

Supporting Information (SI)

Title: Greening pathways for synthetic talc production based on supercritical hydrothermal flow process

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Table S-1. Inventory for production of magnesium acetate

Magnesium acetate, at plant (RER)	Reference flow amount: 1kg		Adapted from Ullmann's Encyclopedia Of Industrial Chemistry	
Inventory Item	Amount	units	Other	Inventory Flow source
Acetic acid, without water, in 98% solution state, at plant (RER)	0,56002	kg		Ecoinvent
Magnesium Hydroxide, at plant (RER)	0,27195	kg		This study
Water, ultrapure, at market (GLO)	0,16801	kg		Ecoinvent
Electricity, medium voltage, Production (RER), at grid (RER)	0.25*	MJ	Considering additional energy consumption during to run auxiliary machines, processes and equipment	Ecoinvent
Heat, industrial, natural gas, at industrial furnace >100kW (RER)	1.102*	MJ		Ecoinvent

*The values adapted from the acetic acid production inventory in Ecoinvent database.

Table S-2. Inventory for production of magnesium hydroxide

Magnesium hydroxide, at plant (RER)	Reference flow amount: 1kg		Adapted from Ullmann's Encyclopedia Of Industrial Chemistry	
Inventory Item	Amount	units	Other	Inventory Flow source
Sea water	442.3 kg	kg		Ecoinvent
Quick lime, at plant (RER)	1.27	kg		Ecoinvent
Electricity, medium voltage, Production (RER), at grid (RER)	0.534	MJ	Considering additional energy consumption during to run auxiliary machines, processes and equipment	Ecoinvent

Table S-3. Selected background data in Ecoinvent

Intenvory input/output	Selected ecoinvent dataset
sodium metasilicate	market for sodium silicate, solid sodium silicate, solid Cutoff, U - RER
acetic acid	market for acetic acid, without water, in 98% solution state acetic acid, without water, in 98% solution state Cutoff, U - GLO
water	market for water, ionised, GLO
wastewater	market for wastewater, average wastewater, average Cutoff, U - Europe without Switzerland
heat	market for heat, district or industrial, natural gas heat, district or industrial, natural gas Cutoff, U - Europe without Switzerland
electricity	Electricity, average EU w/Swiss

sulfuric acid	market for sulfuric acid sulfuric acid Cutoff, U - RER
magnesium sulfate	market for magnesium sulfate magnesium sulfate Cutoff, U - GLO

Table S-4. Wastewater effluent composition of talc at 1.9g/L concentration

Parameter	Value	Unit
Nitrite (expressed as N)	0.006	mg N/l
Nitrate (expressed as N)	0.1	mg N/l
Total phosphorous	0.02	mg/l
DBO5	1360	mg O ₂ /l
DCO	2330	mg O ₂ /l
Suspension material	3.8	mg/l
pH	6.75	
Temperature of the sample	17.9	°C
Global nitrogen	1.106	mg N/l
Kjeldahl nitrogen	1	mg N/l

Impact categories and indicators abbreviations and units

Table S-5. Impacts of reagents in talc synthesis for reaction R1 (76g/L)

Impact category	Sodium metasilicate	Magnesium acetat	Acetic acid	Water	Heat	Electricity	Waste-water	Unit
Land use	1.1E-01	3.3E-02	8.0E-03	1.2E-04	7.5E-05	3.4E-04	4.9E-04	m ² a crop eq
Marine eutrophication	4.5E-05	4.4E-05	1.2E-05	2.4E-07	1.3E-07	7.1E-07	1.0E-04	kg N eq
Marine ecotoxicity	2.3E-01	1.4E-01	4.3E-02	6.2E-04	5.3E-04	5.8E-04	1.2E-03	kg 1,4-DCB
Freshwater eutrophication	5.6E-04	6.8E-04	1.8E-04	2.4E-06	1.5E-06	1.0E-05	2.0E-05	kg P eq
Stratospheric ozone depletion	4.6E-07	1.0E-06	2.8E-07	5.8E-09	3.1E-08	5.7E-09	2.5E-08	kg CFC11 eq
Freshwater ecotoxicity	1.8E-01	1.1E-01	3.3E-02	4.7E-04	2.6E-04	4.4E-04	9.4E-04	kg 1,4-DCB
Human non-carcinogenic toxicity	2.2E+00	1.4E+00	4.2E-01	6.3E-03	3.2E-03	8.4E-03	5.0E-02	kg 1,4-DCB
Global warming	1.7E+00	2.4E+00	5.3E-01	5.9E-03	1.1E-01	1.0E-02	8.7E-03	kg CO ₂ eq
Ionizing radiation	5.7E-02	1.7E-01	3.8E-02	5.4E-04	5.1E-04	5.1E-03	1.0E-03	kBq Co-60 eq
Fossil resource scarcity	3.4E-01	1.1E+00	3.2E-01	1.6E-03	4.5E-02	2.7E-03	1.9E-03	kg oil eq
Fine particulate matter formation	2.6E-03	3.3E-03	9.4E-04	1.6E-05	2.2E-05	1.5E-05	2.4E-05	kg PM _{2.5} eq
Ozone formation, Human health	3.5E-03	5.3E-03	1.3E-03	1.4E-05	8.2E-05	1.8E-05	3.3E-05	kg NO _x eq
Mineral resource scarcity	1.6E-02	6.6E-03	1.9E-03	4.7E-05	3.3E-05	1.3E-05	1.9E-04	kg Cu eq
Human carcinogenic toxicity	6.7E-02	6.7E-02	1.8E-02	4.5E-04	4.0E-04	5.7E-04	1.8E-03	kg 1,4-DCB
Terrestrial acidification	7.8E-03	7.2E-03	2.0E-03	4.1E-05	6.4E-05	3.9E-05	6.6E-05	kg SO ₂ eq
Terrestrial ecotoxicity	1.1E+01	6.9E+00	1.8E+00	2.8E-02	1.2E-02	1.1E-02	4.3E-02	kg 1,4-DCB
Ozone formation, Terrestrial ecosystems	3.6E-03	5.5E-03	1.4E-03	1.4E-05	8.5E-05	1.9E-05	3.3E-05	kg NO _x eq
Water consumption	2.1E-02	4.4E-02	1.4E-02	1.4E-02	7.1E-05	1.7E-04	-1.6E-02	m ³
Cumulative energy demand	1.9E+01	5.0E+01	1.6E+01	9.1E-02	2.0E+00	2.5E-01	1.1E-01	MJ

Table S-6. Impacts of reagents in talc synthesis for reaction R2 (76 g/L)

Impact category	Sodium metasilicate	Magnesium sulfate	Sulfuric acid	Water	Heath	Electricity	Waste-water	Unit
Land use	1.1E-01	1.3E-02	1.5E-03	1.2E-04	7.5E-05	3.4E-04	4.8E-04	m2a crop eq
Marine eutrophication	4.5E-05	2.5E-05	8.0E-07	2.4E-07	1.3E-07	7.1E-07	1.0E-04	kg N eq
Marine ecotoxicity	2.3E-01	2.7E-02	1.1E-02	6.2E-04	5.3E-04	5.8E-04	1.2E-03	kg 1,4-DCB
Freshwater eutrophication	5.6E-04	3.6E-04	1.7E-05	2.4E-06	1.5E-06	1.0E-05	2.0E-05	kg P eq
Stratospheric ozone depletion	4.6E-07	3.6E-07	1.4E-08	5.8E-09	3.1E-08	5.7E-09	2.5E-08	kg CFC11 eq
Freshwater ecotoxicity	1.8E-01	2.0E-02	8.5E-03	4.7E-04	2.6E-04	4.4E-04	9.3E-04	kg 1,4-DCB
Human non-carcinogenic toxicity	2.2E+00	3.7E-01	1.2E-01	6.3E-03	3.2E-03	8.4E-03	4.9E-02	kg 1,4-DCB
Global warming	1.7E+00	7.4E-01	2.9E-02	5.9E-03	1.1E-01	1.0E-02	8.5E-03	kg CO2 eq
Ionizing radiation	5.7E-02	1.0E-01	2.7E-03	5.4E-04	5.1E-04	5.1E-03	9.8E-04	kBq Co-60 eq
Fossil resource scarcity	3.4E-01	1.9E-01	2.6E-02	1.6E-03	4.5E-02	2.7E-03	1.8E-03	kg oil eq
Fine particulate matter formation	2.6E-03	1.9E-03	6.4E-04	1.6E-05	2.2E-05	1.5E-05	2.4E-05	kg PM2.5 eq
Ozone formation, Human health	3.5E-03	2.7E-03	2.2E-04	1.4E-05	8.2E-05	1.8E-05	3.2E-05	kg NOx eq
Mineral resource scarcity	1.6E-02	1.0E-03	6.2E-04	4.7E-05	3.3E-05	1.3E-05	1.8E-04	kg Cu eq
Human carcinogenic toxicity	6.7E-02	2.9E-02	2.3E-03	4.5E-04	4.0E-04	5.7E-04	1.8E-03	kg 1,4-DCB
Terrestrial acidification	7.8E-03	3.1E-03	2.2E-03	4.1E-05	6.4E-05	3.9E-05	6.5E-05	kg SO2 eq
Terrestrial ecotoxicity	1.1E+01	1.3E+00	8.6E-01	2.8E-02	1.2E-02	1.1E-02	4.3E-02	kg 1,4-DCB
Ozone formation, Terrestrial ecosystems	3.6E-03	2.7E-03	2.2E-04	1.4E-05	8.5E-05	1.9E-05	3.3E-05	kg NOx eq
Water consumption	2.1E-02	5.2E-03	6.6E-03	1.4E-02	7.1E-05	1.7E-04	-1.5E-02	m3
Cumulative energy demand	1.9E+01	1.2E+01	1.3E+00	9.1E-02	2.0E+00	2.5E-01	1.1E-01	MJ

Table S-7. Impacts of reagents in talc synthesis for reaction R2 (76 g/L)

Impact category	Sodium metasilicate	Magnesium sulfate	Acetic acid	Water	Heath	Electricity	Waste-water	Unit
Land use	1.1E-01	1.5E-02	8.0E-03	1.2E-04	7.5E-05	3.4E-04	4.8E-04	m2a crop eq
Marine eutrophication	4.5E-05	2.9E-05	1.2E-05	2.4E-07	1.3E-07	7.1E-07	1.0E-04	kg N eq
Marine ecotoxicity	2.3E-01	3.1E-02	4.3E-02	6.2E-04	5.3E-04	5.8E-04	1.2E-03	kg 1,4-DCB
Freshwater eutrophication	5.6E-04	4.1E-04	1.8E-04	2.4E-06	1.5E-06	1.0E-05	2.0E-05	kg P eq
Stratospheric ozone depletion	4.6E-07	4.2E-07	2.8E-07	5.8E-09	3.1E-08	5.7E-09	2.5E-08	kg CFC11 eq
Freshwater ecotoxicity	1.8E-01	2.3E-02	3.3E-02	4.7E-04	2.6E-04	4.4E-04	9.3E-04	kg 1,4-DCB
Human non-carcinogenic toxicity	2.2E+00	4.2E-01	4.2E-01	6.3E-03	3.2E-03	8.4E-03	5.0E-02	kg 1,4-DCB
Global warming	1.7E+00	8.5E-01	5.3E-01	5.9E-03	1.1E-01	1.0E-02	8.6E-03	kg CO2 eq
Ionizing radiation	5.7E-02	1.2E-01	3.8E-02	5.4E-04	5.1E-04	5.1E-03	9.9E-04	kBq Co-60 eq
Fossil resource scarcity	3.4E-01	2.2E-01	3.2E-01	1.6E-03	4.5E-02	2.7E-03	1.8E-03	kg oil eq
Fine particulate matter formation	2.6E-03	2.2E-03	9.4E-04	1.6E-05	2.2E-05	1.5E-05	2.4E-05	kg PM2.5 eq
Ozone formation, Human health	3.5E-03	3.1E-03	1.3E-03	1.4E-05	8.2E-05	1.8E-05	3.2E-05	kg NOx eq
Mineral resource scarcity	1.6E-02	1.2E-03	1.9E-03	4.7E-05	3.3E-05	1.3E-05	1.8E-04	kg Cu eq

Human carcinogenic toxicity	6.7E-02	3.4E-02	1.8E-02	4.5E-04	4.0E-04	5.7E-04	1.8E-03	kg 1,4-DCB
Terrestrial acidification	7.8E-03	3.6E-03	2.0E-03	4.1E-05	6.4E-05	3.9E-05	6.5E-05	kg SO2 eq
Terrestrial ecotoxicity	1.1E+01	1.5E+00	1.8E+00	2.8E-02	1.2E-02	1.1E-02	4.3E-02	kg 1,4-DCB
Ozone formation, Terrestrial ecosystems	3.6E-03	3.1E-03	1.4E-03	1.4E-05	8.5E-05	1.9E-05	3.3E-05	kg NOx eq
Water consumption	2.1E-02	6.0E-03	1.4E-02	1.4E-02	7.1E-05	1.7E-04	-1.5E-02	m3
Cumulative energy demand	1.9E+01	1.3E+01	1.6E+01	9.1E-02	2.0E+00	2.5E-01	1.1E-01	MJ

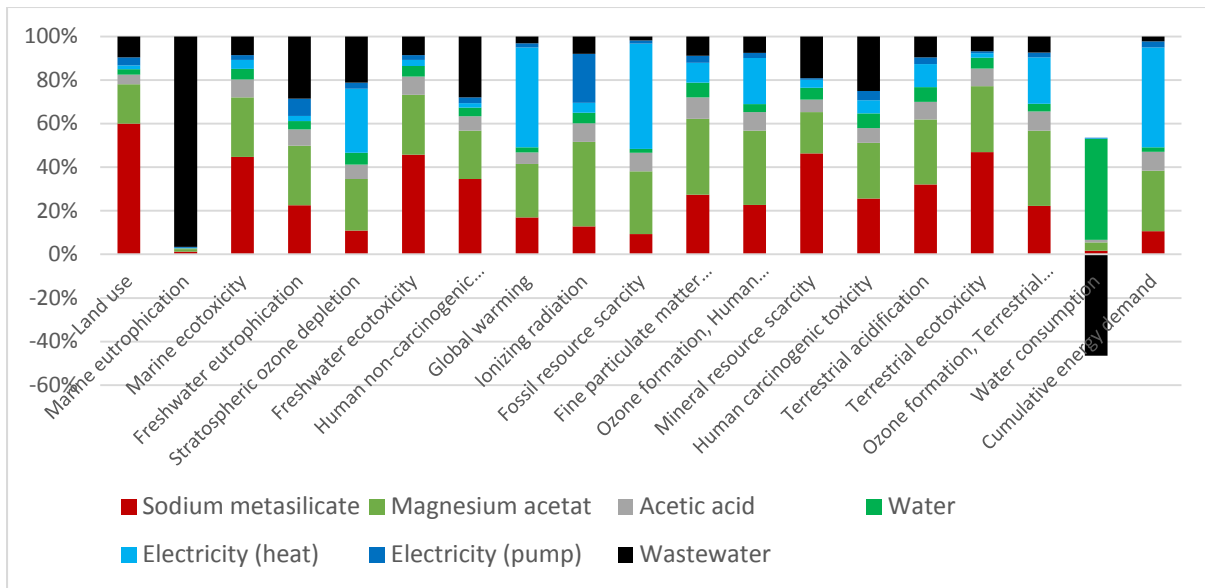


Figure S-1. Contribution analysis of reaction R1 at talc concentration of 1.9 g/L

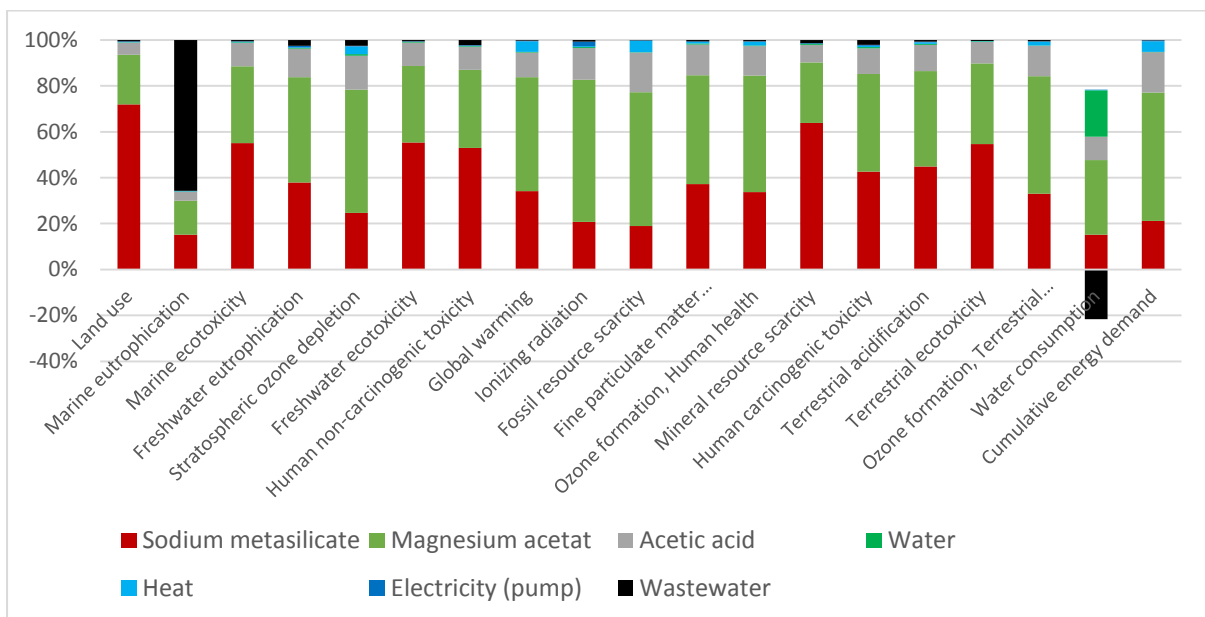


Figure S-2. Contribution analysis of reaction R1 at talc concentration of 38 g/L