Life Cycle Assessment of SLS And SLES (Sodium Lauryl Sulfate And Sodium Laureth Sulfate) Product

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Abstract- *Alcohol ethoxylates surfactants are produced via the ethoxylation of fatty alcohol (FA) with ethylene oxide. The source of FA could be either palm kernel oil (PKO) or petrochemicals. The study aimed to compare the potential environmental impacts of PKO-derived FA (PKO-FA) and petrochemicals-derived FA (petro-FA). Cradle-to-gate life cycle assessment has been performed for this purpose because it enables understanding of the impacts across the life cycle and impact categories. The practices in land use change for palm plantations, end-of-life treatment for palm oil mill wastewater effluent and end-of-life treatment for empty fruit bunches are the three determining factors for the environmental impacts of PKO-FA. For petro-FA, n-olefin production, ethylene production and thermal energy production are the main factors. We found that judicious decisions on land use change, effluent treatment and solid waste treatment are key to making PKO-FA environmentally sustainable. The sourcing of FA involves trade-offs and depends on the specific practices through the PKO life cycle from an environmental impact perspective.*

Keywords- Life cycle assessment, Alcohol ethoxylates, Fatty alcohol, Palm kernel oil, Oleochemicals, Greenhouse gases, Environmental impacts

I. INTRODUCTION

In personal care products including soaps, shampoos, and lotions, fatty alcohols are employed as detergents and surfactants. The market for fatty alcohol is thought to be around $5 billion globally. The majority of fatty alcohols used today come from either crude oil or palm kernel oil, both of which are not long-term sustainable feedstocks. Instead, fatty alcohols can be made through microbial fermentation from a variety of abundant renewable feedstocks. Certain marine bacteria can naturally create fatty alcohols, however, because of their low titers and unsuitability for large-scale fermentation, these species should not be used. As a result, numerous hosts with industrial applications have been created to synthesise fatty alcohols. To create 6.3 g/L of total fatty alcohols, Escherichia coli was modified. Saccharomyces cerevisiae, a type of baker's yeast, was modified to have a titer of 6.0 g/L. Many oleaginous yeast species have also expressed interest in producing fatty alcohol. These early studies compiled data on the natural resources consumed, wastes generated, and emissions for then-industry practices for AE production from both petrochemical and oleochemical feedstocks. However, the impacts of land transformation for palm plantation were not covered and the scope was limited to LCI due to a lack of agreed-upon LCIA methods.

II. LITERATURE REVIEW

[1]Hansen, S.

This study intends to introduce the idea of LCA and conduct a screening LCA on the production of crude palm oill Malaysia, encompassing the planting, transportation, and milling phases. The assessment, which is mostly based on general data, aims to serve as a warning of the environmental risks and nearby institutions on how to conduct an assessment in a palm oil scenario. The findings conclusively demonstrate that the system's most damaging process is ferrtiliser production, which is followed by transportation and boiler emissions at a tie. The system's greatest environmental effects are the depletion of fossil fuels and respiratory inorganics, with the former mostly caused by boiler emissions and the latter by fertiliser manufacture and transportation. Since crude palm oil extraction in Malaysia accounts for around 3.5% of all environmental impacts in the nation, focus must be paid to minimising effects.

[2] Nogueira, A. R., Popi, et. al.,

Using a 'cradle-to-gate' life cycle assessment, this study evaluated the environmental performance of 1.0 tonnes of sodium lauryl ether sulphate that included 3 mol of ethylene oxide (SLES 3EO). Primary energy demand (PED) and global warming potential were used to quantify environmental effects. Additionally, a carbon footprint analysis was made using ISO 14067 standards. For the baseline scenario, the global warming indicator was determined to be 1.87 t CO2eq/t, whereas PED was predicted to be 71.7 GJ/t. Lauryl alcohol performance was shown to have a significant impact on the utcomes. Additionally, biomass-derived thermal energy reduced the rate of global warming while raising the proportion of renewable energy in the PED index. On the other hand, because of the substantial fuel and thermal energy requirements along its whole manufacturing chain, the manufacture of ethylene oxide from ugarcane ethanol was not a viable option. When it comes to the Brazilian setting, this might be seen as an innovative approach. The findings from this inquiry are anticipated to support further projects looking at detergent formulation from an environmental standpoint as a pioneering endeavour.

[3] Shah, J., Arslan, E., Cirucci, J. et al.

By ethoxylating fatty alcohol (FA) with ethylene oxide, alcohol ethoxylates surfactants are created. Petrochemicals or palm kernel oil (PKO) may be the source of FA. The study compared the possible environmental effects of FA obtained from petrochemicals and PKO (petro-FA) with FA derived from PKO (PKO-FA). For this reason, a cradle-to-gate life cycle evaluation has been carried out since it makes it possible to comprehend the effects on various life cycle and impact categories. The findings indicate that petro-FA emits less greenhouse gas (GHG) on average than PKO-FA (*5.27 kg CO2e), at 2.97 kg CO2e on average. The three deciding elements for the environmental effects of PKO-FA are (1) the practises in land use modification for palm plantations, (2) end-of-life treatment for palm oil mill wastewater effluent, and (3) end-of-life treatment for empty fruit bunches. When factoring trade-offs into decision-making, the stakeholders' innate sustainability values based on their own local environmental profiles would be crucial.

III. METHODOLOGY

Step I: Production of Palm kernel oil: This was done to build a detailed database with respect to the inventory as desired by the production process.
Step II: Production of lauryl alcohol (Dodecanol, fatty alcohol): This was done to build a detailed database with respect to the inventory as desired by the production process.
Step III: LCA of SLS: Detailed Cradle to Gate assessment of Sodium Lauryl Sulfate (SLS).
Step VI: LCA of SLES: Detailed Cradle to Gate assessment of Sodium Laureth Sulfate (SLES).

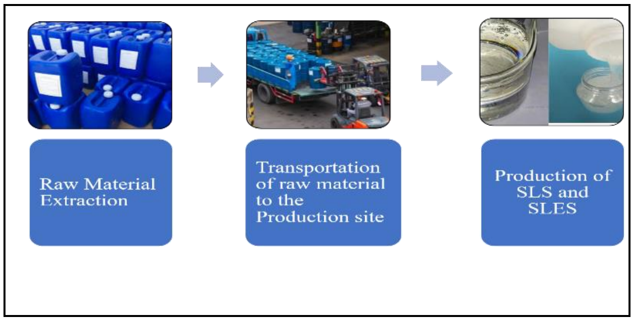

Figure 1: Cradle to Gate Life cycle stage

IV. FUTURE SCOPE AND LIMITATIONS OF THE STUDY

- To include the advancements in analyses as technology continues to evolve. This entails taking into account novel manufacturing techniques, substitute feedstocks, and cutting-edge waste treatment innovations that might lessen the environmental impact.
- Integrating social and economic factors into LCA studies can provide a more comprehensive evaluation of the sustainability.
- There should be a data validation of the output data results extracted after the analysis for the better quality of results.
- The process involves simplifications and assumptions to make the analysis manageable. These assumptions can affect the accuracy of the results. For example, the choice of energy sources, such as electricity generation, can significantly influence the assessment outcomes. Assumptions made regarding the treatment of waste and emissions can also impact the results
- Depending upon the availability of data, especially for different production methods and geographical regions, can be limited. This may lead to uncertainties and assumptions in the assessment

V. RESULTS AND DISCUSSION

Life cycle interpretation is a systematic procedure for effectively identifying, quantifying, verifying, and evaluating data from the LCI and LCIA outcomes. Its primary objectives are to:

1. Analyze the data;
2. Draw conclusions based on the results;
3. Clarify the study's/limitations, and processes;
4. Offer long-term remedies to prospective problems;
5. Offer policy linked solutions to enhance the overall sustainability of the industry.

In the present report, the life cycle assessment of SLS and SLES. LCA will give a clear understanding of the environmental impacts caused by the process throughout its life cycle starting from the extraction of raw material to its end of life. The goal and scope of the study were decided based on the feasibility of the study and the intended comparison between the SLS and SLES.

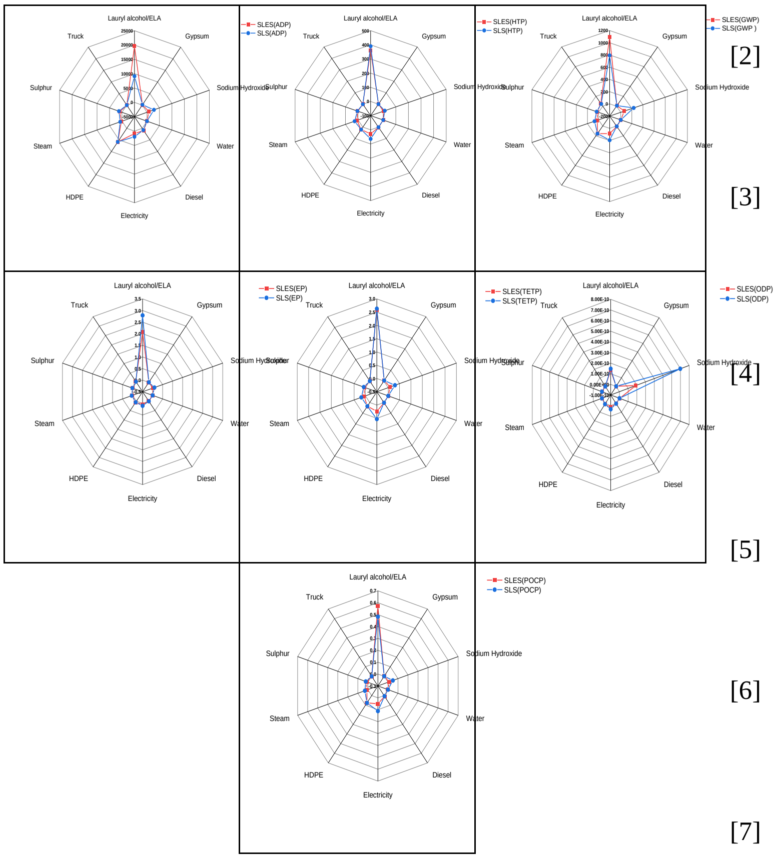

Figure 2: Impact assessment for all the process stages

VI. CONCLUSION

The chemical industry in India is a crucial driver of the country's economic progress and advancement. Renowned for its strong manufacturing capabilities and wide array of products, the industry encompasses various sectors including petrochemicals, fertilizers, pharmaceuticals, dyes, and agrochemicals. India has established itself as a prominent global chemical hub, making significant contributions to both the domestic market and international trade. The industry benefits from ample access to raw materials, a skilled workforce, and a favorable investment climate. Furthermore, the government's initiatives to promote the "Make in India" campaign and facilitate business operations have further accelerated the industry's growth. With a steadfast commitment to sustainable practices and innovation, the Indian chemical industry is well-positioned to meet the escalating demand for chemicals at home and abroad, while driving the nation's economic prosperity

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