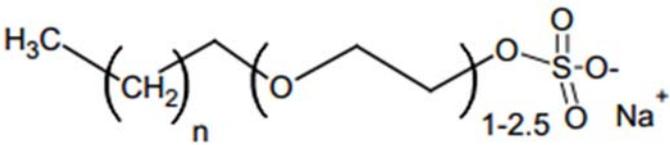


# Environmental fact Sheet (#6)

## C12-14 E2S Sodium Salt

oleochemical anionic surfactant

<b>Substance Identification</b>	
<b>IUPAC Name</b>	Alcohols, C12-14(even numbered), ethoxylated < 2.5 EO, sulfates, sodium salts
<b>CAS Number</b>	68891-38-3
<b>Other Names</b>	Sodium polyoxyethylene fatty alcohol sulfate; AES; SLES
<b>Molecular Formula</b>	UVCB substance (substances of Unknown or Variable composition, Complex reaction products or Biological materials), no univocal molecular formula available Structural formula: 
<b>Physical/Chemical Properties [1]</b>	
Molecular Weight	353.50 - 381.55 g/mol
Physical state	Solid
Appearance	Slightly yellow. Paste
Odour	Rancid
Density	1.08 g/cm <sup>3</sup> at 22°C
Melting Points	150-159°C at 102.1 kPa
Boiling point	>400 °C at 101 kPa
Flash Point	Study technically not feasible (Irrelevant property for solids)
Vapour Pressure	No data available
Water Solubility	280 g/l at 20°C
Flammability	Solid/liquid: Ignition on contact with air: No Solid: flammable (Burning time: >2400 s)
Explosive Properties	No data available
Surface Tension	33 mN/m at 25 °C
Octanol/water Partition coefficient (Kow)	log K <sub>ow</sub> = 0.3 at 23 °C
<b>Product and Process Description</b>	<p>C12-14 E2S (oleo) belongs to the group of alcohol ethoxysulphates (AES), also known as Alcohol Ether Sulphates, a widely used class of anionic surfactants. They are manufactured by the sulphation of alcohol ethoxylates, generally containing 1-4 ethylene oxide units [6]. Sodium salts of AES are by far the commonly used grades.</p> <p>Four steps are involved in the manufacture of AES: alcohol production, ethoxylation, sulphation and neutralization. C12-14 E2S (oleo) is manufactured by the reaction of the ethoxylate of C12-14 alcohol from oleo-chemical sources, with sulphur trioxide in a falling film reactor.</p> <p>In these reactors, a thin film of material to be sulphated flows down the inside surface of vertical tubes through which dry air containing SO<sub>3</sub> is passed. The reaction takes place at the gas-liquid interface with a degree of conversion in excess of 98%. The heat of reaction is removed by a cooling agent flowing around the outside of the tubes and may be subsequently recovered. The resulting</p>

	acid is immediately neutralized, typically with sodium hydroxide, ammonia or ethanol amines. Here the production of the most common product, the sodium salt, is considered [5].
Application	AES are used by the personal care, household, agriculture, oilfield, mining, coatings and lubricant industries. Their properties make them particularly well-suited for use in shampoos, bath and shower products, body cleansing products, manual dish detergents, etc.

## 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 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 C12-14 E2S Sodium Salt. C12-14 E2S 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](http://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 [3,5,6] for the production of C12-14E2S and its main precursors/intermediates.

Temporal Coverage	Data collected represents a 12 month averages representing 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	The primary production data for AES production was from five different suppliers from Asia and Europe representing the imported and produced AES in Europe. The geographical representativeness for C12-14 E2S was considered 'good'.	
Technological Coverage	The technological representativeness for C12-14 E2S was considered 'good'. Figure 1 provides a schematic overview of the production process of C12-14 E2S.	
Representativeness for market volume	>60% (Represented market volume (in mass) covered by primary data used in ERASM SLE project)	
Declared Unit	In the 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 C12-14 E2S (oleo) 100% active substance.	
Cradle-to Gate System Boundaries	<b>Included</b>	<b>Excluded</b>
	Fatty alcohol C12-14 (oleo) production (this production is further explained in the Eco Profile fact sheet of the precursor C12-14 fatty alcohol (#3))	Construction of major capital equipment (Infrastructure)
	Sodium hydroxide and sulphur trioxide production	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. Vehicle of transport for national transport were estimated as truck, where necessary.	
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	For C12-14 E2S production allocation was not applied to the foreground system. However, allocation was applied for some background data (mass allocation for the renewable precursors PKO and CNO).
	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 C12-14 E2S (oleo) 100% active substance**

LCI result	Unit	Amount
<b>Primary energy demand</b>		
Primary energy demand from renewable materials (net calorific value)	MJ	21718
Primary energy demand from fossil materials (net calorific value)	MJ	33449
Primary energy demand from fossil and renewable materials (net calorific value)	MJ	55167
<b>Air emissions related to Global Warming Potential</b>		
Carbon uptake, biotic	kg CO <sub>2</sub> equiv.	-2567
Carbon dioxide, fossil	kg	1395
Carbon dioxide, biotic	kg	974
Carbon dioxide, from land use, land use change and peat oxidation	kg	975
Methane	kg	11.11
Nitrous oxide (laughing gas)	kg	0.45
NMVOC emissions	kg	1.42
<i>Total GWP (according to [IPCC 2007])</i>	<i>t CO<sub>2</sub>-equiv.</i>	<i>1.19</i>

Primary Energy Demand (PED): An analysis of the inventory data showed that the PED is significantly caused by the production of the oleo based fatty alcohol (50% contribution) and its precursor ethylene oxide (30% of total). The remaining contribution is due to production of sodium hydroxide, production of other chemicals, transports and generation of thermal energy and electricity.

Global Warming Potential (GWP): An analysis of the inventory data showed that the GWP is significantly caused by the

production of the precursor ethylene oxide (approx.40% of total) and the production of the oleo based fatty alcohol (more than 20% contribution). The production of sodium hydroxide accounts for about 10% of the GWP. The generation of thermal energy and electricity cause roughly 20% of the GWP and the production of other chemicals and transports contribute with around 10% to the GWP. The biotic carbon uptake relates to the production of the precursor C12-C14 fatty alcohol.

### 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 ( <a href="http://www.erasm.org">www.erasm.org</a> )
LCA Practitioner	thinkstep AG ( <a href="http://www.thinkstep.com">www.thinkstep.com</a> )
Reviewers	Prof. Walter Klopffer, LCA Consult Mrs. Charlotte Petiot and Dr. Yannick Leguern, BioS by Deloitte Dr. Yannick Schmidt (2.0 LCA consultant)
References	<p>[1] ECHA. <a href="http://echa.europa.eu">http://echa.europa.eu</a></p> <p>[2] Schowanek, D <i>et al.</i> (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.</p> <p>[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</p> <p>[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.</p> <p>[5] Thomas, H. (1995). A life-cycle inventory for the production of alcohol ethoxy sulphates in Europe. Tenside Surf. Det. 32, 140-151.</p> <p>[6] Hirsinger, F. &amp; Schick, K.-P. (1995). A life-cycle inventory for the production of alcohol sulfates in Europe. Tenside Surf. Det. 32, 128-139.</p>

Figure1. Production process of C12-14 E2S (sodium salt).

