Zeology

A step towards socially and environmentally sustainable leather

SMIT & ZOON

20211108

Global Zeology adoption

Zeology adoption

Tanneries
Over a 100 tanneries in Europe, Asia, North and South America and Africa are working with Zeology.

Ranging from R&D applications, to bulk scale and full commercial production towards brands and OEM's.

Hides & skins
Zeology is used for cows, bulls, jaks, sheep, goats, buffalo's, deer and several other sources.

Lime split & full substance
Zeology leather is made on lime split hides, full substance hides. Both salted and green hides.

Leather articles
Zeology tanned leather is used for e.g., bags, shoes, belts, leather accessories, furniture, automotive and aviation leather

Brands & OEM's
Over 50 brands and OEMs are directly or indirectly involved with Zeology. Zeology leather is being offered, is being tested, is approved or offered to consumers.

Zeology adoption

The first chrome free sneaker in the US by Italic

Italic, a direct-to-consumer e-commerce marketplace in the USA, has launched a pilot program of Zeology tanned leather **minimalistic white sneakers.** The Zeology sneakers are offered in three styles. With these sneakers Italic is presenting the very first chrome free tanned leather sneakers in the US market.

Tasman Leathers of New Zealand
746volgers
2 w • + Volgen •••

A tanning agent that provides both sustainability benefits and superior leather performance — Royal Smit & Zoon Zeology is designed to deliver.

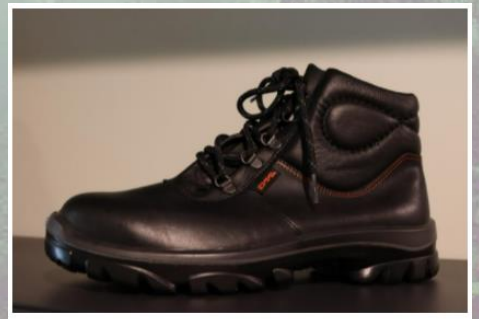
Zeology is zeolite-based and therefore chrome-free, heavy metal-free and aldehyde-free. It's the ultimate sustainable alternative to existing tanning agents, and Tasman is proud to support a product that aligns with what we believe in.

Black fashion bag in collaboration with Sitoy

In a special collaboration with SITOY Group we have created a small black high-end fashion bag, made of Zeology leather.

Coat and leather trousers by Mart Visser

The leather used for these fashion items is white supple lambskin leather is tanned with Zeology by Spanish tannery Riba Guixà.



Sustainable safety shoes by EMMA Safety Footwear

The use of Zeology leather significantly reduces the environmental impact of the production of the EMMA shoes.

Scan-Hide A/S
529volgers
1 w • Bewerkt • + Volgen •••

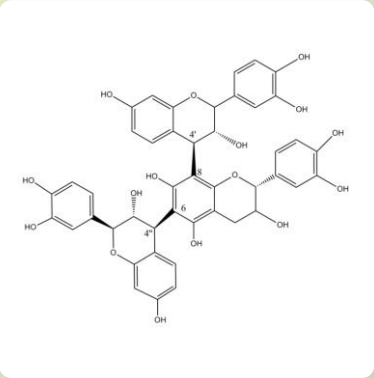
This is the future...

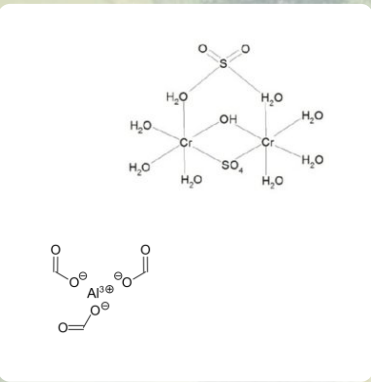
Zeology is a revolutionary tanning agent providing green benefits without compromising the leathers superior performance. It surpasses all characteristics including, grain tightness, physical leather properties, lightfastness, and heat-resistance. In addition, its bright white color enables white leather and lighter and brighter colors than ever before.

Chemistry & Mechanics

Different tanning agents

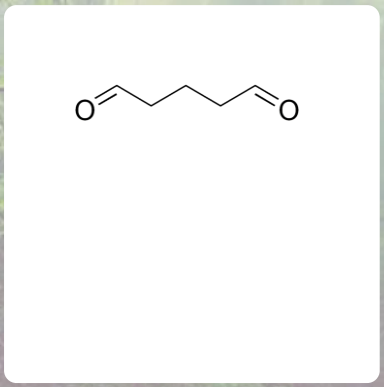
Vegetable tanning agents are biobased originating from a variety of plant and wood-based materials. The tanning interactions are based on hydrogen bonding and phenolic interactions with the collagen.

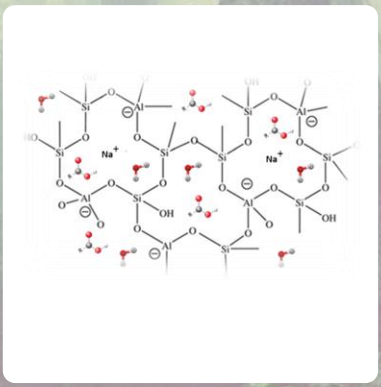




Metal salts tanning agents are most well-known salts of chromium, aluminum, and zirconium. The tanning interactions are based on ionic (semi-covalent) bonding to the collagen, especially the carboxyl groups interact with the metal salts.

Synthetic tanning agents are typically based on aldehyde chemistry. The tanning interactions are mostly based on covalent bonds.





Zeology , is based on aluminosilicates and occur both natural and are made synthetical. How does zeolite interact with collagen?

How does Zeology tanning work

Zeology tanning agent

Zeolites are microporous, alumino-silicate minerals that form the basis of Zeology tanning. The tanning agent is free of chrome, aldehydes and heave-metals.

Zeology in pickle

The zeolite's initial structure is crystalline. In the pickle float it falls apart into smaller structures. This is a dispersion and not a solubilization into the separate elements.

Penetration into fibers

Zeology begins to penetrate the collagen matrix. While penetrating, parts of the zeolite tanning agent start to interact with the collagen, increasing the shrinkage temperature, Ts.

Activation

In this process the dispersed Zeology tanning agent covers the collagen fibers in a new and continuous sheath. Each individual interaction has a relatively small strength, whereas the whole zeolite network has a large strength.

For more details see '*The science and chemistry behind Zeology*' on www.neratanning.com

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Zeology supply chain & Certifications

Zeology

Supply Chain

Zeology sustainable sourcing and supply

- Fully established, scalable and global supply chain for Zeology
- Zeolite is built from the elements Aluminum (Al), Silicium (Si) and Oxygen (O), the most abundantly available elements in the Earth's crust (~40km thick). The three elements represent >80% of the top layer of our globe. See table
- Chrome only has a ~0,01% presence in the Earths crust (element #21)
- The bauxite/ATH/aluminum used for Zeology is certified for Environmental Social Governance (ESG) industry standards. Covering: Environmental aspects, Human rights, Material stewardship, Governance, Labor rights and occupational health and safety
- Key suppliers : ISO 9001, 14001, 45001 certified

Zeology certifications and Life Cycle Analyses (LCA)

- Zeology Cradle-to-Gate LCA data available
- Zeology is ZDHC MRSL Conformance® – Level 3 certified
- Zeology is Cradle to Cradle Material Health® – Platinum certified
- Zeology is ToxFMD Screened Chemistry® certified
  - Required for e.g.; H&M, Levi Strauss & Co., Nike Inc., C&A

Rank	Element	% of Earth's Crust
1	Oxygen (O)	46.1%
2	Silicon (Si)	28.2%
3	Aluminum (Al)	8.2%
4	Iron (Fe)	5.6%
5	Calcium (Ca)	4.1%
6	Sodium (Na)	2.3%
7	Magnesium (Mg)	2.3%
8	Potassium (K)	2.0%
9	Titanium (Ti)	0.5%
10	Hydrogen (H)	0.1%
	Other elements	0.5%
	Total	**100.0%**

Source : The Most Abundant Elements In The Earth's Crust - WorldAtlas

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ZDHC MRSL Conformance Level 3

ZEOLOGY | P919RQ49

Leather | Tanning and Retanning Agents | Mineral tanning agents

Other Name: MZ 8132

LEVEL 3: CHEMICAL SUPPLIER SITE VISIT

Your ZDHC ChemCheck™ report confirms that your product has been verified to the above ZDHC Conformance Standard.

Product Description

Sustainable Zeolite tanning

Inventory Product Conformance

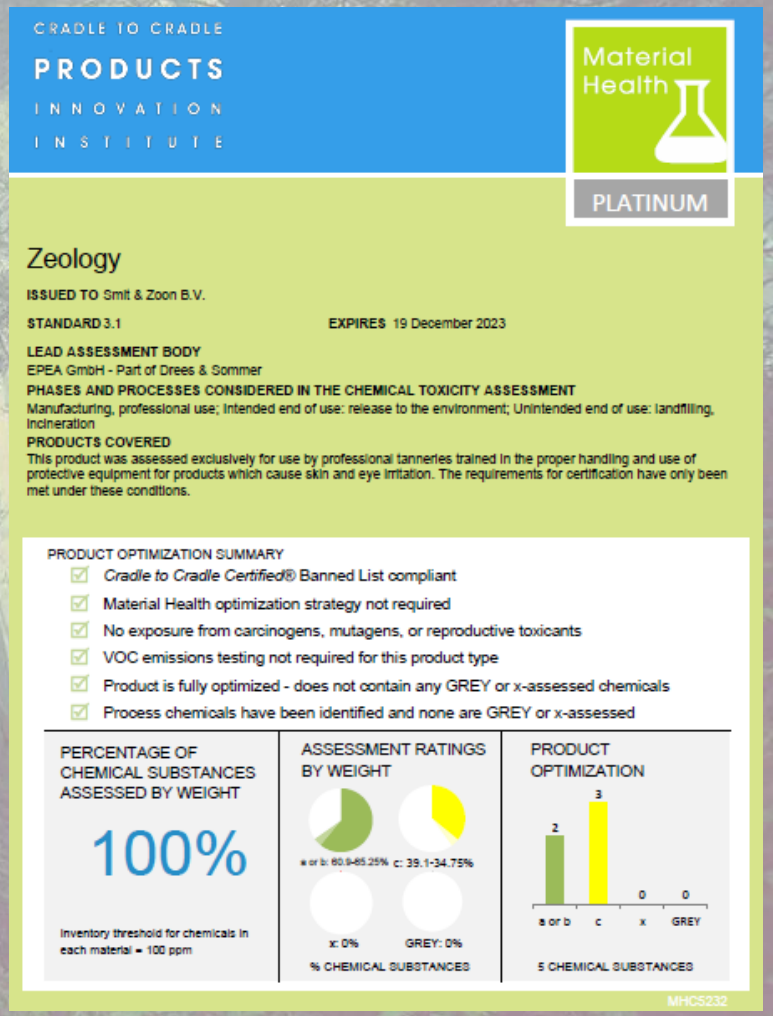
Level 1 – Passed a third-party review of documentation or an analytical test report where the data meet the QA and QC requirements in the MRSL Conformance Guidance to be accepted as evidence of conformance.

Level 2 – All requirements for Level 1 passed and passed a review of the product stewardship practices of the chemical supplier by the third-party certifier.

Level 3 – All requirements for Level 2 passed and passed a site visit to the chemical formulator to evaluate their product stewardship first-hand.

Tell me more about MRSL conformance

Cradle to Cradle Material Health Certificate - Platinum



CRADLE TO CRADLE
PRODUCTS
INNOVATION
INSTITUTE

Material Health
PLATINUM

Zeology

ISSUED TO Smit & Zoon B.V.

STANDARD 3.1 **EXPIRES** 19 December 2023

LEAD ASSESSMENT BODY
EPEA GmbH - Part of Drees & Sommer

PHASES AND PROCESSES CONSIDERED IN THE CHEMICAL TOXICITY ASSESSMENT
Manufacturing, professional use; Intended end of use: release to the environment; Unintended end of use: landfilling, incineration

PRODUCTS COVERED
This product was assessed exclusively for use by professional tanneries trained in the proper handling and use of protective equipment for products which cause skin and eye irritation. The requirements for certification have only been met under these conditions.

PRODUCT OPTIMIZATION SUMMARY

- ☑ *Cradle to Cradle Certified®* Banned List compliant
- ☑ Material Health optimization strategy not required
- ☑ No exposure from carcinogens, mutagens, or reproductive toxicants
- ☑ VOC emissions testing not required for this product type
- ☑ Product is fully optimized - does not contain any GREY or x-assessed chemicals
- ☑ Process chemicals have been identified and none are GREY or x-assessed

PERCENTAGE OF CHEMICAL SUBSTANCES ASSESSED BY WEIGHT

100%

Inventory threshold for chemicals in each material = 100 ppm

ASSESSMENT RATINGS BY WEIGHT

a or b: 60.9-65.25% c: 39.1-34.75%

x: 0% GREY: 0%

% CHEMICAL SUBSTANCES

PRODUCT OPTIMIZATION

5 CHEMICAL SUBSTANCES

MHCS232

ToxFMD Screened Chemistry Certified

TOX FMD SCREENED CHEMISTRY®

ROADMAP TO ZERO

ZDHC MRSL
Level 1 Conformance

ToxServices hereby grants use of the Licensed Mark identified above to:

Smit Tanning B.V.'s Zeology

This Certificate confirms that the following product has met ToxFMD Screened Chemistry® Program requirements, including establishing ZDHC MRSL Level 1 Conformance (v. 2.0):

CLIENT Smit Tanning B.V.	**CERTIFICATE#** 643
FORMULATION Zeology	**FMD#** 822
ToxFMD® VERSION 3.0	**ISSUE DATE** December 2, 2021
ToxFMD SCREENED CHEMISTRY® SCORE 33.8	**EXPIRY DATE** December 2, 2024

Margaret H. Whittaker, Ph.D., M.P.H., CBiol., F.R.S.B., E.R.T., D.A.B.T.
ToxServices LLC

To verify status of certificate, please visit www.toxservices.com to access certificate registry.

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

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Winner - Green Product Award ‘22 in the category Best of New

Since 2013, the Green Product Award distinguishes products and services, good in sustainability, innovation & design. It is aimed at products & services on the market from start-ups and established companies who wish to highlight their sustainable achievements.

Creators of visionary concepts - not on the market yet - head to the Green Concept Award.

The Green Product Award raises awareness & visibility through its own channels (7 million online contacts) and additionally with the media and trade fair partners in Germany.

Outstanding participants have a chance to become a Member of the Green Future Club to enhance their network.

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Compostable Leather & Biodegradability

Dr. Ir. Wouter Hendriksen - R&D Manager Nera & Zeologist

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Compostability Sustainability at end of life

- Making compostable leather starts with the end-of-life in mind and then reverse engineer/design.
- Biodegradability needs to be considered at all stages in the chain of production and during the life cycle of leather

- Biodegradability is a
  - material property, i.e., plastics, packaging, textile, leather, building materials.
  - complex matter of end-of-life scenarios, testing methods and terminologies.
  - the testing of substrate, substances and materials under environmental conditions.

We focus on biodegration under controlled conditions (industrial composting).

Testing for compostability is time consuming (3 to 6 months)

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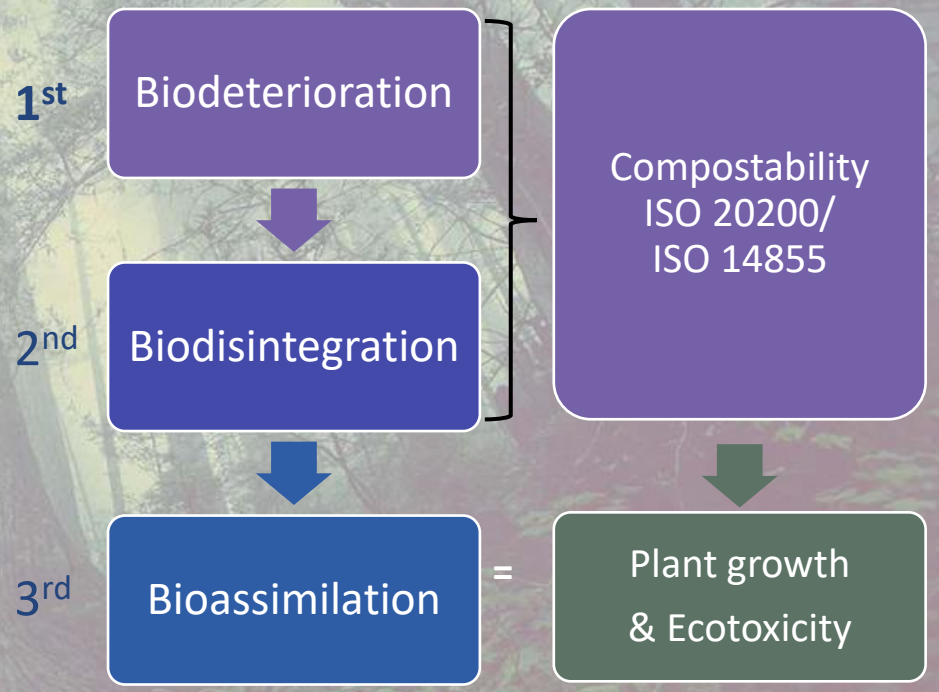
Biodegradability vs. Compostability

- Compostability is a specific case of a biodegradation process, under controlled conditions with a limited time frame.
- Industrial compostability can be analysed with different methods, all adapted for leather, examples are ISO 20200, ISO 14855.
- Compostability focusses on the Biodeterioration & Biodisintegration.
- A typical time frame of 90 to 180 days of testing is given to decompose the material up to 90% minimum.
- Plant growth and Ecotoxicity follow to close the cycle (OECD 208), with the Bioassimilation



Degradability by microorganisms - **Zeo White vs. wetblue**
Results obtained – ISO20136: 2017

DETERMINATION OF DEGRADABILITY BY MICRO-ORGANISMS			
Parameters	Samples		
	Collagen (C+)	Sample 181779 Wet blue	Sample 181780 Zeowhite
Absolute biodegradability (%)	84.1	**47.0**	**82.6**
Relative biodegradability (%)*	100.0	**55.9**	**98.3**

Disintegration of **Zeo White based crust** Results obtained – ISO 20200

Determining the degree of disintegration of plastic materials when exposed to a laboratory-scale composting environment.

Results obtained – ISO 20200 on Zeology crust

The average disintegration for the test sample was **100 ±0.00%** (measured as change in mass) after the thermophilic stage. There is no leather industry specification as such that defines the desirable degree of disintegration.

The packaging industry specification (BS EN 13432:2000) that informs the requirements of EU Directive 94/62/EC states that in terms of disintegration a material is said to be disintegrated, in compost, if 90% of the starting material passes through a 2 mm sieve after the thermophilic incubation period (first 90 days).

0.00% of the test sample was retained by a 2 mm sieve after the thermophilic stage and would thus pass the BS EN 13432:2000 requirement. It seems full disintegration took place around Day 11-15.

Sufficient disintegration was observed in the thermophilic stage and therefore, the mesophilic phase was not required.

Table 2: Testing operation, observations, and results (Thermophilic)

Test Requirement	Days from Start	Operation
Incubation (58°C, 90 days) – observations (for all replicates):	0	Initial mass recorded
	1,2,3,4,7,9,11,14	Weighed and restored to original mass. Mixed.
	8,10,16,18,21,23, 25,28	Weighed and restored to original mass. No mixing done.
	30,45	Weighed and restored to 80% of original mass. No mixing done.
	Day 30-60 (twice a week)	Weighed and restored to 80% of original mass. No mixing done.
	Day 60 onwards (twice a week)	Weighed and restored to 70% of original mass. No mixing done.
	7 days	White mycelia appeared quickly
	14 days	Only a hint of ammonia
	21 days	Very few pieces left by Day 11
	28 days	Some reactors cannot see samples
	35 days	Earthy smell
	42 days	No changes
	49 days	No changes
	56 days	Compost progressing as normal
	63 days	Compost progressing as normal
	77 days	Compost progressing as normal
	84 days	Compost progressing as normal
	90 days	Thermophilic terminated
Sample weight (M_f), in triplicate (end):	Mean: 0.00 g (±0.000 g)	
Sample disintegration, D, (thermophilic): $D = \left(\frac{M_i - M_f}{Mi}\right) x\ 100$	**100.0% (±0.00%) (0.0% *stays in the 2 mm sieve*)**	
Synthetic compost evaluation (end)	C:N ratio: 39:1	
	pH: 7.70 (±0.02)	
	Dry matter (DS_f): 93.13%	
	Volatile solids (VS_f): 92.80%	
Synthetic compost's decrease in volatile solids (R), after thermophilic: $R = \left(\frac{(M_i x DS_i x VS_i) - (M_f x DS_f x VS_f)}{(M_i x DS_i x VS_i)}\right) x\ 100$	44.29%	

Compostability leather bags and shoes

RE:SUEDE

Sports company PUMA has developed an experimental version of its most iconic sneaker, the SUEDE, to test for a product to make it biodegradable. By doing so, PUMA aims to meet the growing demand for sustainable products for a better future. The RE:SUEDE, which uses the latest technology available today, is made from more sustainable materials such as Zeology tanned suede, biodegradable TPE and hemp fibres. The Zeology tanning system is based on the mineral zeolite and is chrome-free, heavy metal-free and aldehyde-free.

Return to Nature

The leather used in the Return to Nature collection uses a pioneering tanning and finishing method, developed with Richard Hoffmans (est. 1899) and Nera Tanning, resulting in a product that is chrome, heavy-metal and aldehyde-free – and thus able to biodegrade. The hides are tanned with Zeology, an innovative new way of tanning that replaces chrome (which hinders biodegradability) with zeolite. It refrains from the use of PU coatings, and is finished instead with liquid silk to allow the bag to biodegrade 89.2% in 28 days, with tests showing 100% disintegration in 45 days under composting conditions

Zeology, effluent & waste

Dr. Beate Haaser - Environmental Affairs

Effluent & Zeology

Zeology processing creates a waste water stream that can be treated in existing treatment plants like any other effluent from chrome tanning.

Each tanning agent yields specific effluents, with specific needs for treatment, and Zeology is no exception. Specific characteristics of Zeology's waste water compared to the most widespread tanning methods (Chrome, GDA) are:

- Comparable amounts of float drained
- COD comparable to chrome and lower than GDA tanning
- Lower salt freight (chloride and sulphate) than chrome tanning
- Slightly higher in suspended solids and ash content

These insights are based on the tanning floats drained from limed pelt to wet-semi finished with identical pre-treatment.

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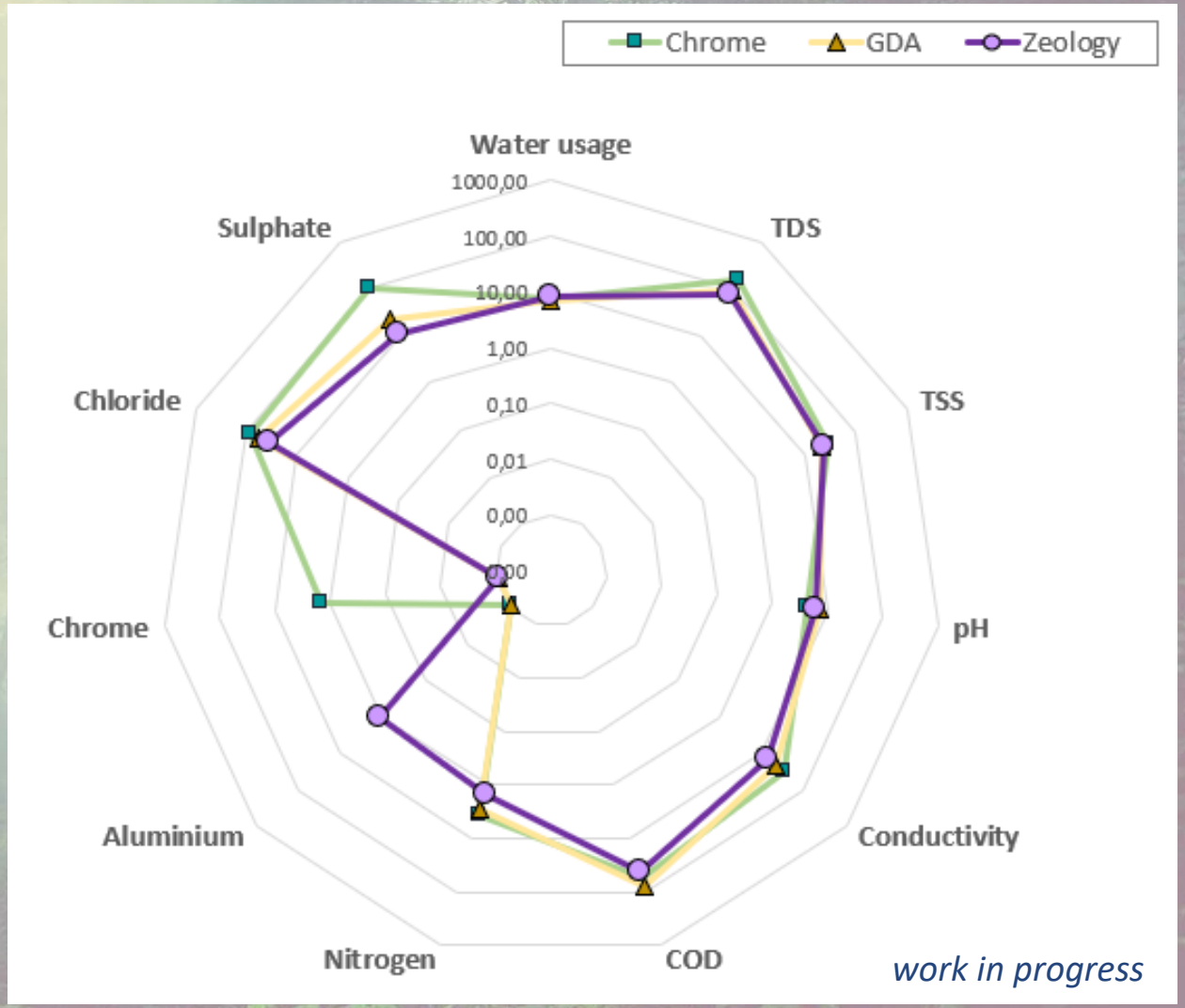
Effluent & Zeology

Here a comparison of the proportional mixture of the corresponding drained floats is shown, respecting the different loads in the effluent. All values given as freight per ton of pelt.



work in progress

Zeology leather shavings

- The waste streams that arise from the tanning and tanned leather are typically shavings, clippings and sludge. With the use of Zeology, these mainly contain zeolite, as well as the natural collagen. Therefore, these waste streams are typically heavy metal-free, white of color and easy to handle.

- Furthermore, the sludge stream can be treated so that it meets the right conditions to be biodegradable/compostable.

- Smit & Zoon runs activities to use Zeology shavings as raw materials for other industries.

Zeology

A step towards socially and environmentally sustainable leather

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