Chem-LCA = (**Environmental Impacts** of the production process at laboratory scale) * **Scaling-up** factor.

LCAs for chemical production at industrial scale: A review

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1. Introduction

The chemical sector is actually a four trillion-dollar global business, employing more than 20 million people directly and indirectly, and touching over the 95% of manufactured goods (WBCSD, 2021). Chemistry and chemical industry play an essential role in helping society achieve the SDGs.

The present literature research paper is reviewing and comparing the publications on 47 LCAs of chemical processes from 2012 to 2021, indexed in three of the most common scientific databases (Science Direct, Scopus and Web of Science).

2. Methodology

1) Searching scientific papers developed as LCA studies for chemical processes at industrial scale
   - "("Life cycle") AND (LCIA OR inventory) AND (chemical OR reaction OR synthesis) AND (reactant OR solvent OR catalyst)"
   - "("Life cycle analysis" OR "Life cycle assessment") AND ("Life Cycle Impact Assessment" OR "Life cycle inventory") AND reaction AND reactant"
2) Screening results in accordance with the pre-defined selection criteria for the scope of the study
3) Compiling results in an Excel table for the analysis of the selected papers and relating them with the pre-defined indicators and variables selected in the scope of the study

3. Results and discussion

Life-cycle environmental inventory of chemical processes can be identified by:
1) Working out the impacts of the input material flows,
2) Adding the impacts of the output flow treatment,
3) Adding the impact of the energy used heating up and cooling down and
4) Adding the impacts of the energy used stirring, pumping, milling and other mechanical processes applied to the material flows.

Then, if data have been obtained at laboratory scale, it needs to be scaled up to industry level either by 1) using process simulation, 2) advanced process calculation benchmarks or 3) retrosynthetic breakdown.

Characterization factor most utilized are ReCiPe 2008 or 2016 (55%), CML 2001 (33%), Ecoindicator 99 (8%) and IMPACT 2002+ (4%).

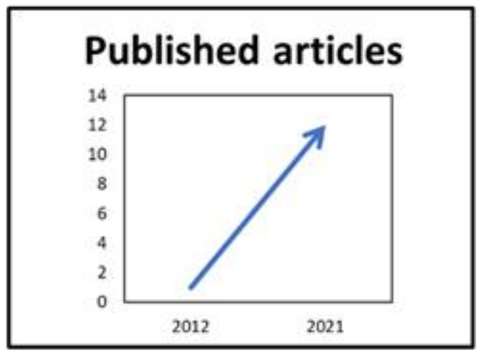
Most of the papers use software in order to make more accurate calculations. From the 68% which used software for mass and energy balances, 84% used AspenPlus. From the 89% which used software for LCIA, 67% used SimaPro, 19% used GaBi; 10% used Umberto LCA+; 2% used OpenLCA and another 2% used CMLCA.

4. Conclusions

None of the reviewed articles carries out a study of the evolution of the impact calculated assuming the new energy mix foreseen in the European Union for the years 2030 and 2050 according to the SDG roadmap. This would be highly interesting considering that it may directly affect the environmental impacts of some energy-intensive processes.

In addition, very few of the articles include other dimensions of sustainability (economical and social vectors), bringing transversality to the study.

These would be two important improvements for future life cycle studies of chemical processes, which allow us to assess the overall impact of a process now and in the coming years.



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