

Life Cycle Assessment studies for typical formulations of stabilisers

Replacing the proxy based modelling of stabilisers used in the PVC industry with newly developed datasets: Ca and Zn stearates

Mihaela Thuring¹, Carolin Spirinckx¹ & Alain Cavallero²

¹ VITO, Flemish Institute for Technological Research

² ESPA, European Stabiliser Producers Association

Contacting Author: Mihaela.Thuring@vito.be

Goal and scope of the LCI study

To have an insight into the integral environmental aspects of the stabilisers used among others, in PVC pipes, PVC windows and PVC flooring (like the cushion vinyl type) in order to integrate them in the LCAs and EPDs of PVC based articles

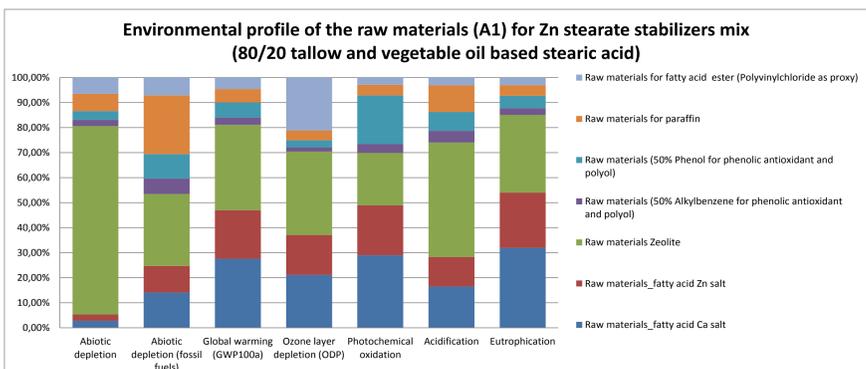
Importance of stabilisers for PVC industry:

Stabilisers are added to PVC to allow its processing and to improve its resistance to external factors such as heat and sunlight (ultraviolet rays).

Modelling of stabilisers* and the relevance of data quality

Ca stearate (1 tonne product)			
Inputs	Used data records	LCI datasource	Comments
Ca(OH) ₂	Hydrated Lime EU 2007, production at plant RER S	Ecoinvent 3	Dataset includes transportation of raw materials
Stearic acid (tallow based)	Stearic acid, adapted	IVAM adapted	Dataset not fully representative, however best available option. To improve the data quality the dataset was adapted as follows: IVAM dataset "Tallow" replaced with Ecoinvent 3 "Tallow, at plant/CH U"; IVAM "Steam (kg)" replaced with Ecoinvent 3 "Steam, in chemical industry {RER} production Alloc Def, U"; IVAM "-MieI NL model (set: @MieI NL # [ETH3])" replaced with ELCD dataset "Electricity mix, AC, consumption mix, at consumer, 1kV - 60kV EU-27 S". Recommended: dataset to be updated.
Stearic acid (vegetable oil based)	Stearic acid, adapted	IVAM adapted	Dataset not fully representative, however best available option. To improve the data quality the dataset was adapted as follows: IVAM dataset "Crude palm oil" replaced with Ecoinvent 3 "Palm oil, crude (RoW) palm oil mill operation Alloc Def, U"; IVAM "Steam (kg)" replaced with Ecoinvent 3 "Steam, in chemical industry {RER} production Alloc Def, U"; IVAM "-MieI NL model (set: @MieI NL # [ETH3])" replaced with ELCD dataset "Electricity mix, AC, consumption mix, at consumer, 1kV - 60kV EU-27 S". Recommended: dataset to be updated.
Energy (for the reaction, for drying, milling...)	Electricity mix, AC, consumption mix, at consumer, 1kV - 60kV EU-27 S	ELCD	
Steam	Heat, in chemical industry {RoW} steam production in chemical industry Alloc Def, U	Ecoinvent 3	
Transportation of the Ca(OH) ₂ raw materials	Transport, freight, lorry >32 metric ton, EURO5 {GLO} market for Alloc Def, U	Ecoinvent 3	Assumption agreed with ESPA member companies, as insufficient company specific data are available
Transportation of the stearic acid raw materials	Assumptions:		
	Transport, freight, lorry >32 metric ton, EURO5 {GLO} market for Alloc Def, U	Ecoinvent 3	Calcium hydroxide transported over 500 km
	Transport, freight, sea, transoceanic ship {GLO} market for Alloc Def, U	Ecoinvent 3	90% of stearic acid transported over 1 km by truck 10% of stearic acid transported over 1000 km by truck 10% of stearic acid transported over 15000 km by sea
	Outputs		
Ca stearate	Ca Stearate produced	newly created, ESPA specific dataset	
H ₂ O	Water (Emission to air)	SimPro, Emissions to air	
Ca stearate to air	Neglected, no available modeling options		
Ca stearate to water	Neglected, no available modeling options		

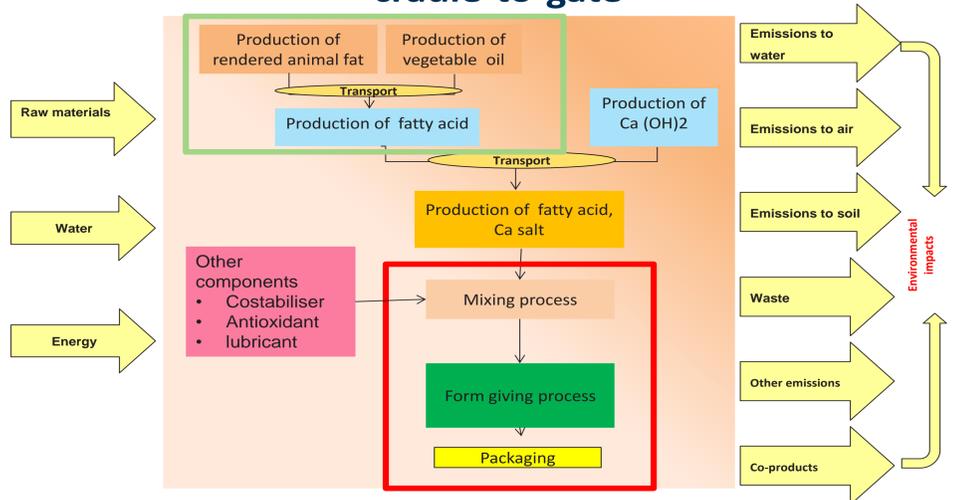
*the full model of Ca and Zn stabilisers mix is available at request (contact ESPA at <http://www.stabilisers.eu>)



LCA assessment was performed from the cradle to the gate, for:

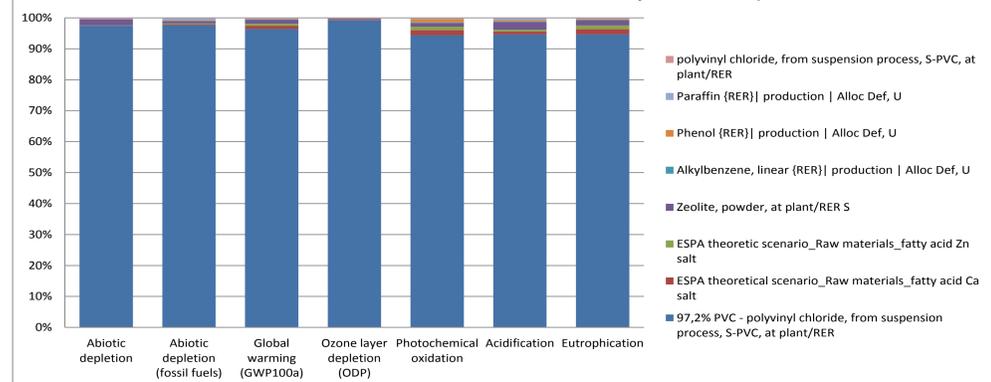
Fatty acids, C16-C18, calcium salts CAS: 85251-71-4 EINECS: 286-484-6
Fatty acids, C16-C18, zinc salts CAS: 91051-01-3 EINECS: 293-049-4

Process tree for fatty acids calcium salts (C₁₆-C₁₈): cradle-to-gate



Results

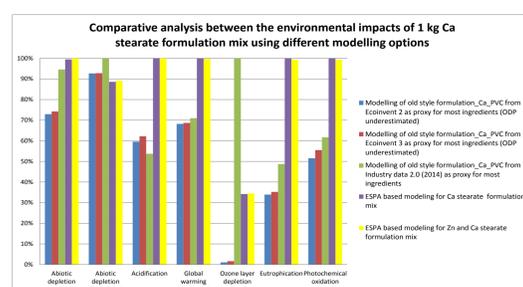
Environmental profile of a PVC product (raw materials stage only**) where the stabilisers mix are 2,5% of the total product mass (CML method with 'sodium chloride' CF from Plastics Europe included)



**Environmental impacts of transport of raw materials and of the manufacturing process is part of other specific life cycle stages. They account for less than 15% of the impact of the raw materials.

Mixes of components used for this study(%)

Components	Specific name	Ca Stabiliser mix	Ca and Zn Stabiliser mix
Stabilizer	Ca stearate	40,68%	23,73%
	Zn stearate	0,00%	16,95%
	Zeolite costabiliser	23,73%	23,73%
	Phenolic antioxidant	1,69%	1,69%
	Polyol	6,78%	6,78%
Lubricant	Paraffin waxes	20,34%	20,34%
	Fatty acid ester	6,78%	6,78%
Total mix		100,00%	100,00%



Conclusions

- The Environmental impact of stabilisers in PVC compound is largely proportional to their %weight, i.e. relatively small as can be seen in the graph "Results"
- Continue to develop more robust background datasets will make the outcome more representative
- The data gaps can be filled in with industry input