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Understanding the product carbon footprint of lubricants

The UEIL Sustainability Committee was established with the intention of providing guidance to define, develop and measure sustainability in the European lubricants industry. The objective is to lead the whole lubricants value chain to become more sustainable. To reach those objectives, it is critical to understand the main elements of sustainability. This article addresses one of the key elements, which is the **product carbon footprint**.

The term carbon footprint has grown in popularity and has become a widely used buzzword in the industry and among consumers. The background is increasing awareness of climate change and global warming.

Carbon footprint - Unit of measurement

The carbon footprint is the total mass of all greenhouse gas (GHG) emissions for an activity or organization over a given period. The total mass of greenhouse gas emissions is typically expressed in carbon dioxide equivalents (CO_2e or CO_2eq).

The greenhouse effect is the process that occurs when gases in the earth's atmosphere trap the sun's heat. The result is a rise in the average temperature of the air, land and oceans; or in other words global warming. Greenhouse gases accelerate the greenhouse effect by absorbing infrared radiation. The most well-known examples of GHGs are carbon dioxide and methane (CH_4) but other gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluorides (SF_6) and nitrous oxides (N_2O)) also contribute to the greenhouse effect.

The climate effects of the various greenhouse gases are standardized using carbon dioxide equivalents (CO_2e or CO_2eq) as the unit of measurement. The reason for standardization is that different GHGs contribute to the greenhouse effect to different extents. In order to make the effects of different GHGs comparable, the global warming potential (GWP) was defined. This index expresses the warming effect of a certain amount of a GHG over a defined period of time, typically 100 years relative to carbon dioxide (GWP 1). For example, one ton of methane would be equal to approximately 30 tons of CO_2eq, because it has a global warming potential of 30 times (on average) that of carbon dioxide. Note that GWPs are typically presented as ranges as they can vary due to updated estimates and differences in calculation methods.

Company and Product carbon footprint

When considering carbon footprint, it is critical to define the context, as various approaches are possible. Carbon footprint can be calculated for an organization, for specific activities or for a product.

The **company carbon footprint**[i] is the annual GHG emissions related to all the company's activities. This includes energy consumed (electricity, heat, steam and cooling), fuel combustion, use of company vehicles and fugitive emissions (accidental emissions of vapours or gases from pressurised apparatus), and all other indirect emissions that occur in an organisation's value chains, for example, purchased goods and services, use of product sold, waste disposal and business travel.

Although this principle appears simple, the challenge is in obtaining the required data, using the correct framework and understanding the methodology.

It is difficult to compare company carbon footprints, as individual company activities vary enormously, but it can be a valuable exercise for tracking carbon reduction progress over time for a single company.

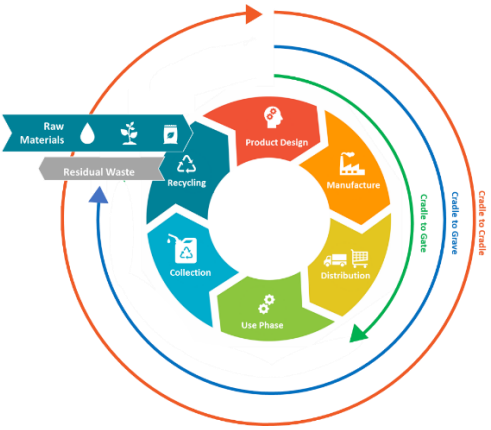
The **product carbon footprint** is the total mass of all GHG emissions over the whole life cycle of the product. This means from the extraction of raw materials through end-of-life. For lubricants, the product carbon footprint in simple terms means: the sum of all emissions (expressed in CO_2e or CO_2eq), which were induced (directly and indirectly) by all activities related to the production, use and disposal of the lubricant.

The figure below identifies the various stages through which a lubricant may pass, that is, the product life cycle. Three scopes or boundaries are considered important when describing product life cycle:

- A complete circular product life cycle (cradle to cradle) is a life cycle where the product at the end of its useful life is regenerated into the original raw materials, product or is re-purposed. Regenerated raw materials can be used in the production of new lubricants and would be considered as an example of applying the principle of designing lubricants from waste oil, in other words keeping lubricants in use for as long as possible.

- Cradle to grave is an assessment of a linear product life cycle from resource extraction to end-of-life disposal (for example, as waste oil).

- Cradle to gate is a partial assessment of a product life cycle from resource extraction to the factory gate.



Carbon Footprint versus Carbon Handprint

Lubricants are products which are designed to reduce friction, heat, and wear and tear betweenmechanical components that come into contact with each other.

A product carbon handprint describes the positive environmental impact of the product in use throughout its lifetime. The positive environmental benefits that end-users and consumers expect to see from lubricants can be described in terms of reduced energy consumption, reduced emissions, increased equipment lifetime, longer drain intervals, reduced lubricant consumption and reduced human and environmental impact. The value of the handprint can often be expressed in avoided emissions and reported as CO_2e or CO_2eq.

Note that handprint savings resulting from the use of high-quality lubricants can be much higherthan the product carbon footprint itself, resulting in a net benefit to the environment.

The handprint is always compared against a reference case. In other words, this means that the footprint is always absolute emissions, while the handprint varies based on the context in comparison to a reference case.

Life Cycle Assessment (LCA)

The process used to compare and validate the footprint and handprint over the full life cycle of the lubricant is called the **life cycle assessment**. UEIL is supporting industry activities to make the methodology of life cycle assessments more comparable across the lubricants industry.

Within the industry multiple concepts and terms have been developed for the evaluation of the carbon footprint. Examples are greenhouse gas calculation/accounting as well as carbon accounting/calculators. The most common approach, which is used to evaluate the environmental impact, is through a **life cycle assessment (LCA)**. In an LCA, the true environmental impact of a product is considered, including all materials, energy inputs, and outputs throughout the life cycle ofthat product.

Although cradle to gate LCAs for lubricants are possible, a cradle to grave approach is preferred. The cradle to gate approach can be useful when comparing products that fulfill the same function with similar performance, meaning that the cradle to gate results are the main differentiator between the two products. However, lubricant performance can differ significantly from product to product and from application to application. This means that for lubricants the use phase is important. A high- quality lubricant can reduce energy consumption and increase

equipment life compared to a conventional lubricant. This means that a cradle to grave LCA helps to show and quantify the impacts during the complete lubricant life cycle.

When going through an LCA, four steps are taken. First the goal and scope are defined. During this step the boundaries and the methodology are decided, as well as the reason for doing the LCA. This is important in order to define the information needed as well as clarifying uncertainties around the interpretation of the outcome. The second step is the inventory analysis, all relevant data (energy needed, raw materials, emissions and waste) is evaluated. The third step is the impact assessment, which is an evaluation of the various environmental impact categories. Apart from the most common global warming category, other environmental categories can be evaluated. Examples are fossil resource depletion, acidification, toxicity, eutrophication and others. The final step is the interpretation phase in which conclusions are drawn.

Life cycle assessment is a powerful tool to calculate product carbon footprint. By evaluating the carbon footprint during each life cycle phase, the full environmental impact can be determined, hot-spots and opportunities for improvement identified.

Summary

Lubricants keep the world moving. They reduce friction and can reduce energy consumption. At the same time, it is important that lubricants are produced and used in a responsible manner, to minimize the lubricant (product) carbon footprint and maximize the product handprint. To quantify their impact, an LCA can be used to evaluate each phase of the lubricant life cycle.

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[i] Company carbon footprint self-assessment tool, UEIL.org/sustainability/toolbox/