PlasticsEurope recommendation on

Steam Cracker allocation

Life Cycle and Sustainability working group of PlasticsEurope,

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1. Goal and scope of this paper

LCA data for products, especially information on the carbon footprint (global warming potential) gained more interest through the last years in B2B as well as in B2C communication. LCA data of products comprise the environmental impact of such products from cradle-to-gate. LCA data of steam cracker products directly influence a huge amount of further downstream products, hence they will become even more important. It is therefore important that LCA data for steam cracker products are modelled consistently by LCA experts as a basis for further use in LCA studies. Practitioners need to be enabled to facilitate a comparison of LCA information of downstream products based on sound LCA data of steam cracker products.
For multi-output processes, such as a steam cracker, ISO 14040 and 14044 standards define a hierarchy of several options to tackle that. Following these rules and due to the nature of steam cracker processes allocation is the preferred option of the assessment.
The goal of this paper is to give a recommendation for the allocation of steam cracker processes.

2. Steam cracker product system

2.1 General

The steam cracker process turns fossil hydrocarbon feedstocks (predominantly ethane, LPG, naphtha, or gas oil) into several different main products, like ethylene and propylene, benzene, butadiene and hydrogen. The process yields additional further chemicals like, acetylene, butene, toluene and xylene. This product spectrum is fairly independent from steam cracker´s feedstock, however the ratio of the produced products changes with the feedstock. Some of the products, like toluene and xylene are considered as “side-catch” compared to the main objectives of a steam cracker. Toluene and xylene bulk production predominately originates from reformate, a refinery intermediate product rather than from pyrolysis gas, a steam cracker effluent. This is described in the report “Benzene, Toluene and Xylenes – Aromatics, BTX”, published by PlasticsEurope in February 2013.

The environmental footprint of the steam cracker products depends on:
- the feedstock composition and its environmental profile
- the energy demand of the steam cracker process.
- the proportion of products and by-products produced
- the treatment of steam cracker waste streams prior to their final disposal

2.2 Influence on LCA data

2.2.1 Feedstock

The major impact on the environmental profile of a single product is the product mix produced in the steam cracker. The feedstock used is influencing the environmental profile in two ways, one, as described is the product mix produced, the other is the impact of the feedstock itself, whose environmental profile is differing due to origin (natural gas or oil), location and refinery characteristics, in case of oil.

2.2.2 Energy demand and related emissions

Another relevant factor is the energy demand for the process operation. Most of the energy demand is needed to heat up the feedstocks to cracking temperature and for the cracking process itself. The heat from the process is recovered by steam production which is used amongst others for heat input into separation processes and as motive fluid for steam turbines driving various compressors in the process. Depending on the process configuration and steam cracker´s efficiency these values can vary. The energy demand needs to be allocated in the preparation of LCI as well.

3. Allocation of steam cracker processes

3.1 General

Due to ISO 14040 and 14044, the allocation should be done between the different products or functions in a way that reflects the underlying physical relationships between them. Where physical relationships (e.g. mass, heating value, C-content etc.) alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and functions in a way that reflects other relationships between them on another basis. For example, input and output data might be allocated between co-products in proportion to the economic value of the products.

In relation to these ISO standards it is recommended to define the **“main products (MP)”** for the steam cracker process. Co-products, others than on “main products” will be defined as **“additional products (AP)”**.

For steam crackers the “main products” are:

- Ethylene

- Propylene
- Benzene (*)
- Butadiene (*)
- Hydrogen
- Toluene (*)
- Xylene (*)
- Butenes

(*) if separated from mix

independently which cracker technology or which feedstock is used.
The allocation scheme for “main products” and “additional products” is defined in the following section. This regulation enables practitioners to consistently create LCA data for steam cracker processes.

3.2 Allocation of feedstock

Feedstock shall be allocated on mass basis to all steam cracker products. It is recommended for a better understanding to report the relative share of “main products” and “additional products”.

3.3 Allocation of s energy demand and emissions

Energy demand and emissions shall be exclusively allocated on a mass basis to the “main products”. “Additional products” shall not take an environmental burden from energy demand and emissions.

4. Summary

The concept of defining a main “products” fixed list in combination with a mass-based allocation for steam crackers leads to a consistent LCA approach, independently from market prices, technological changes or market driven adaptions of steam cracker outputs. It gives practitioners a clear guidance for the allocation process. This results in less differing environmental data for steam cracker products and will lead to a higher comparability. The results are much more stable, although the same product will have slightly different LCI results depending on different amounts of products derived from the steam cracker.

Questions and Answers

How was this recommendation established?

It was built through a consensual 5 years long process by The Life Cycle Thinking and Sustainability working group of PlasticsEurope, composed of experts from its member companies, plus some experts of the Chemical Sector of the World Business Council for Sustainable Development, and LCA consultants.

Why is there a need for such a recommendation?

Allocation is a key aspect of LCA of steam crackers. Different assumptions can be made and all of them are somehow right and also wrong. To avoid influencing the results by different understanding of companies of the allocation scheme, it is needed to agree on the basic principles of the allocation without knowing the details of specific processes. Different allocation and different lists of “main products” and ‘co-products” may be absolutely relevant in function of the situations and configurations of different steam-crackers and in function of the goal and scope of the studies.
But the purpose here is to ensure the comparability of petrochemical datasets.
As full transparency is not an option, given the confidentiality of business and to respect the competition laws, the only way to enable comparability is to fix an allocation method,
Then it makes sense that this allocation method is built through a consensual approach, aiming at being as much representative as possible of the steam-cracker population.

Why not allocating to all products, whatever “main products” or “co-products”?

Some co-products are used as fuel or get back as feedstock so they do not carry more values than the steam-cracker feedstock,

Why not having an open list of “main products” and “co-products”?

All products, but particularly those being a small part of the total production, like for example, acetylene, toluene, xylene, may undergo a huge environmental profile difference between being

in one list or the other. As said before, for the sake of comparability, the list must be the same for all, limited and clear, even if it could be detrimental to the representativeness of some steam-crackers. By going through a consensual work, we have tried to minimize this consequence.