Sustainability assessment of poly(butylene succinate) production for wheat straw

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ABSTRACT

This study aims to assess the valorisation of wheat residues for the production of the bio-based polymer poly(butylene succinate) (PBS) by implementing an integrated economic model for the assessment of sustainability. More specifically, the production of PBS from wheat straw will be evaluated taking into account both techno-economic and environmental assessment. The processing steps of pretreatment [1], ferementation and recovery of monomers [2-4] as well as polymerization [5] of the final product will be designed and simulated employing the UniSim Design software. A techno-economic analysis employing discounted cash flow analysis will be implemented to compare the profitability and process viability of PBS against the appropriate reference products. The estimation of the minimum production capacity leading to minimum production cost, minimum feedstock requirement to ensure market profitability of the final products, production cost, payback period and minimum selling price will be presented. The quantities of feedstock requirement will be used in order to assess in which regions the production of the evaluated bio-based products is feasible. Moreover, the End-of-Life (EoL) options of PBS will be also evaluated to recycle the material back into the production process. The conversion routes and the EoL option will be environmentally evaluated by the Life Cycle Assessment approach. Key impact categories such as global warming potential and cumulative energy demand will be considered. A holistic evaluation of sustainability that takes the environmental and techno-economic pillars into account and combines them into a final life cycle cost by monetizing the environmental externalities will be presented.

KEYWORDS: Biopolymer, Lignocellulosic residues, Life Cycle Costing, Sustainability assessment, Poly(butylene succinate)

REFERENCES

[1] Al-Zuhair, S., Al-Hosany, M., Zooba, Y., Al-Hammadi, A., & Al-Kaabi, S. (2013). *Renew. Energy*, 56, 85-89.

[2] Ma, J.F., Jiang, M., Chen, K.Q., Xu, B., Liu, S.W.,Wei, P., Ying, H.J., Chang, H.N., Ouyang, P.K. (2011). *Bioprocess Biosyst. Eng.* 34 (4), 411–418

[3] Burgard, A., Burk, M.J., Osterhout, R., Van Dien, S., Yim, H. (2016). *Curr. Opin. Biotechnol*. 42, 118–125.

[4] Alexandri, M., Schneider, R., Papapostolou, H., Ladakis, D., Koutinas, A., Venus, J. (2019). *ACS Sustain. Chem. Eng*. 7 (7), 6569–6579.

[5] Kamikawa,M., Matsuo, T., Oka, K., Kondo, T., Sase, Y., Tanto, M. (2013). U.S. Patent No. 8,604,156. Washington