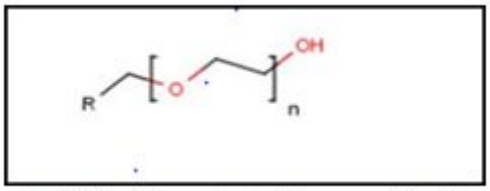
Date: 06/06/2017

Environmental Fact Sheet (#14)

C16-18 Alcohol Ethoxylates with >20 EO (C16-18 AE>20)

oleochemical non-ionic surfactant

Substance Identification			
IUPAC Name	Alcohols, C16-18, ethoxylated	**CAS Number**	68439-49-6
Other Names			
Molecular Formula	UVCB substance (substances of Unknown or Variable composition, Complex reaction products or Biological materials), no univocal molecular formula available	Structural formula :  R = CxH(2x+1)branched and linear, x= 12 - 15	

Physical/Chemical Properties [1]	
Molecular Weight	> 1123.49 g/mol
Physical state	Solid
Appearance	No data available
Odour	No data available
Density	No data available
Melting Points	No data available
Boiling point	No data available
Flash Point	No data available
Vapour Pressure	No data available
Water Solubility	No data available
Flammability	No data available
Explosive Properties	No data available
Surface Tension	No data available
Octanol/water Partition coefficient (Kow)	log K_{OW} = 5.29 – 6.57
Product and Process Description	C16-18 AE ≥ 20 is a non-ionic surfactant, belonging to the group of alcohol ethoxylates. The C16-C18 alcohol ethoxylate with more than twenty ethylene oxide units is produced by the reaction of C16-18 fatty alcohols [5] from natural sources, preferably palm oil and tallow, with ethylene oxide. The addition of ethylene oxide to the fatty alcohol leads to a distribution of homologue polyethylene glycol ether groups. The ethoxylation reaction for detergent range alcohol ethoxylates is usually catalyzed by alkaline catalysts such as potassium hydroxide.
Application	Alcohol ethoxylates are used in chemical products for households and industries.

	C16-18 AE ≥ 20 is used as a softener in textile, paper applications. Home Care /I&I: emulsifier for laundry detergents, cleaning agents. Emulsifier for emulsion polymerisation. No use in personal care.

Life Cycle Assessment

General Introduction

These Environmental Fact Sheets are a product of the *ERASM Surfactant Life Cycle & Ecofootprinting (SLE*) project. The objective of this project was to establish or update the current environmental profile of 15 surfactants and 17 precursors, taking into consideration actual surfactant production technology and consistent high quality background data.

The Fact Sheets Eco-profiles are based upon life cycle assessment (LCA) and have been prepared in accordance with the ISO standard [ISO 14040: 2006 and ISO 14044: 2006]. In addition, the project follows the ILCD (2010) handbook. This Fact Sheet describes the cradle-to-gate production for C16-18 AE ≥ 20. C16-18 AE ≥ 20 is an oleochemical surfactant.

The ERASM SLE project recommends to use the data provided in a full 'cradle-to-grave' life cycle context of the surfactant in a real application.

Further information on the ERASM SLE project and the source of these datasets can be found in [2].

The full LCI can be accessed via www.erasm.org or via http://lcdn.thinkstep.com/Node/

Goal and Scope of ERASM SLE Project [2]

The main goal was to update the existing LCI inventories [3] for the production of C16-18 AE≥20 and its main precursors/intermediates.

Temporal Coverage	Data collected represents a 12 month averages of C16-18 AE≥20 production in the year 2011, to compensate seasonal influence of data. Background data have reference years from 2008 to 2010. The dataset is considered to be valid until substantial technological changes in the production chain occur.
Geographical Coverage	Current data are based on three suppliers representing C16-18 AE≥20 production in Europe. The geographical representativeness for C16-18 AE ≥ 20 was considered ' good'.
Technological Coverage	The technological representativeness for C16-18 AE ≥ 20 was considered 'good'. Figure 1 provides a schematic overview of the production process of C16-18 AE ≥ 20.
Representativeness for market volume	>70% (Represented market volume (in mass) covered by primary data used in ERASM SLE project)
Declared Unit	In ERASM SLE project the declared unit (functional unit) and reference flow is one thousand kilogram (1000 kg) of surfactant active ingredient. This was the reference unit also used in [3]. Functional Unit: 1 metric tonne of C16-18 AE ≥ 20 100% active substance.
Cradle-to Gate System Boundaries	

Included	Excluded
Fatty alcohol C16-18 production - based on tallow and palm oil (this production is further explained in the Eco Profile fact sheet of the precursor C16-18 Fatty Alcohol (#13))	Construction of major capital equipment (Infrastructure)
Ethylene oxide production (this production is further explained in the Eco Profile fact sheet of the precursor ethylene oxide(#8))	Maintenance and operation of support equipment
Energy production	Human labor and employee transport
Utilities	Packaging
Transportation processes for the main materials	
Water use and treatment of waste water	
Treatment of wastes	

Assumptions and Limitations	Transportation was only considered for the main materials (covers about 90% of the mass of all inputs), other transportation was not considered. Some important transports were estimated by European standard due to lack of valuable information.	
Cut-off Criteria [4]	No significant cut-offs were used. The LCI study included all material inputs that had a cumulative total (refers to unit process level) of at least 98% of the total mass inputs to the unit process, and included all material inputs that had a cumulative total of at least 98% of total energy inputs to the unit process. The study included any material that had environmental significance in its extraction, manufacture, use or disposal, is highly toxic, dangerous for the environment, or is classified as hazardous waste. The sum of the excluded material flows did not exceed 5% of mass, energy or environmental relevance.	
Calculation Rules	Allocation	Allocation was applied for some background data. Allocation methods used for the renewable precursors PKO and CNO (allocation mass).
	Aggregated data	Vertical averaging was considered (as long as the final product was the same, different processes with common product intermediates can be aggregated in the average).

Life Cycle Inventory and Impact Assessment [2]

Based on the LCI data an environmental impact assessment was performed for the indicators Primary Energy Demand (PED) and Global Warming Potential (GWP). Other impacts may be calculated from the full LCI dataset.

Table 1. Primary Energy Demand and air emissions related to Global Warming per 1 tonne of C16-18 AE≥20 100% active substance

LCI result	Unit	Amount
Primary energy demand		
Primary energy demand from renewable materials (net calorific value)	MJ	6324
Primary energy demand from fossil materials (net calorific value)	MJ	63912
Primary energy demand from fossil and renewable materials (net calorific value)	MJ	70236
Air emissions related to Global Warming Potential		
Carbon uptake, biotic	kg CO_2 equiv.	- 961
Carbon dioxide, fossil	kg	1930
Carbon dioxide, biotic	kg	246
Carbon dioxide, from land use, land use change and peat oxidation	kg	292
Methane	kg	15.4
Nitrous oxide (laughing gas)	kg	0.22
NMVOC emissions	kg	2.17
Total GWP (according to [IPCC 2007])	*t CO_2-equiv.*	*1.96*

Primary Energy Demand (PED): An analysis of the inventory data showed that the main contribution comes from the ethylene oxide production (nearly 70% contribution), which is also the highest input by mass into the production process. The fatty alcohol production contributes secondly to the total amount of PED. Other chemicals account for less than 5% of the impacts affecting PED. Energy production, namely the generation of thermal energy and electricity, account for up to 5%. The remaining percentages of impacts contributing to the PED are caused by utilities, transports as well as the treatment of process waste

Global Warming Potential (GWP): An analysis of the inventory data showed that the main contribution comes from the ethylene oxide production (nearly 70% contribution), which is also the highest input by mass into the production process. The fatty alcohol production contributes secondly to the total amount of this impact category. Other chemicals account for less than 5% of the impacts affecting GWP. Energy production, namely the generation of thermal energy and electricity, account for up to 5%. The remaining percentages of impacts contributing to the GWP are caused by utilities, transports as well as the treatment of process waste.

References for the ERASM SLE Project

Data Owner and Commissioner of the study	ERASM (Environment & Health Risk Assessment and Management). A research partnership of the Detergents and Surfactants Industries in Europe (www.erasm.org).
LCA Practitioner	thinkstep AG (www.thinkstep.com)
Reviewers	Prof. Walter Kloepffer, LCA Consult Mrs. Charlotte Petiot and Dr. Yannick Leguern, BiolS by Deloitte Dr. Yannick Schmidt (2.0 LCA consultant)
References	[1] Human & Environmental Risk Assessment on ingredients of European household cleaning products - Alcohol Ethoxylates (Version 2.0, September 2009). www.heraproject.org. [2] Schowanek. D *et al*. (2017) New and Updated Life Cycle Inventories for Surfactants used in European Detergents: Summary of the ERASM Surfactant Life Cycle and Ecofootprinting Project. Int J. LCA, in press. [3] CEFIC-Franklin (1994). Resource and environmental profile analysis of petrochemical and oleo chemical surfactants produced in Europe. Phase II Final Report, Franklin Associates, LTD. [4] PLASTICSEUROPE (2011). Eco-profiles and Environmental Declarations – Life Cycle Inventory (LCI) Methodology and Product Category Rules (PCR) for Uncompounded Polymer Resins and Reactive Polymer Precursors, version 2.0. [5] Ullmann's Encyclopedia of Industrial Chemistry (2010). John Wiley & Sons, Inc., Hoboken, USA.

Figure1. Production process of C16-18 AE≥20.