Ecological Glue – Towards a Sustainable Industry?

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1. Background + Aims

The introduction of a new generation of biorefineries into the market presents a multi complex problem, where questions like environmental sustainability, economic feasibility and conceptual exploration need to be answered beforehand. The biorefineries of the second generation need to tackle the objective of how chemicals can be produced from biomass, and not compete with the food production. Lignocellulosic biomass presents a raw material with a high potential to replace corn or sugarcane. Innovative production routes from wood to chemicals have to be included within the biorefinery concept. The quest of finding the optimal biorefinery concept is becoming even more complex by considering besides the conventional also innovative processes for the production of chemicals. The approach for finding the optimal concept is that generic optimization algorithm, developed by EPFL in Lausanne, is able to integrate different processes in order to find a bio refinery concept under the objective of profit maximization and environmental impact minimization.
A major part of the research project is the modelling of the different production paths to produce either platform chemicals (e.g. Glucose, Ethylene, Succinic acid) or high value added chemicals (Polyurethanes, Polyesters, Vinyl polymers). For the production routes conventional concepts as well as innovative concepts are considered for finding the optimal production routes. The concepts are evaluated through environmental indicators (Global Warming Potential, Ecoindicator 99, Cumulative Energy Demand) and economic indicators (Profit, Operational costs, Investment cost).

2. Methods + Results

An important platform chemical, which needs to be considered for a biorefinery, is acetic acid. The main application of acetic acid is the production of vinyl acetate, which is used to produce polyvinyl acetate (PVA). PVA is a common chemical for glue or latex emulsions (e.g. application paper coating, textile treatment) [1]. Nowadays acetic acid is mainly produced from petrochemical resources. The most important synthetic route over the last 25 years to produce acetic acid is the carbonylation of methanol. For introducing a feasible route for acetic acid in a biorefinery concept we modelled and optimized the process of Wacker Chemie [2]. The Wacker process is converting ethanol to acetic acid by the gas phase oxidation of ethanol. The major aim of this research project is to point out the major environmental and economic cost in the production of PVA from lingocellulosic biomass. The results of the project show the economic and environmental impact of different steps for the production of PVA.

1. Converting Wood to Glucose
2. Fermentation of Glucose to Ethanol
3. Dehydration of Ethanol to Ethylene
4. Oxidation of Ethanol to Acetic acid
5. Addition of Ethanol and Acetic acid to Vinyl acetate
6. Polymerization of Vinyl acetate to PVA

3. Summary/Conclusion

Through the assessment based on different rigorous models a conclusion can be drawn if PVA produced from the renewable resource wood can be produced more environmental friendly or is more economical attractive than PVA coming petrochemical industry.

References

[1] Ullmann`s Enycylopedia of Industrial Chemistry, Acetic acid, ISBN: 9783527306732
[2] Wacker Chemie AG, Method for producing Acetic and Formic acid by the gas phase oxidation of ethanol, WO 2008/110468 A1