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Published in:
ISIE Conference 2015

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Damgaard, A., Zarrin, B., Tonini, D., Baumeister, H., & Astrup, T. F. (2015). Capabilities for modelling of conversion processes in LCA. In *ISIE Conference 2015* (pp. 131-132).
http://programme.exordo.com/isie2015/delegates/presentation/1248/

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Capabilities for modelling of conversion processes in LCA

Wednesday, 8th July 11.15 - ISIE 2015

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Life cycle assessment was traditionally used for modelling of product design and optimization. This is also seen in the conventional LCA software which is optimized for the modelling of single materials streams of a homogeneous nature that is assembled into a final product. There has therefore been little focus on the chemical composition of the functional flows, as flows in the models have mainly been tracked on a mass basis, as focus was on the function of the product and not the chemical composition of said product.

Conversely modelling environmental technologies, such as wastewater treatment and waste management, the material being addressed is of a very heterogeneous nature. Between treatment facilities receiving materials with different compositions, but also at the individual treatment facility where the temporal composition of a treated material varies considerably. To address this, EASETECH (Clavreul et al., 2014) was developed which integrates a matrix approach for the functional unit which contains the full chemical composition for different material fractions, and also the number of different material fractions present in the overall mass being handled. These chemical substances can then be traced through the different processes similar to substance flow assessment, but with the added options to address emissions and material and energy usage through each process step.

However, it was found that further capabilities were needed as in some technologies even the chemical substances themselves change through a process chain. A good example of this is bio-refinery processes where different residual biomass products are converted through different steps into the final energy product. Here it is necessary to know the stoichiometry of the different products going in, and being able to set constraints for a possible flow on basis of other flows, and also do return flows for some material streams. We have therefore developed a new editor for the EASETECH software, which allows the user to make specific process modules where the actual chemical conversion processes can be modelled and then integrated into the overall LCA model. This allows for flexible modules which automatically will adjust the material flows it is handling on basis of

its chemical information, which can be set for multiple input materials at the same time. A case example of this was carried out for a bio-refinery process.

References:

Clavreul, J., Baumeister, H., Christensen, T. H., Damgaard, A. 2014. An environmental assessment system for environmental technologies. Environmental Modelling & Software 60: 18–30