

TASK 3. LIFE CYCLE IMPACT ASSESSMENT

GOAL AND SCOPE

The production manager of a company want to choose the detergent product with the lowest global warming and atmospheric acidification impacts. Therefore, you are going to conduct an LCA study. **Figure 1** contains the simplified flowchart of the life cycle of a detergent.

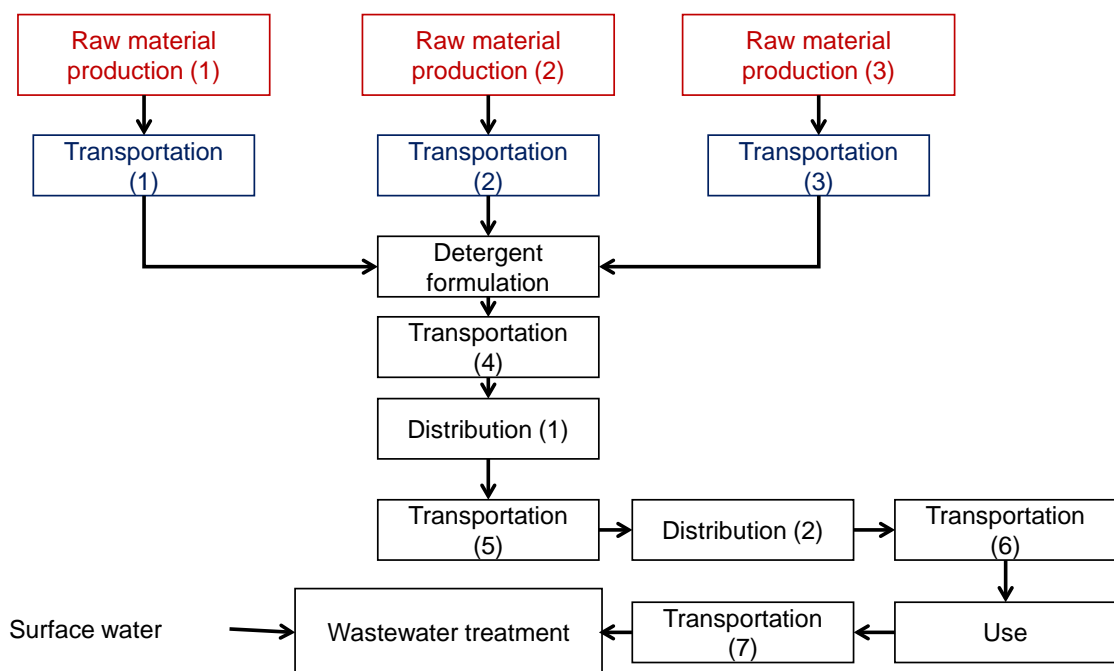


Figure 1. Flowchart of a detergent (Arvidson, 1995).

The function of the system is to produce detergent, so 1 kg of detergent 1 and 2 were selected as functional unit.

LIFE CYCLE INVENTORY

The life cycle inventory for detergent 1 and 2 based on this functional unit is provided in **Table 1**. You need to know that in Spain the production of 1 kWh electricity produces 0.5 kg CO₂, 0.167 g CO, 1.55·10⁻⁵ kg fluoride, 0.353 g COD and 1.76·10⁻⁴ g phenol. Similarly, the production of 1 g of raw materials produces 0.1 kg CO₂, 0.022 g CO, 2.78·10⁻⁷ kg fluoride, 0.0980 g COD and 7.44·10⁻⁶ g phenol. You must consider these emissions for the analysis of the environmental impacts on the cradle-to-gate life-cycle stage.

Table 1. Inventory analysis results from a comparative study of two detergents 1 and 2 (Arvidson, 1995), given per functional unit (kg detergent), from data collected in 1994 (gate-to-gate system).

Detergent 1		
Resources consumption	Emissions to air	Emissions to water
33 g raw materials 4.4 MJ electricity	1.5 kg CO ₂ 0.9 g CO	4.1 g COD 5.7 g fluorides 0.1 g H ₂ SO ₄ 0.3 g Tot-N 0.0010 g Tot P 5.4x10 ⁻⁵ g phenol
Detergent 2		
Resources consumption	Emissions to air	Emissions to water
44 g raw materials 3.3 MJ electricity	1.4 kg CO ₂ 1.0 g CO	1.2 g COD 7.6 g fluorides 0.2 g H ₂ SO ₄ 0.2 g Tot-N 0.0010 g Tot P 5.6x10 ⁻⁵ g phenol

LIFE CYCLE IMPACT ASSESSMENT

To conduct the LCA you have decided to select the impact categories of Global Warming (GWP), Acidification (AA), aquatic oxygen demand (AOD) and eutrophication (EU). So in the Life cycle impact assessment (LCIA) firstly, you have to search the characterization factors for selected impact categories and complete the **Table 2** with the potency/characterization factors for the impact published in “The Sustainability Metrics”.

Table 2. Characterization factors for the selected metrics upon the LCA of the detergents.

	CO ₂	CO	H ₂ SO ₄	Phenol	COD	Fluorides	Total N	Total P
Global Warming (GWP)								
Aquatic acidification (Aq.Ac)								
Aquatic Oxygen Demand (AOD)								
Eutrophication (EU)								

Secondly, for the sustainability report of the company, your task is to carry out a detailed report on the environmental burdens of the life-cycle of the products for each impact category reflecting the emissions to air (GWP) and water (Aq. Ac., EU and AOD) to obtain the emissions in equivalent units than can be summed up.

Complete **Table 3 and Table 4** for cradle-to-gate life cycle and gate-to-gate LCIA of both detergents production.

Table 3. Life Cycle impact assessment – Characterisation results for the production of *DETERGENT 1*

DETERGENT 1	Global warming (GW)	Aquatic Acidification (Aq.Ac)	Aquatic oxygen demand (AOD)	Eutrophication (EU)
CO ₂				
CO				
COD				
Fluorides				
H ₂ SO ₄				
Total N				
Total P				
Phenol				
Total cradle-to-gate				
CO ₂				
CO				
COD				
Fluorides				
H ₂ SO ₄				
Total N				
Total P				
Phenol				
Total gate-to-gate				
Total				
Units				

Table 4. Life Cycle impact assessment – Characterisation results for the production of DETERGENT 2

DETERGENT 1	Global warming (GW)	Aquatic Acidification (Aq.Ac)	Aquatic oxygen demand (AOD)	Eutrophication (EU)
CO ₂				
CO				
COD				
Fluorides				
H ₂ SO ₄				
Total N				
Total P				
Phenol				
Total cradle-to-gate				
CO ₂				
CO				
COD				
Fluorides				
H ₂ SO ₄				
Total N				
Total P				
Phenol				
Total gate-to-gate				
Total				
Units				

After the characterisation you are going to conduct an internal normalisation based on the maximum value, that is to say, using as a reference value the results of the detergent with the highest value. Once you have these dimensionless metrics a weighting procedure to obtain an air and water index will be required. In this case, all the indicators are supposed to have the same weight.

Deliverables

- Life cycle impact assessment: characterization, normalization and weighting
- Interpretation of the results