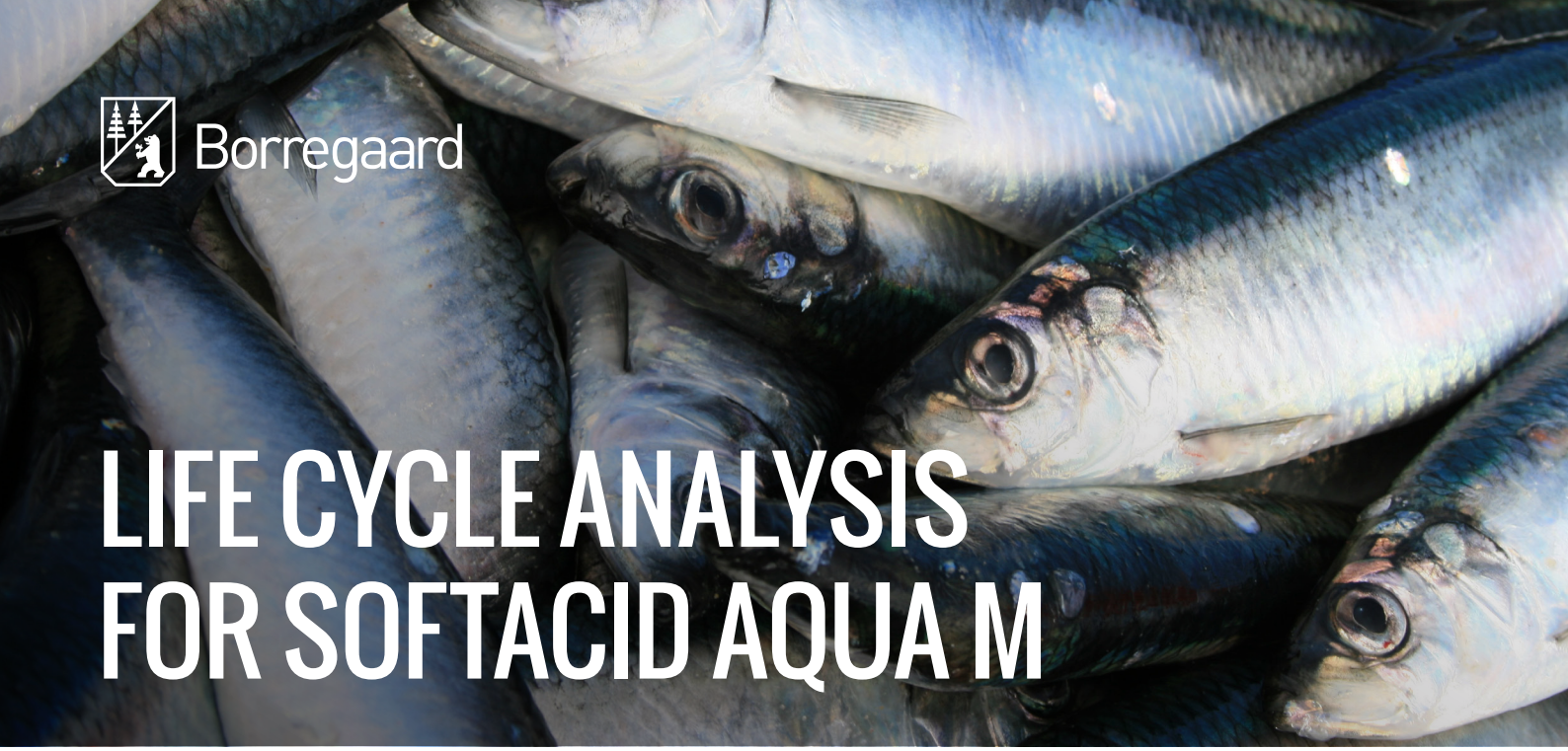

Borregaard

LIFE CYCLE ANALYSIS FOR SOFTACID AQUA M

SoftAcid Aqua M consists of lignosulfonic acid and formic acid and is typically used for fish silage. A Life Cycle Analysis (LCA) for SoftAcid Aqua M and pure formic acid has been conducted by NORSUS. When comparing the seven environmental impact categories included in the LCA, SoftAcid Aqua M is the most sustainable choice.

SUMMARY

The LCA study[1] was performed in 2019 by NORSUS, Norway's leading independent research institute for LCA and other environmental impact analyses. The LCA includes seven environmental impact categories: climate change, ozone layer depletion, photochemical oxidation, acidification, eutrophication, ADP elements and ADP fossil. SoftAcid Aqua M has a lower impact than formic acid in all categories (chart 1). The environmental performance of SoftAcid Aqua M is based on the LCA of the Borregaard Biorefinery[2] and data for formic acid are based on Ecoinvent version 3.4 from 2018[3].

SoftAcid Aqua M is the most sustainable choice of the two products, with lower CO_2 emissions and consumption of fossil fuels.

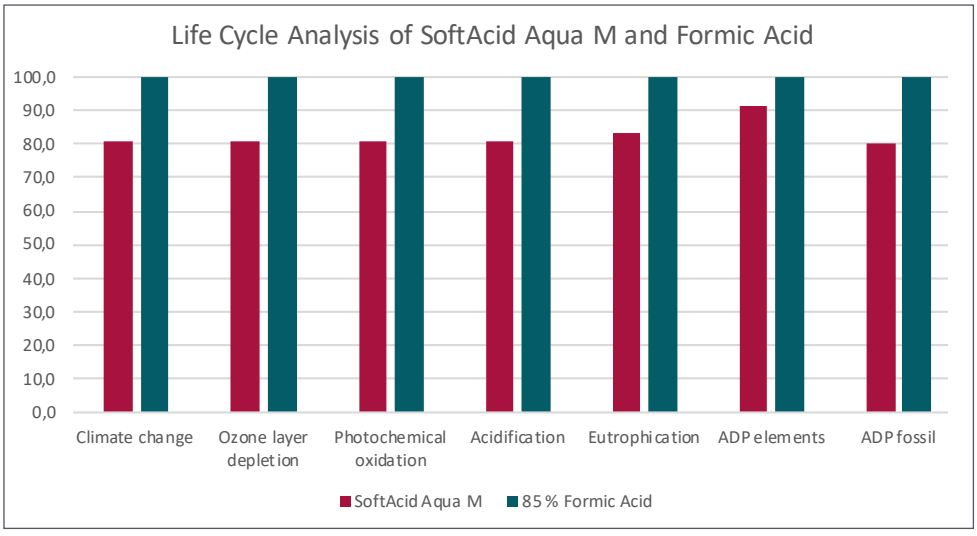

Chart 1: Relative environmental performance for SoftAcid Aqua M versus 85 % Formic Acid. The calculation is based on a 1:1 dosage of the two products.

SoftAcid®
Protecting Value

- Consists of organic acids in combination with lignosulfonic acid
- Based on natural biopolymers derived from trees
- Less corrosive, safer to use and easier to handle than pure organic acids
- More sustainable compared to the pure acids
- SoftAcid Aqua M is a silage additive, specifically developed for the silage process of fish and fish by-products

ABOUT THE TESTING

The seven environmental impact categories evaluated are listed in Table 1, along with the assessment method, unit and a description of the potential value lost for each category. The results from the LCA, which also constitute the basis for Chart 1, are listed in Table 2.

Table 1: Environmental impact categories included in the analysis..

Environmental impact category	Impact assessment method	Unit	Value lost	Comments
Climate change	IPPC 2013 GWP 100a, V1.03	kg CO_2-eqv.	Increased average global temperature could lead to severe impacts on human health, material resources, and ecosystems.	Assuming steady state in biogenic systems (not considering uptake of CO_2 in biological systems, nor counting biogenic CO_2 when burning biological matter).
Ozone layer depletion	CML-IA baseline v3.04 (April 2013, v4.2).	kg CFC-11-eqv.	The ozone layer in the stratosphere protects humans, animals and plants from possibly damaging UV rays from the sun.	
Photochemical ozone creation	CML-IA baseline v3.04 (April 2013, v4.2).	kg C_2H_4-eqv (ethene/ ethylene-eqv.)	The creation of ozone near ground level can lead to respiratory diseases and inhibited growth for plants and other members of the ecosystem.	
Acidification	CML-IA baseline v3.04April 2013, v4.2).	kg SO_2-eqv.	Acid depositions lower pH in soil and water bodies and affect plants and animals, as well as buildings and other infrastructure.	'Sulfur oxides' has been included manually by NORSUS.
Eutrophication	CML-IA baseline v3.04 (April 2013, v4.2).	kg PO_4^{-3}-eqv.	Eutrophication occurs when too many nutrients are released into the environment. This leads to some species growing fast, depleting oxygen in lakes and rivers, for example, and causing loss of biodiversity.	'Monoethanolamine' (to air/water/soil, factor 0,132 for all) was added manually by NORSUS. This factor was calculated in the report OR 15.09 ('LCA of Electricity, including CCS - A study of a Gas Power Plant Case with Post-Combustion CO_2 Capture at Tjeldbergodden') for Statoil.
Use of resources: ADP elements	CML-IA baseline v3.04 (April 2013, v4.2).	kg Sb-eqv.	Non-renewable resources consumed (minerals).	
Use of resources: ADP fossil fuels	CML-IA baseline v3.04 (April 2013, v4.2).	MJ LHV	Non-renewable resources consumed (fossil fuels).	Extended with additional fossil fuel substances and values to make the list of fossil fuels complete.

Table 2: Potential environmental impacts from production of the chemicals included in the analysis: SoftAcid Aqua M and Formic acid. The potential environmental impacts are calculated per 1000 kg product.

Impact category	Climate change	Ozone layer depletion	Photochemical oxidation	Acidification	Eutrophication	Use of resources: ADP elements	Use of resources: ADP fossil
Unit	kg CO_2 eq	kg CFC-11 eq	kg C_2H^4 eq	kg SO_2 eq	kg PO_4^{3-} eq	kg Sb eq	MJ LHV
SoftAcid Aqua M	1,58E+03	3,38E-04	5,10E-01	7,71E+00	2,77E+00	2,85E-04	3,34E+04
Formic Acid (85%)	1,96E+03	4,19E-04	6,33E-01	9,52E+00	3,33E+00	3,11E-04	4,16E+04

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2. Modahl, Ingunn & Soldal, Ellen. 2016. The 2015 LCA of cellulose, ethanol, lignin and vanillin from Borregaard, Sarpsborg. OR 11.15. Fredrikstad, Ostfold Research (now NORSUS).
3. Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at: <http://link.springer.com/10.1007/s11367-016-1087-8>

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