environmentally friendly because it is not renewable and is not a recycling process. The nature of the material will also be different from the raw material for vegetable waste. This vegetable waste is also relatively easy to obtain. The use of vegetable waste is an effort to keep the environment clean. These factors are supporting environmental friendly.

4. CONCLUSION

Based on these results, it can be concluded that the processing of bagasse solid waste into SLS surfactant which has high economic value can help us preserve and protect the environment. Concept of Ecological Processes can be applied to the petroleum industry Environmental management can be carried out between two industries that have a symbiotic relationship of mutualism through secondary production. Waste minimization can be done through reprocessing of bagasse. Based on this, industrial ecological processes applied to various industrial sectors will be able to encourage the achievement of environmental management objectives.

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REFERENCES

Abu-Rahma, A., & Jaleel, B. 2019. Perceived Uncertainty and Use of Environmental Information in Decision Making: The Case of the United Arab Emirates. *International Journal of Organizational Analysis.* 27(3): 690-711. <u>https://doi.org/10.1108/IJOA-07-2017-1205</u>.

- Bah, Y.M. and Artaria, M.D. 2021. Privatization of Solid Waste Management: Opportunities and Challenges. *Indonesian Journal of Urban and Environmental Technology*. 4(2): 142-163 https://trijurnal.lemlit.trisakti.ac.id/index.php/urbanenvirotech/article/view/8219/pdf.
- Barrow, CJ, 2020, Environmental Management: Challenges and Opportunities (3rd Edition), obtained from: <u>https://www.researchgate.net/publication/347524725 Environmental</u> <u>Management Challenges and Opportunities 3rd Edition In prep from Jan 2021</u>.
- Celik, B., G. 2013. Exploring Sustainable Development and Its Interpretation in the Built Environment. *Journal of Sustainable Development.* 6(12). Doi: <u>http://dx.doi.org/10.5539/jsd.v6n12p83</u>.
- Chegenizadeh Negin, Saeedi Ali, Quan Xie. 2017. Most Common Surfactants Employed in Chemical Enhanced Oil Recovery. Petroleum. 3(2): 197-211. ISSN 2405-6561, <u>https://doi.org/10.1016/j.petlm.2016.11.007.(https://www.sciencedirect.com/science/article/pii/S2405656116300621)</u>.
- Das, P. K. 2018. An Introduction to the Concept of Environmental Management: Indian Context. International Journal of Innovation and Economic Development. 2(4): 25-34.
- Ferdian H., Purwanto, Santoso, H. 2016. The Domination of Manage and Supervise Management Paradigm on SVLK: The Evaluation of Environmental Management and Review Implementations on Furniture Industry in Jepara. *Jurnal Ilmu Lingkungan*. 14(2): 108-114. Doi: 10.14710/jil.14.2.108-114.
- Ghodrati, B., Al-Chalabi H., & Hoseinie, H. 2018. Environmental Friendly Manufacturing and Support-Issues and Challenges, Conference Paper, presented on June 2016, Doi: 10.1142/9789813 141124_0023.
- Jiliang Zheng and Xiaoting Peng. 2019. Does an Ecological Industry Chain Improve the Eco-Efficiency of an Industrial Cluster? Based on Empirical Study of an Energy-Intensive Industrial Cluster in China. *Sustainability*. 11: 1651. Doi:10.3390/su11061651.
- Karin Andersson, Selma Brynolf Hanna Landquist, Erik Svensson, 2016, Methods and Tools for Environmental Assessment, Shipping and the Environment pp 265-293, https://link.springer.com/chapter/10.1007/978-3-662-49045-7_9.
- Khairunisa, R. 2015. Profit Oriented Environmental Management, Article, Drs. J. Tanzil & Associates, obtained from: https://www.jtanzilco.com/blog/detail/207/slug/manajemen-lingkungan-berori entasi-keuntungan.
- Khorasanizadeh, M., Bazargan, A., & McKay, G. 2019. An Introduction to Sustainable Materials Management, Springer International Publishing AG 2018, Handbook of Environmental Materials Management, Doi: 10.1007/978-3-319-58538-3_105-1.

- Lazaroiu, G., Lonescu, L. A., Cristian, U., Hurloiu, I., Andronie, M. & Dijmarescu, I. 2020. Environmentally Responsible Behavior and Sustainability Policy Adoption in Green Public Procurement. *Sustainability*. 12(2110). Doi: 10.3390/su12052110.
- Martadila, A. 2020. The Definition of Environment According to Experts and Its Important Classification, obtained from: https://www.merdeka.com/sumut/pengertian-lingkungan-hidup-menurut-para-ahli-dan-jenisnya-yang-perlu-diketahui-kln.html?page=1, accessed on: Tuesday, 15 December 2020 13:50.
- Nugroho W. & Utomo, M. 2016. Definition of The Environment, Environmental Services of Sleman Regency, obtained from: <u>https://dinlh.slemankab.go.id/memahami-definisi-dari-lingkungan-hidup/</u>
- Prakoso, N. I., & Purwono, S. 2018. Synthesis and Application of Green Surfactant from Oil Palm Empty Fruit Bunches's Lignin for Enhanced Oil Recovery Studies. *Chemical Engineering Transactions.* 63: 739-744. <u>https://doi.org/10.3303/CET1863124</u>.
- Ragab, A., Mansour, E. M. , 2021, Enhanced Oil Recovery: Chemical Flooding, in K. S. Essa *et al.*, (eds.), Geophysics and Ocean Waves Studies, IntechOpen, London. 10.5772/intechopen.90335.
- Setiati, R., Kasmungin, S., Riswati, S. S., Rinanti, A., Satriabudi, J. 2021. The Performance Effects of Solid Waste From Bagasse on Increased Oil Recovery. *Indonesian Journal* of Urban and Environmental Technology (Urbanenvirotech). 4(2): 183-195. Doi: <u>https://doi.org/10.25105/urbanenvirotech.v4i2.9195</u>.
- Setiati, R. 2017. Synthesis and Characterization of Sodium Lignosulfonate from Bagasse: The Effects of Concentration and Salinity toward the Performance of Oil Injection in Core, [Dissertation], Bandung, Indonesia, Bandung Institute of Technology (ITB).
- Wati, E. P. 2018. Environmental Protection and Management of Sustainable Development. *Jurnal Ilmu Hukum Lingkungan.* 3(1). Doi: http://dx.doi.org/10.24970/bhl.v3i1.63.
- Wiharja. 2018. The Implementation of Clean Product to Improve Industrial Efficiency. *Prosiding Seminar Nasional dan Konsultasi Teknologi Lingkungan*. presented on 20 September 2018.
- Yogaswara, M. F., Juwana, I., Sari, Y. S., Bakar, H. 2019. A Study of Pollution Load Capacity of the Industrial Sector in Cibabat River in the Watershed of Citarum River. *Indonesia Journal of Urban and Enviromental Technology (Urbanenvirotech).* 3(1): 67-83. Doi: http://dx.doi.org/10.25 105/urbanenvirotech.v3i1.5569.
- Wibisana, A. G. 2019. Economic Instruments, Command and Control, and Other Instruments: Friends or Foes? Comments From A Smart Regulation Perspective, Bina Hukum Lingkungan, 4(1). Doi: http://dx.doi.org/10.24970/bhl.v4i1.104.