Development of Product Category Rule (PCR) for Environmental Product Declaration (EPD) of Conveyor Chain Systems

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Environmental Product Declarations are a form of sustainability performance measures, because they provide information about environmental aspects. They are based on results of Life Cycle Assessment (LCA), which is an international standardized method for the assessment of environmental impacts of products within their life-cycle. [4] Nowadays it is usual to adopt the life-cycle-thinking, which has its roots in biological science, on every material, product or activity
By building up a "Reference Conveyor System", which conveys goods over a length of about 5 meters and includes one L-curve we were able to examine a first Life Cycle Assessment. The results of the LCA can be used for choosing the Rules of Product Categories to develop the requested Environmental Product Declaration. Furthermore it is interesting to have a closer look on the different Impact Categories, (Global Warming, Acidification etc.) which results differ between the phases of the life cycle (up-stream, core, down-stream). Of importances is as well the influence of velocity, good-load and useful lifetime. By including the last into the functional Unit, the comparability between different technological solutions is assured. Processess of recycling were not taken into account because it would exceed the goal of the examination for the moment. The results of the examination are uninspected and have to be discussed.

***Keywords: Environmental Product Declaration, Life Cycle Assessment, Conveyor Chain Systems*.**

1 INTRODUCTION

"Warming from anthropogenic emissions […] will continue to cause further long-term changes in the climate system, such as sea level rise." This is one of the most relevant theses from the latest special report "Global Warming of 1,5°C" published by the Interngovernmental Panel of Climate Change (IPCC).[1] The IPCC is an organization of the United Nations which provides reliable scientific information concerning the climate change and measurements of mitigation and adaption for policy makers in all countries. [2]

To avoid an excessive use of the earth ressources it is necessary to live sustainable. However, you can only manage, what can be measured - so the question is "how to measure sustainability?". First of all, it is necessary to take a life cycle perspective. Life Cycle Assessment (LCA) is one of the common scientific methods to estimate the environmental impact of products, people and organisations. It offers this perspective, because it analyses the whole life cylce of the researched object. [3]

Our focus concerns the ecological dimension (the two others are: social and economic) of sustainability of products, in our special case conveyor chain systems. Products normally have a life cycle, with several phases like extraction of raw materials, production, assembly, use and disassambly at the end of life. Every phase has impacts on the environment, e.g. reducing of natural ressources or using non-renewable energy sources. It is not helpful to reduce the effect in one phase by moving it into another phase (so called shifting). To minimize the entire environmental impact, it is important to examine the whole life-cycle.[4]

The results of an LCA show the environmental impact in different categories: Global Warming Potential (GWP), Eutrophication, Land-Use etc., for the observed product (life cycle). By publishing the results in an Environmental Product Declaration (EPD) it is possible to make an environmental choice for users of the product. How EPDs are created and what the results can tell, will be object of this paper.

2 PRODUCTS, ECODESIGN AND POLITICAL BACKGROUND

2.1 Political background

In 2001 the European Commission (EC) promoted its "Integrated Product Policy" as in instrument to push eco-friendly products, energy, fuel consumption and chemicals. [8] Environmental labels and declarations measure the performance of sustainability. Furthermore, they provide the information to non-environmental experts to serve their decision to more eco-friendly products.[3] In Germany the Blue Angel was one of the first environmental labels developed in 1978 by the Government. After the UN conference on environment and development in 1992 a lot of countries have promoted green labelling to achieve the target concerning sustainable development. [3]

2.2 Products and their influence on the environment

Every product has got influence on the environment during its life-cycle. This influence results from the chosen materials, production sites and ways, the transport and its use. It is possible to distinguish products between passive and active ones, concerning their use-phase. Furthermore, you can divide products by their energy demand in the different phases of life. Figure 1 illustrates this withy using the energy fraction.

As the energy fraction is a simple indicator for environmental stress and also easy to monitor, it is useful for distinction of products at this point. Following Lafuente [10] you can differentiate between :

I. Energy producing products (e.g. solar modules)

II. Energy using products for one user, dependant on the behaviour of their user (like houses, cars)

III. Energy using products for a group of users, an prediction is difficulty, scenarios could be made (trains, aircrafts)

IV. Energy using products designed for one application, it can be optimized for it (e.g. conveyor systems, lifts)

In every phase of the life-cycle you can optimize the design for reducing the energy/CO_2 emissions. This

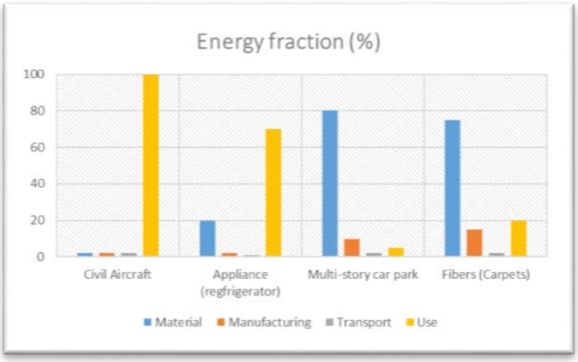

Figure 1Approximate values for energy consumed at each phase, without disposal. [4]

process is called ecodesign. At the first glance, conveyor systems belong to category IV, which means that the optimization has to be targeted to the use phase. Furthermore, the manufacturing phase should have an influence on the environmental impact, valuable measurements could be minimizing process energy and in the use phase reducing losses by friction.[4]. If this assumption is right will be shown by the Life Cycle Assessment and detailed examinations hereafter.

2.3 Ecodesign for Products

As explained before life-cycle-perspective is one of the main features concerning eco-labelling, EPDs, LCA and more. Recently the After-Use or End-of-Life phase becomes more and more in the focus of the researcher. Regarding the huge amount of waste coming from the industrial nations, new odds are demanded. Figure 2 shows the different possiblities for the end-of-life of industrial products. All these measurements like re-use or re-engineering have to been foreseen in the design-phase and do therefore belong to the eco-design.

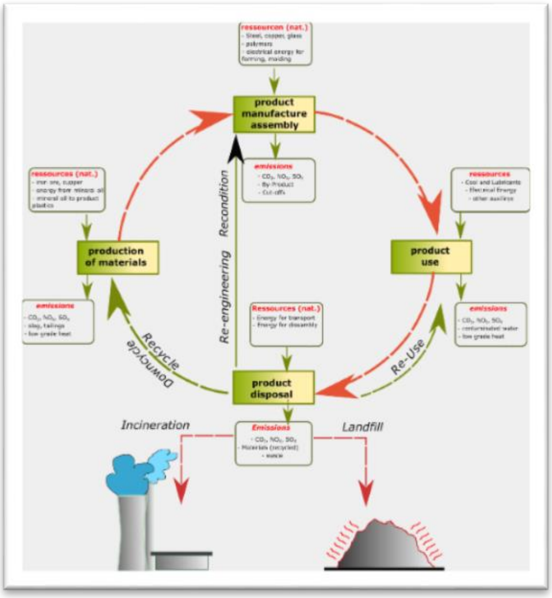

Figure 2 Potential materials life-cycle including end-of-life options for industrial products, like conveyor systems [4]

There is another conflict for energy using products like conveyor chains: finding a useful lifetime, between “renewing because of increased effiency” and “re-use because of resource reduction”. EPDs include information about the end-of-life phase and are therefore a useful instrument for being aware of this conflict.

3 ENVIRONMENTAL LABELLING, PRODUCT CATEGORY RULES AND ENVIRONMENTAL PRODUCT DECLARATIONS (EPDS)

3.1 Environmental Labels

On the website “the Ecolabel Index” (www.ecolabelindex.com) there are more than 400 different labels from 199 countries and 25 industry sectors listed. You can find labels concerning single issues, like “animal-friendly” or sector labels like “sustainable forest management” useable for different kinds of products.

Environmental labels measure sustainability peformance of product (-systems) or organisation. Their intention is to inform and influence the consumer or purchaser. By developing the standards of ISO 14020ff the International Organization for Standardization (ISO) wanted to tackle down misuse of labels for “greenwashing”. They developed three types of Label-categories, which are regulated by ISO 14021, ISO 14024 and ISO 14025. Type I labels point out products and services with an overall environmental preferability, Typ II labels are self-declarations and are published by the organisation itselves and are therefore often misused. Typ III labels are based, as Typ I, on Life Cycle Assessment.[3]

3.2 Environmental Product Declarations (EPDs)

Creation and publishing of so called Typ III declarations are standardized by ISO 14025. EPDs are primarily intended to B2B communication and enable the comparison between products, fulfilling the same function. In the introduction of the International Standard [12] the main requirements for publishing EPDs are pointed out: provided by one or more organizations; based on independently, verified LCAs (according to ISO 14040 [6] and ISO 14044 [7]) and administrated by a programm manager.

In Germany one programm manager for EPDs is the “Institut für Bauen und Umwelt” (Institute for Construction and Environment (IBU). It provides more than 1.700 EPDs in the construction sector. Therefore a specific standard was developed, which declares the core rules of the product category of construction products.[16] As part of green building programms like BREEAM® they are often used in the construction sector.[17]

In her masterthesis M. Mageroy examines eleven different international EPD systems, five of them publish EPDs in the construction sector, two in the electronic and one only in the food sector. [19] Only the International EPD System environdec® settled in Sweden offers the possibility to publish EPDs for different product categories. We decided to follow the rules of environdec® for developing the PCR and conducting the LCA.

3.3 Product Category Rules (PCRs)

PCRs are one of the mandantory requirements for calculating and publishing an EPD. Rules for developing PCRs are declared in a specific standard [18] but also in specific rules provided by the programm operators of the EPD System. The above mentioned IBU for example divides a PCR into two parts, part A for the standard calculation rules concerning every PCR and than spefific rules concerning only one product in Part B. The international EPD system, environdec® provides own “General Programm Instruction – GPI”, which concerns all information about publishing and producing verified Typ III declaration.

PCRs have to be developed for each product group and are meant to enable transparency and comparability between EPDs. In PCR you find information concerning the functional unit, allocation rules, system boundaries and more. The development of PCR requires open consultation involving interested parties. [3] As there exist more than one programme operator, aligning and harmonising different EPD schemes is a challenge for today. In practice it is difficult to use EPDs for comparison of products coming from different programmes. [3]

4 LIFE CYCLE ASSESSMENT (LCA)

4.1 Introduction

PCRs and EPDs have to be developed in accordance with the results of a conducted LCA. That’s why we performed a Life Cycle Assessment of a part of a Conveyor Chain System, which we called Reference-Conveyor-System (RCS) and used the results to continue our research. After a short summary of the theoretical background of LCA, the results of the conducted LCA are presented.

4.2 Phases of an LCA

LCA is a technique developed for better understanding and adressing the possible impacts of products on the environment. [6] LCA calculates the impacts of a product throughout its entire life, from the cradle to the grave. It forms the basis of an EPD and has to be performed according to the standard.[19] Figure 3 shows the four phases of an LCA, each of them interacting with the other, the box in the right shows the application of LCA.

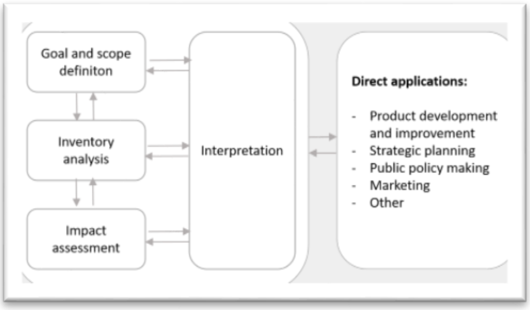

Figure 3The four phases of an LCA [4]

One of the key characteristics of an LCA is its relative nature, due to the functional Unit (fU) feature of the methodology.[6]

4.3 Goal and Scope Definition

The first phase of an LCA is the definition of goal and scope. The goal is composed of six aspects, which are (1) Intended applications of the results, (2) Limitations due to methodological choices, (3) Decision context and reasons for carrying out the study, (4)Target audience, (5) Comparative studies to be disclosed to the public, (6) Commissioner of the study and other influential actors [21]. The scope determines what product system will be assessed and how. In the ILCD Handbook you find nine scope items, but the ISO defines fourteen. The most important items effect to the definition of the object of the assessment and its functions. An important result is the specification of the functional unit and the reference flow. [7]

The functional Unit represents the main function of the product, which is a simple example to illustrate its conception. [20] If you want to calculate an LCA to compare plastic bottles with glas bottles, you have to declare as functional Unit “transport and supply of 1.000 Liter water” instead of comparing 1 plastic bottle to 1 glass bottle. For fulfilling the above mentioned function, you need to select the right reference flow, which means the amount of materials and auxiliaries to fulfill the choosen function. In the example you need therefore 1.000 bottles made from plastics and 100 bottles made from glass. Furthermore you need ressources to produce, to transport and to wash the bottles.

According to the standard, the scope should be sufficiently well defined to ensure that the goals of the study can be achieved. The scope covers system boundaries, allocation procedures, the selected impact categories, data requirements.

4.4 Life Cycle Inventory Analysis

In the 2nd step, the Life Cycle Inventory Analysis (LCI) - the flow model of the product system with all input and output flows for each unit process is built. The LCI involves data collection and calculation procedures to quantify inputs and outputs of the product system. As it is interactive, the results can lead to changes of scope. Data collections can be headed under four major groups: inputs (energy, raw materials, auxillary etc); outputs (products, co-products and waste); emissions (air, water, soil); other environmental aspects. For the data recording several methods are useful: measuring, estimating, calculating. Data can be original (measured at the production site) or generic, which means that they come from databases as ecoInvent and are representative for a process. Afterwards the datas have to be splitted to the different life cycle stages, such as up-stream, core and down-stream. All data have to be referred to the choosen fU.

4.5 Life Cycle Impact Assessment

The Life Cycle Impact Assessment (LCIA) is in the first instance the last phase of the LCA. By using LCA software it is automated in practice, but to understand the results and for right interpretation – the practitioner should well understand the methodology behind. [3]

The results of the LCIA have to be fitty and consistent impact categories, category indicators and characterisation models for the given goal of the study. The indicators should i.a. have environmental relevance and be traceable. A lot of LCIA methods have been developed since the 1984. In the used software more than hundred methods are available. By explaining the most common impact category “Global Warming (GW)/ Climate change” – the conception of environmental impact should be explained. GW is a midpoint impact category, which is caused by the antropogenic greenhouse effect. Global warming means the phenomenon of rising surface temperature across the planet averaged over longer periods of time. It is caused by emissions of greenhouse gases, like carbon dioxide, methane or nitrous dioxid. These emissions results from activities like heat production, construction of buildings, transport and other. There are other impact categories, such as stratospheric ozone depletion and acidification – which also belong to midpoint categories. Beside the midpoint impact categories, also endpoint impact indicators could be defined. Typical endpoints are human health, ecosystem quality, natural resources. This conception allows more condensed information to consider for a decision, while still being transparent.

Normalization and weighting are mandantory steps of an LCIA and could also help for better understanding. The results of the LCIA are the core of the EPD and are presented in the next chapter. The choose of LCIA categories is predetermined by the international EPD system.

5 DEVELOPMENT OF PCR AND EPD FOR CONVEYOR CHAIN SYSTEMS

5.1 Introduction

In the next paragraphes the present status of our research is described. Goal of the project is the development of a PCR for conveyor chain systems. As mentioned above several steps are required: conducting an LCA, defining functional Unit and reference flow, defining product category rules and so on. The chosen starting point is a closer research concerning existing PCR – to define the fU and RF, afterwards an LCA on a Reference Conveyer System (RCS) will be examined. All results will be aggregated for perception of next research steps.

5.2 PCR Development

The international EPD System uses the UN classification Central Product Classification (CPC) for sorting the examined products. The CPC constitutes a comprehensive classification of all products, including goods and services, it presents categories for all products that can be the object of domestic or international transactions or that can be entered into stocks. [26] Following the CPC system the appropriated PCR category for the examined conveyor chains is

4355 Pneumatic and other continuous action elevators and conveyors, for goods or materials

Whereas the 4 stands for the section (here metal products), the 3 for the division (machinery), the 5 for the group (lifting and handling equipment) and the 5 for the class of product (continuous handling equipment).

After choosing a fitting PCR number, the next steps following the General Program Instruction (GPI) from environdec® and the given information on their website, are

- Definition of the Product Category (primary and secondary functions of product; fitting UN/CPC Code)
- Consideration of other available PCR (from environdec® or other EPD programmes)
- Appointing a PCR moderator
- Seeking for cooperation with other parties to take part in the PCR committee
- Planning the PCR development; Announcement of the PCR development

At present we focus our research on the the first two points of the list above. In literature no PCR for conveyor chains exists. Table 1 shows eight selected EPDs/PCR for examination of functional Unit and the reference flow.

Table 1 Examples of examaniend PCR for the Development

Nr	Product (system)	Functional Unit (fU)	Reference flow	Source
1	Forklift (Jungheinrich)	1 LifeCycle (operationg time 10.000h for each reference car)	Averaged weight of the reference car (product cluster weighted with sales ranking)	The Jungheinrich environmental label [22]
2	Lifts (elevators)	Transportation of a load over a distance, expressed in tonne[t] over a kilometre [km] travelled, i.e. tonne-kilometre FU = %Q x S_{RSL}	1 lift (specific) or „generic“ lift	Environdec PCR: **UN CPC 4354** [23]
3	Machines for filling and packaging of liquid food	1000 litres of filled product delivered by the machine (undependent from the packing size)	Not specified	Environdec PCR: **UN CPC 43921**
4	Road transport service of freight of food products and meals	1 kg of delivered food transported from the loading to the unloading site	Not specified	Environdec PCR: **UN CPC 6511**
5	Pump for liquides, liquid elvators mixers	1 kW hydraulic power at best efficiency point, 1 N (for mixers)	Not declared (one pump, one mixer)	Environdec PCR: **UN CPC 4322**
6	Machine tools for drilling, boring or milling metall	One product unit (Declared Unit) from the core including packaging	Reference flow of the use phase: 1 working hour reference service life: 62.400 hours	Environdec PCR: **UN CPC 44214**
7	Rolling stock	1 passenger over 1 km (total number of passengers calculated according to EN 15663)/ 1 ton above 1 km	Not specified	Environdec PCR: **UN CPC 495**
8	Plastic waste and scrap recovery	Declared unit: 1 kg of recycled material		Environdec PCR: **UN CPC 8942**

As mentioned above the chosen functional unit should represent the function of the product system. Examples therefore could be found in selected PCRs, having an active use phase (all exclude 8). Some of the examined PCRs included the lifetime in their calculation (1,2,6). Jungheinrich calculated their LCA over a reference forklift, which was done by product cluster weighted with sales ranking.

5.3 Goal and Scope of Life Cycle Assessment

In our research we decided to build up a Reference Conveyor System (RCS) like Jungheinrich. Figure 4 shows the chosen RCF, which consists of four pillars, a five meter long chain, one curve and the necessary drive unit. The chain can be made of plastic or steel, in the last case parts for providing cooling and lubrication have to be foreseen.

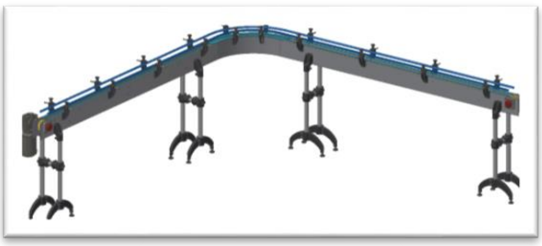

Figure 4 Reference Conveyor System

Following the above described instruction, it is necessary to define the scope and goal of the study. The six aspects of the goal are:

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(1) Intended applications of the results → development of PCR rules for conveyor chain systems

(2) Limitations due to methodological choices → only estimated values, coming from catalagues and databases

(3) Decision context and reasons for carrying out the study → gaining deeper knowledge about the research topic

(4) Target audience → for intern discussion, readers of the arcticle, other researchers

(5) Comparative studies to be disclosed to the public → not for the moment

(6) Commissioners of the study and other influential actors → authors of the arcticle.

This means that the study is first of all intended to get closer knowledge about the life cycle of conveyor chain systems, the results should help to identify the next research steps.

To find out the exact fU of the RFC, it is necessary to look at the functions of a conveyor chain system. The primary function is the transportation of goods over a defined route in a defined time span. Additional functions are protecting, sorting, accelerating or others procedures concerning the good. Normally the transportation of goods goes continually, concerning velocity and load, so no “use-scenario” has to be foreseen, as it has to be at the lifts, which often have diverse uses.

In a previous publication, the material throughput in kg per second was choosen as fU. [25] With the perceptions about the examined PCR, it becomes clear, that is not widespread enough. It is obviously to include the useful lifetime into the fU. For the goal of comparability of two different systems of conveyor chains, e.g. chains made of plastic and chains made of steel, it is necessary to include the useful lifetime, because steel chains are durable and also easier to recycle than plastic chains.

To complete the scope definition it's necessary to choose the fitting LCIA categories for the last phase of the LCA. Publishing the EPD by the international EPD System on the website of environdec® is targeted. On its website environdec proposes at least the following LCIA categories to be included in EPD and PCR:

Table 2 Examples of LCIA categories proposed from the International EPD syste

Impact category (Unit)	Characterisation factors	Original reference(s)
Global warming potential (kg CO_2 eq.)	GWP100, CML 2001 baseline Version: January 2016.	IPCC (2013)
Acidification potential (kg SO2 eq.)	AP, CML 2001 non-baseline (fate not included), Version: January 2016.	Hauschild & Wenzel (1998)
Eutrophication potential (kg $PO^4{}_3$- eq.)	EP, CML 2001 baseline (fate not included), Version: January 2016.	Heijungs et al. (1992)
Photochemical oxidant formation potential (kg NMVOC eq.)	POFP, LOTOS-EUROS as applied in ReCiPe 2008	Van Zelm et al 2008 ReCiPe 2008

At this point of research, we decided to examine only the first three categories – to explain all features would be go beyond the scope for the moment. The other will examined in the next step.

5.4 LCI and LCIA of the Reference Conveyor System

The next step in the LCA-procedure is to conduct the Life Cycle Inventory, this means for the different processes (modules) of the RCS the necessary data have to be collected and splitted on to the life cycle phases. To identify processes for the LCI model it is useful to detail the coarse initial system picture (Figure 2) into a diagram by incorporating the scope and the goal of the study.

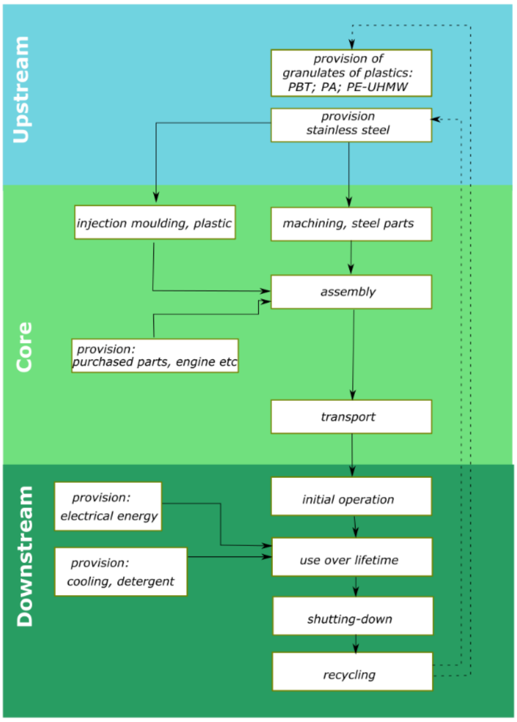

Figure 5 Processes and life cycle phases of Reference Conveyor System

The life cycle is separated in three phases, the upstream compromises all processes before the conveyor purchaser (cradle-to-gate), the core process all steps done by the purchaser (gate-to-gate) and the downstream all processess after the finishing of the conveyor (gate-to-grave/cradle). For every process the fitting flows/processes of the databases were researched and the product system was built up in open LCA.

Table 3 Example of processes of the examined RCS

	Process module	Part	Flow in open LCA	Amount	Unit
Upstream	providing POM-granulat	chain link	Polyoxymethylene (POM)	31,16	kg
	providing PE-UHMW-granulat	guiding profile, side guidance, slide rail	Polyethylene high density granulate (PE-HD)	7,18	kg
	providing PA-granulat	cross connection profile, bipod, leveller	Polyamid 6 (PA6)	17,99	kg
	providing stainless steel	side guidance profile, pillar profile, leveller, side guide holder	steel, chromium steel 18/8	87,49	kg
Core	injection moulding	chain link, leveller, bipod	injection moulding	49,47	kg
	extrusion	guiding profile, side guidance, slide rail	extrusion, plastic film	7,18	kg
	metall working	side guidance profile, pillar profile, leveller, side guide holder	metal working average for chromium steel	92,51	kg
	laser cutting	guiding profile	Laser machining, metal, CO2-laser, 2000W	1	h
	laser welding	guiding profile	welding, arc, steel	30	m
	power unit	electric motor	div.	20	kg
	Transport to user	Transport via route	transport, freight, lorry 3.5-7.5 metric ton, EURO5	0,075	tkm

Down-stream	energy input	Electricity supply	electricity mix, 230 V, Germany	15.848	KWh

The presented amounts were taken from catalogues or calculated considering physical formulas. For the transport the weight of the RCS (150 kg) was multiplied with 500 km. Cooling/lubrication is only needed when the examination concerns a chain made of steel. The next step is calculating the energy use in the downstream-phase.

5.5 Energy-Use of the Reference-Conveyor-System

Under presumption that the use phase is the most important one for the whole life cycle assessment of a conveyor system, its examination is crucial. By using a conveyor chain system made of plastic (like POM), the friction coefficent could be lowered to amounts near 0,2. Together with the less dead load of the chain (one-third compared to steel), the energy consumption declines significantly. There are two main methods to get the energy consumption of the RCS, measuring or calculating. Below the last one is presented.

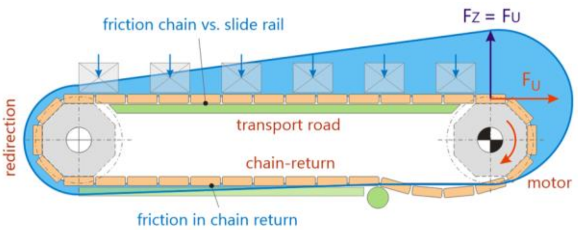

Figure 6 Force progression in a conveyor chain system

As shown in the figure the maximum chain force occurs near the power unit in the upper run. The calculation of the maximum force follows along the system, at every point of change (direction, accumulation, load) a new force is calculated which is cumulated to the last force.

$$F_n = F_{n-1} + F_i \qquad (1)$$

On a straight section, without accumulation or vertical curve the tensile force is a result of multiplication of the weight with the friction coefficient.

$$F_n = F_g \cdot \mu \qquad (2)$$

If the chain has to follow a horizontal sliding arch, the curve friction causes an exponential increase in the chain tensile force compared to a linear increase in straight and curved wheels. At the end of the calculation the maximum chain force can be used to continue the calculation of the energy consumption.

With the following given parameters

- Specific weight of the chain = 1,01 kg/m [m_{ch}]
- Maximum chain Force = 356,44 N [F_{max}]
- Number of working hours/year = 5.760 [Numb]
- Coefficient of friction = 0,2 [μ]
- Reference Life-time = 10 year [RSL]
- Velocity of chain = 30 m/min = 0,5 m/s [v_{ch}]
- Losses cause of inefficiency = 0,499 [η_{all}]
- Absolute losses in the periphery = 8 W [E_{per}]

it is calculated as follows

$$P_{operating} = F_{max} \cdot v_{ch} \qquad (3)$$

$$P_{losses} = P_{operating} \cdot \eta_{all} \qquad (4)$$

$$P_{total} = P_{operating} + P_{losses} + P_{per} \qquad (5)$$

The total of Power can be calculated as follows

$$P_{total} = (356{,}44 \cdot \frac{30}{60}) \cdot (1 + 0{,}499) + 8$$

$$P_{total} = 275{,}15\, W$$

$$P_{Use\_RSL} = \frac{P_{total}}{1000} \cdot Numb \cdot RSL \qquad (6)$$

$$P_{Use\_RSL} = 15.848\, kWh$$

Following this calculation the energy-input is 15.848,69 kWh. All the amounts were put into the software and than product system was built up. After setting-up the LCI model in open LCA the calculation of the LCIA results can be made.

5.6 Results of the LCIA

As mentioned before only three categories (global warming, acidification, eutrophication) are examined. They all can be find in the method CML2001. This collection of LCIA factors is published by the Centrum of Milieukunde Leiden, which is a very well know environmental research institute.

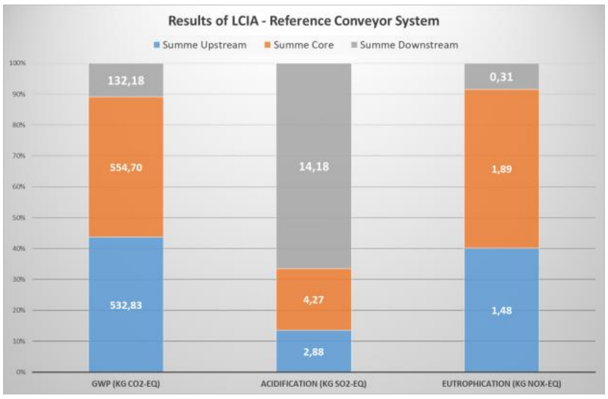

Figure 7 Results of the LCIA of RCS

Figure 7 shows the result of the examination for the three categories separated after Upstream, Core and Downstream. The results are not as excpected. For the categories global warming and eutrophication the upstream and core phase have the most impact (about 90%), the use phase (downstream) only contributes to 10%. Concerning acidification the use phase has the most impact (about 70%), which is due to the emission of sulfur dioxide by burning down fossil energies like coal or oil.

In chapter 3 it was stated that conveyor chain systems belong to product category IV (energy using products) and that the use phase has the greates impact on the LCIA. The results negate this results. On the contrary, despite acidification the upstream and core processes contribute to the most impact. The next step will therfore be the validation of the results, on one hand the energy use has to be measured and on the other hand a sensitive analysis has to be conducted.

6 CONCLUSION

Environmental Product Declarations, which are needed to publish the results of a Life Cycle Assessment are appropriate to show the environmental impact of product systems like conveyor chain (systems) over their life cycle. The research of our institute concerns the development of EPDs for this product category. Therefore rules (PCR) and a publishing programm manager are needed. The international EPD system environdec® is suitable. Furthermore the goal and scope of the examination has to be defined. A suitable functional Unit and the division of the life cycle into stages was examined. It is unevitable to include the life-time into the functional Unit. The results are not as expected, because the use phase has not such an important impact as assumed. The next steps has to be a validation of the results and an implementation of the end-of-life phase. Also a comparison with LCA results of conveyor chains made of steel is foreseen, this will help to better understand the presented results and to continue the research.

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