Safety Data Sheet

According to Regulation (EU) No. 1907/2006, Annex II, Amended by REGULATION (EU) No 453/2010

Citric acid

SDS Record Number: CSSS-TCO-010-100155

Printing date:6/5/2011 **Version 2.0**
Revision date: 6/5/2011

1 Identification of the substance and of the company/undertaking

1.1 Product identifier:

Identification on the label/Trade name:	Citric acid
Additional identification:	2-hydroxy-1,2,3-propanetricarboxylic acid
Identification of the product:	CAS#77-92-9; EC#201-069-1
Index Number:	Not available
REACH registration No.:	01-2119457026-42-0004

1.2 Relevant identified uses of the substance and uses advised against:

1.2.1 Identified uses:

Use as an intermediate in the production of other organic chemicals.

Formulation into preparations.

Use in personal care products.

Use in detergent/cleaning and other household products.

Use in paper making.

Use in construction products

Use in polymers and plastics products.

Use in the oil industry.

Use in the textile industry.

Use in paints and coatings.

Use in photography products.

Use in laboratory reagents.

Use in water treatment.

Use in the treatment of metal surfaces.

Use in agricultural applications.

Use in medical devices

1.2.2 Uses advised against:

Not available.

1.3 Details of the supplier of the safety data sheet:

Supplier(Only representative):	Chemical Inspection & Regulation Service Limited
Supplier(Manufacturer):	COFCO BIOCHEMICAL(ANHUI)CO.,LTD
Address:	NO.73 Daqing Road, Bengbu City, Anhui, China 233010
Contact person(E-mail):	sly469@163.com
Telephone:	+86-552-4928078
Fax:	+86-552-4928460

1.4 Emergency telephone Number:

+353 41 980 6916

Available outside office hours?	YES		NO	X

2 Hazards Identification

2.1 Classification of the substance

2.1.1 Classification:

The substance is classified as following according to 67/548/EEC and REGULATION (EC) No 1272/2008:

EU CLP 1272/2008	
Hazard classes/Hazard categories	Hazard statement
Eye Irrit. 2	H319

For full text of H- phrases: see section 2.2.

67/548/EEC	
Hazards characteristics	R-Phrases
Xi	R36

For full text of R- phrases: see section 16.

2.1.2 The most important adverse effects

2.1.2.1 The most important adverse physicochemical effects:

Not available

2.1.2.2 The most important adverse human health effects:

Causes serious eye irritation.

2.1.2.3 The most important adverse environmental effects:

Not applicable.

2.2 label elements

Hazard Pictograms:

Signal Word(S): Warning
Hazard Statement: H319: Causes serious eye irritation
Precautionary Statement: P264: Wash…thoroughly after handling. (with soap and water)
P280: Wear protective gloves/protective clothing/eye protection/face protection
P305+ P351 +P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337+P313: If eye irritation persists: Get medical advice/attention.

2.3 Other hazards

Not available(PBT,vPvB, Substance is an endocrine disruptor etc.)

3 Composition/information on ingredients

Substance/Mixture: Substance

Ingredient(s):

Chemical Name	Registration No.	CAS No.	EC No.	Concentration
2-hydroxy-1,2,3-propanetricarboxylic acid	01-2119457026-42-0004	77-92-9	201-069-1	>99%

4 First aid measures

4.1 Description of first aid measures:

In all cases of doubt, or when symptoms persist, seek medical attention.

4.1.1 In case of inhalation:

Get medical aid immediately. Remove from exposure to fresh air immediately.

4.1.2 In case of skin contact:

Wash off with soap and water. If skin irritation persists: Get medical advice/attention.

4.1.3 In case of eyes contact:

Rinse cautiously with water for several minutes as a precaution. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

4.1.4 In case of ingestion:

Drink plenty of water. Do not induce vomiting. Consult a physician if necessary.

4.2 Most important symptoms and effects, both acute and delayed

Causes serious eye irritation.

4.3 Indication of any immediate medical attention and special treatment needed

If skin irritation or rash occurs, get medical advice/attention.

5 Fire-Fighting measures

5.1 Extinguishing media:

Suitable extinguishing media: Use Water, water spray, dry powder, foam, carbon dioxide (CO2).

Unsuitable extinguishing media: Not available.

5.2 Special hazards arising from the substance or mixture

Carbon oxides.

5.3 Advice for fire-fighters:

Firefighters must wear fire resistant protective equipment. Wear self contained breathing apparatus and protective gloves.

6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures:

6.1.1 For non-emergency personnel:

Remove all sources of ignition. Ventilate area of leak or spill.

6.1.2 For emergency responders:

Wear appropriate personal protective equipment as specified in section 8.

6.2 Environmental Precautions:

Prevent further leakage or spillage if safe to do so. No special environmental precautions required.

6.3 Methods for Containment and Cleaning up:

Pick up and transfer to properly labelled containers. After cleaning, flush away traces with water.

6.4 Reference to other sections:

See Section 7 for information on safe handling.
See section 8 for information on personal protection equipment.
See Section 13 for information on disposal.

6.5 Additional information:

Hold for waste disposal.
Ventilate area and wash spill site after material pickup is complete.

7 Handling and storage

7.1 Precautions for safe handling:

7.1.1 **Protective measures:**

No technical protective measures are required. Take precautionary measures against static discharges.

7.1.2 **Advice on general occupational hygiene:**

Do not eat, drink and smoke in work areas. Wash hands after use.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/Storage conditions: Keep tightly closed in a dry and cool place.
Incompatible products: Strong oxidizing agents, strong bases.
Packaging material: Polyethylene coated paper bags, Polyvinyl or Polyethylene/propylene big bags

7.3 Specific end use(s):

Not applicable.

8 Exposure control/personal protection

8.1 Control parameters:

8.1.1 Occupational exposure limits: Not listed.

8.1.2 Additional exposure limits under the conditions of use: Not available.

8.1.3 DNEL/DMEL and PNEC-Values: Not available.

8.2 Exposure controls

8.2.1Appropriate engineering controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

8.2.2 Individual protection measures, such as personal protective equipment:

Eye/face protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Hand protection	Wear appropriate protective rubber gloves to prevent skin exposure.

Body protection	Wear protective gloves and clean body-covering clothing.
Respiratory protection	A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.
Thermal hazards	Wear suitable protective clothing to prevent heat.

8.2.3 Environmental exposure controls:

Handling according to local regulations, Federal and official regulations.

9 Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance:	Crystalline
Colour:	White
Odour:	Odorless
Odour threshold:	Not available
pH:	1.8(25°C)
Melting point/range (°C):	426 K at 101 325 Pa
Boiling point/range (°C) :	Not available
Flash point (°C) :	345°C at 101.3 kPa
Evaporation rate:	Not applicable
Flammability (solid, gas);	Not flammable
Ignition temperature (°C) :	Not determined
Upper/lower flammability/explosive limits:	Not determined
Vapour pressure (20°C) :	2.21×10^{-6} Pa at 25°C
Vapour density:	Not applicable
Relative Density (25°C):	1.665 at 20°C.
Bulk density (kg/m^3) :	Not determined
Water solubility (g/l) at 20°C :	592 g/l at 20°C
n-Octanol/Water (log Po/w) :	Not available
Auto-ignition temperature:	Not available
Decomposition temperature:	Not available
Viscosity, dynamic (mPa s) :	Not available
Explosive properties:	Non explosive
Oxidising properties:	No oxidising

9.2. Other information:

Fat solubility(solvent– oil to be specified) etc:	No data available
Bulk density:	No data available
Surface tension:	No data available
Dissociation constant in water(pKa):	No data available
Oxidation-reduction Potential:	No data available

10 Stability and reactivity

10.1 Reactivity:

The substance is stable under normal storage and handling conditions.

11 Toxicological information

11.1 Toxicokinetics, metabolism and distribution

Non-human toxikological data

Citric acid is ubiquitous in the animal kingdom. No study which meets current OECD guidelines is available. However, sufficient information exists on the substance as it is part of the metabolic processed in animals and plants. Therefore pathways for adsorption, distribution and excretion as well as its metabolism are well established, and even essential to all living organisms. The same conclusion may be applied to the citrate salts as discussed at the beginning of chapter 5.

11.2 Information on toxicological effects

Acute toxicity:

LD50(Oral, mouse):	5400 mg/kg bw
LD50(Dermal, rat):	2000mg/kg bw
LC50(Inhalation):	No data available
Skin corrosion/Irritation:	Not irritating
Serious eye damage/irritation:	irritating
Respiratory or skin sensitization:	Not sensitising
Germ cell mutagenicity:	Negative
Carcinogenicity:	Not classified
reproductive toxicity:	Not classified
STOT- single exposure:	Not classified
STOT-repeated exposure:	Not classified
Aspiration hazard:	Not classified

12 Ecological information

Toxicity:

Acute toxicity		*Time*	*Species*	*Method*	*Evaluation*	*Remarks*
LC50	440mg/l	48h	Fish	OECD 203	N/A	N/A
EC50	1535mg/l	24h	Daphnia	OECD 202	N/A	N/A
EC50	425 mg/l	8d	Algae	Not available	N/A	N/A

Persistence and degradability:

Abiotic degradation Citric acid and the metal salts do not possess any functional group that is susceptible to hydrolysis and the substance is expected to be stable in aqueous solution. In addition, the biodegradability of the substance dominates the understanding of stability.

Biotic degradation Available data suggest that citric acid and the metal salts are rapidly degradable in surface water, soils and sediment. Therefore, based on available data, the substances in this category are not expected to present a hazard to the environment.

Bioaccumulative potential: Low potential for bioaccumulation.

Mobility in soil: Not available.

Results of PBT&vPvB assessment: The substance does not meet the criteria for PBT or vPvB.

Other adverse effects: Not applicable.

13 Disposal considerations

13.1 Waste treatment methods

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing use or contamination of this product may change the waste management options. According to local regulations, Federal and official regulations.

13.2 Product / Packaging disposal:

If empty container retains product residues, all label precautions must be observed. Return for reuse or dispose according to national or local regulations. .

14 Transport information

	Land transport (ADR/RID)	*Sea transport (IMDG)*	*Air transport (ICAO/IATA)*
UN-Number:	Not regulated	Not regulated	Not regulated
UN Proper shipping name:	Not regulated	Not regulated	Not regulated
Transport hazard Class:	Not regulated	Not regulated	Not regulated
Packaging group:	Not regulated	Not regulated	Not regulated
Environmental hazards:	Not regulated	Not regulated	Not regulated
Special precautions for user:	See section 2.2	See section 2.2	See section 2.2
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not regulated	Not regulated	Not regulated

15 Regulation information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Relevant information regarding authorization: Not applicable.
Relevant information regarding restriction: Not applicable.
Other EU regulations: Employment restrictions concerning young person must be observed. For use only by technically qualified individuals.
Other National regulations: Not applicable

Chemical Safety Assessment has been carried out?	YES	X		NO		

16 Other information

16.1 Indication of changes Version 1.1 Amended by EU No 453/2010

Version 2.0 Placed exposure scenarios in the Annex (eSDS)

16.2 Relevant R- phrases (number and full text):

R36 Irritating to eyes.

16.3 Training instructions:

Not applicable.

16.4 Further information:

This information is based upon the present state of our knowledge. This SDS has been compiled and is solely intended for this product.

16.5 Notice to reader:

Employers should use this information only as a supplement to other information gathered by them, and should make independent judgment of suitability of this information to ensure proper use and protect the health and safety of employees.

This information is furnished without warranty, and any use of the product not in conformance with this Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

Annex to extended safety data sheet (eSDS)
Exposure scenario

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	1、Production of citric acid
	Processes and activities covered by the exposure scenario	PROC 1, PROC 2, PROC 3, PROC 4, PROC 8b, SU 3,SU 8,
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance:	Solid.
	Concentration of substance in preparation or article	90%
	Other relevant operational conditions of use	No measured data are available for releases of citric acid to air and waste water for the generic production site. Releases are therefore estimated on the basis of other information. Releases to air: Due to the very low vapour pressure of the key intermediates and of citric acid itself, losses to air are considered to be zero. Releases to waste water: The key production stage is the precipitation of calcium citrate. This substance is of low solubility, although a small quantity of citric acid could remain dissolved, a fraction of 0.0001, or 2.86 kg/d over 350 days. There could be losses during handling and packaging processes, but when around 30 tonnes per day are handled these processes are highly automated. It can be anticipated that occasional spillages can occur due to small levels of leakage, amounting to at most 1 kg per day passing to aqueous waste. The total passing to aqueous waste water is 3.86 kg/d.
	Risk management measures:	
2.1	Control of worker exposure	
	Operational conditions related to respiration and skin contact	

Information type	**Data field**	**Explanation**
Respiration volume under conditions of use	10 m^3/d	Default for workers, light activity
Area of skin contact with the substance under conditions of use	240 cm^2 480 cm^2	ECETOC TRA default: PROC 1: palm of one hand PROC 2: palms of both hands

		240 cm^2	PROC 3: palm of one hand	
		480 cm^2	PROC4: palms of both hands	
		480 cm^2	PROC8b: palms of both hands	
	Body weight	70 kg	Default	

Technical fate of substance and losses from process/use to waste, waste water and air	**Information type**	**Data field**	**Explanation**	
	Fraction of applied amount lost from process/use to waste gas	0 kg/kg	See text	
	Fraction of applied amount lost from process/use to waste water	0.0001 kg/kg	See text	

Engineering controls:

Personal protective equipment (PPE)	**Information type**	**Data field**	**Explanation**	
	Containment plus good work practice required	Yes		
	Local exhaust ventilation required plus good work practise	Yes	Typical practice of chemical industry. Not applicable for PROC1.	
	Skin protection	Protective gloves		
	Eye protection	Safety glasses		
	Respiratory protection	Dust mask. In case of open handling of larger quantities or accidental release: particle mask or respirator with independent air supply		
	Clothing	Working clothing worn.		

	Risk management measures related to environmental emissions from industrial sites	**Information type**	**Data field**	**Explanation**	
		Onsite pre-treatment of waste water	Yes	Neutralisation	
		Resulting fraction of initially applied amount in waste water released from site to the external sewage system		On-site biological waste treatment is expected to remove a high proportion of citric acid, as the substance is highly biodegradable.	
		Air emission abatement	No measured data		
		Resulting fraction of applied amount in waste gas released to environment	No measured data		
		Onsite waste treatment	No measured data	Secondary biological treatment	
		Fraction of initially applied amount sent to external waste treatment. This is the sum of direct losses from processes to waste, and the residues from onsite waste water and waste gas treatment.	No measured data		
		Municipal or other type of external waste water treatment	None	None	
		Effluent (of the waste water treatment plant) discharge rate	1×10^7 l/d	Default for a large industrial site	
		Recovery of sludge for agriculture or horticulture	Yes	Dried sludge may be sold as an approved agricultural fertiliser	
	Frequency and duration of use				

		Information type	**Data field**	**Explanation**	
		Used amount of substance per day	30 tonnes		
		Duration of exposure per day at workplace [for one worker]	>4 hours (all PROCs)	REACH default used exposure times	as a w may be s
		Frequency of exposure at workplace [for one worker]	Once per day		
		Annual amount used per site	10,000 tonnes		
	Use per site Duration of emission Waste water flow Dilution factor	Emission days per site	350		
	Information on estimated exposure and Downstream-user guidance				
3	Exposure estimation and reference to its source:				

Dermal exposure estimates (based on ECETOC TRA model)

Process category	**Description**	**LEV present?**	**Predicted exposure (µg/cm^2/day)**	**Exposed skin surface area (cm^2)**	**Dermal exposure (mg/kg/day)[a]**
PROC1	Use in closed process, no likelihood of exposure	Nob	100	240	0.3
PROC2	Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	Yes	20	480	0.14
PROC3	Use in closed batch process (synthesis or formulation)	Yes	10	240	0.03
PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	Yes	100	480	0.69
PROC8b	Transfer from/to large vessels	Yes	100	480	0.69

			(dedicated)				

a) Calculated assuming a default bodyweight of 70 kg for worker.

b) In the ECETOC TRA model, LEV is not considered relevant for PROC1.

Inhalation exposure estimates (based on ECETOC TRA model)

Process category	**Description**	**LEV present?**	**Predicted exposure (ppm)**	**Predicted exposure (mg/m^3)[c]**	**Inhalation exposure (mg/kg/day)[d]**
PROC1	Use in closed process, no likelihood of exposure	No[b]	0.001	0.01	0.001
PROC2	Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	Yes	0.01	0.1	0.01
PROC3	Use in closed batch process (synthesis or formulation)	Yes	0.01	0.1	0.01
PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	Yes	0.31	2.5	0.36
PROC8b	Transfer from/to large vessels(dedicated)	Yes	0.16	1.25	0.18

b) In the ECETOC TRA model, LEV is not considered relevant for PROC1.

c) Results are calculated as mg/m3 for solids and ppm for non-solids

d) Calculated assuming a default bodyweight of 70 kg for workers and a default respiratory volume of 10 m3, light activity, for an 8 hour work shift

	Summary of long-term exposure concentration to workers	**Routes of exposure**	**Concentrations**	**Justification**
		Dermal local exposure (in µg/cm2)	0.6	ECETOC TRA prediction for PROC8b, multiplied by an uptake factor of 0.006.
		Dermal systemic exposure (in mg/kg bw/d)	0.004	ECETOC TRA prediction for PROC8b, multiplied by an uptake factor of 0.006.
		Inhalation exposure (in mg/m3)/8h workday	2.5	ECETOC TRA prediction for PROC8b
		Inhalation exposure (in mg/kg/d)/8h workday	0.36	ECETOC TRA prediction for PROC8b
4	Environmental releases			
	Predicted environmental release	Predicted environmental release estimates have been used for releases during production. No measured data are available for the concentration of citric acid in any environmental compartment. The releases have been estimated using the exposure scenario for production (section 9.1.1.2 and 9.1.1.6) and Predicted Environmental Concentrations have been determined using EUSES 2.1.1. The EUSES program implements the environmental exposure models described in REACH Technical Guidance Chapter R16. Default model parameters have been used unless stated below. The basis of local and regional production tonnages is to consider the sizes of the largest sites in the EU relative to the total tonnage as follows: Production volume in EU: 100 000 tonnes Regional tonnage: 10 000 tonnes Fraction of main local source: 1 Local tonnage: 29 tonnes per day Number of days: 350 The contribution of local releases to the regional concentration has been considered using the appropriate calculation in EUSES 2.1.1.		
	Summary of Predicted Exposure Concentrations		PEC	unit
		AIR		
		Annual average local PEC in air (total)	3.50×10^{-16}	[mg m^{-3}]
		WATER, SEDIMENT		
		Local PEC in surface water during emission episode (dissolved)	0.0153	[mg l^{-1}]
		Annual average local PEC in surface water (dissolved)	0.0153	[mg l^{-1}]
		Local PEC in fresh-water sediment during emission episode	0.261	[mg kg wwt^{-1}]

		Local PEC in seawater during emission episode (dissolved)	1.80×10^{-3}	[mg l^{-1}]
		Annual average local PEC in seawater (dissolved)	1.78×10^{-3}	[mg l^{-1}]
		Local PEC in marine sediment during emission episode	0.0307	[mg kg wwt^{-1}]
		SOIL, GROUNDWATER		
		Local PEC in agric. soil (total) averaged over 30 days	0.0227	[mg kg wwt^{-1}]
		Local PEC in agric. soil (total) averaged over 180 days	7.43×10^{-3}	[mg kg wwt^{-1}]
		Local PEC in grassland (total) averaged over 180 days	2.97×10^{-3}	[mg kg wwt^{-1}]
		Local PEC in pore water of agricultural soil	1.12×10^{-4}	[mg l^{-1}]
		Local PEC in pore water of grassland	4.48×10^{-5}	[mg l^{-1}]
		Local PEC in groundwater under agricultural soil	1.12×10^{-4}	[mg l^{-1}]

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	2、Use of citric acid as a chemical intermediate
	Processes and activities covered by the exposure scenario	SU3 (Industrial uses), SU8, SU9, PROC 1, PROC 2, PROC 3, PROC 4, PROC 8b,
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance:	solid
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	
	Risk management measures:	
2.1	Control of worker exposure	

Containment and local exhaust ventilation

Information type	Data field	Explanation
Containment plus good work practice required	Yes	
Local exhaust ventilation required plus good work practise	Yes	Typical practice of chemical industry. Not applicable for PROC1.

Personal protective equipment (PPE)

Information type	Data field	Explanation
Skin protection	Protective gloves	
Eye protection	Safety glasses	
Respiratory protection	Dust mask. In case of open handling of larger quantities or accidental release: particle mask or respirator with independent air supply	
Clothing	Working clothing worn.	

	Risk management measures related to environmental emissions from industrial sites:	**Information type**	**Data field**	**Explanation**
		Onsite pre-treatment of waste water	Yes	Neutralisation
		Resulting fraction of initially applied amount in waste water released from site to the external sewage system		On-site biological waste treatment is expected to remove a high proportion of citric acid, as the substance is highly biodegradable.
		Air emission abatement	No measured data	
		Resulting fraction of applied amount in waste gas released to environment	No measured data	
		Onsite waste treatment	No measured data	Secondary biological treatment
		Fraction of initially applied amount sent to external waste treatment. This is the sum of direct losses from processes to waste, and the residues from onsite waste water and waste gas treatment.	No measured data	
		Municipal or other type of external waste water treatment	None	None
		Effluent (of the waste water treatment plant) discharge rate	1x 10^7 l/d	Default for a large industrial site
		Recovery of sludge for agriculture or horticulture	Yes	Dried sludge may be sold as an approved agricultural fertiliser
2.2	Control of environmental exposure			
	Frequency and duration of use			
	Duration, frequency and amount	**Information type**	**Data field**	**Explanation**

Used amount of substance per day	10,000 kg/d	Generic information	
Duration of exposure per day at workplace [for one worker]	>4 hours (all PROCs)	REACH default used as a worst case; actually exposure times may be significantly less	
Frequency of exposure at workplace [for one worker]	Once per day	In situations where the duration of exposure is lower, frequency of exposure may be higher	
Annual amount used per site	3,000 tpa	Generic information	
Emission days per site	300 d/y	REACH default number of days for high volumes	

Other operational conditions of use	
Releases to air	Due to the very low vapour pressure of the key intermediates and of citric acid itself, losses to air are considered to be zero.
Releases to water	The REACH ERC 6A (Industrial use of intermediate) release default estimates to waste water is 2%.
Technical conditions and measures at process level (source) to prevent release	No specific measures are considered
Technical onsite conditions and measures to reduce or limit discharges, air emissions	The default TGD (TGD ESD part IV) release rate from processing of synthetic intermediate is 0.7% by weight for a wet process and 0% for a dry (water-free) process. Processing of citric acid is a wet-process. On-site waste water treatment at the plant (e.g. activated carbon, precipitation and so on) is already included in the emission factors. The default loss of 70 kg/d (EU TGD 0.7% default) from the processing of 30 t/d of citric acid is not considered to be realistic. Realistic losses to waste water from the processing of citric acid at a typical industrial site are expected to come from: • Substance washout from ventilation systems • Minor routine spillages • Occasional equipment loss/leakages Given that a solid is precipitated efficiently it is considered that 7 kg/d is a more realistic estimate. Citric acid is highly degradable and on-site waste water treatment is expected to mean that little of the substance is released to the wider environment. It can be assumed that this process will be taking place at a large industrial site with waste water passing to a larger-than-default WWTP with a flow rate of 10,000 m^3/day.

Technical fate of substance and losses from process/use to waste, waste	**Information type**	**Data field**	**Explanation**

	water and air	Fraction of applied amount lost from process/use to waste gas	0 kg/kg	See text	
		Fraction of applied amount lost from process/use to waste water	0.007 kg/kg	See text	

Information on estimated exposure and Downstream-user guidance

3 Exposure estimation and reference to its source:

Dermal

Process category	Description	Dermal exposure?	Predicted exposure (µg/cm^2/day)	Exposed skin surface area (cm^2)	Dermal exposure (mg/kg/day)[a]
PROC1	Use in closed process, no likelihood of exposure	Yes	100	240	0.3
PROC2	Use in closed, continuous process with occasional controlled exposure	Yes	20	480	0.14
PROC3	Use in closed batch process (synthesis or formulation)	Yes	10	240	0.03
PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	Yes	100	480	0.69
PROC8b	Transfer from/to large vessels (dedicated)	Yes	100	480	0.69

a) Calculated assuming a default bodyweight of 70 kg for worker
b) In the ECETOC TRA model, LEV is not considered relevant for PROC1.

Inhalation

Process category	Description	LEV present?	Predicted exposure (ppm)	Predicted exposure (mg/m^3)[c]	Inhalation Exposure (mg/kg/day)[d]
PROC1	Use in closed process, no likelihood of exposure	No[b]	0.001	0.01	0.001
PROC2	Use in closed, continuous process with occasional controlled exposure	Yes	0.01	0.1	0.01
PROC3	Use in closed batch process (synthesis or formulation)	Yes	0.01	0.1	0.01
PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	Yes	0.31	2.5	0.36
PROC8b	Transfer from/to large vessels (dedicated)	Yes	0.16	1.25	0.18

b) In the ECETOC TRA model, LEV is not considered relevant for PROC1.

c) Results are calculated as mg/m^3 for solids and ppm for non-solids

d) Calculated assuming a default bodyweight of 70 kg for workers and a default respiratory volume of 10 m^3, light activity, for an 8 hour work shift

long-term exposure concentration to workers

Routes of exposure	**Concentrations**	**Justification**
Dermal local exposure (in µg/cm2)	0.6	ECETOC TRA prediction for PROC8b, multiplied by an uptake factor of 0.006.
Dermal systemic exposure (in mg/kg bw/d)	0.004	ECETOC TRA prediction for PROC8b, multiplied by an uptake factor of 0.006.
Inhalation exposure (in mg/m3)/8h workday	2.5	ECETOC TRA prediction for PROC8b
Inhalation exposure (in mg/kg/d)/8h workday	0.36	ECETOC TRA prediction for PROC8b

Predicted Environmental Concentrations

	PEC	unit
AIR		
Annual average local PEC in air (total)	5.45×10^{-16}	[mg m^{-3}]
WATER, SEDIMENT		
Local PEC in surface water during emission episode (dissolved)	0.0154	[mg l^{-1}]
Annual average local PEC in surface water (dissolved)	0.0154	[mg l^{-1}]
Local PEC in fresh-water sediment during emission episode	0.263	[mg kg wwt^{-1}]
Local PEC in seawater during emission episode (dissolved)	0.0084	[mg l^{-1}]
Annual average local PEC in seawater (dissolved)	0.00716	[mg l^{-1}]
Local PEC in marine sediment during emission episode	0.144	[mg kg wwt^{-1}]
SOIL, GROUNDWATER		
Local PEC in agric. soil (total) averaged over 30 days	0.0411	[mg kg wwt^{-1}]
Local PEC in agric. soil (total) averaged over 180 days	0.0135	[mg kg wwt^{-1}]
Local PEC in grassland (total) averaged over 180 days	0.00539	[mg kg wwt^{-1}]
Local PEC in pore water of agricultural soil	0.000203	[mg l^{-1}]
Local PEC in pore water of grassland	0.0000813	[mg l^{-1}]
Local PEC in groundwater under agricultural soil	0.000203	[mg l^{-1}]

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	3、Formulation of citric acid into preparations
	Processes and activities covered by the exposure scenario	SU3, 10, SU5, SU13, 20 PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC9, PROC13, PROC14, PROC15, PROC19
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance:	solid
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	The citrates used in the formulation of products are generally solids which may be mixed with other solids or dissolved in aqueous solution. There is some potential for airborne release of citric acid (or citrate) particulates on charging (transfer, dosing) to the process equipment used, especially if containment is not good. However, the most likely release will be to waste water via clean out or spillage. Taking the HERA figure of approx. 100 000 tpa [HERA, 2005] for total use of citrates in detergents, and realistic values of 10% formulated in a single region, and 60% of that at a single location, gives a volume of 6,000 tpa citrates formulated at a single location. For this generic site, the daily loss rate to waste water is 6000 t x 1000 kg/t x 0.0009 / 300 d = 18 kg/d. The tonnage to be covered is now 150 000 tpa, but the site size is retained. The loss rate is considered to be a reasonable worst case for a large site. At smaller formulation sites the amount handled per day would be lower and the controls could be less, but overall rates per day would be similar.
	Risk management measures:	
2.1	Control of worker exposure	
	Containment and local exhaust ventilation	

Information type	Data field	Explanation
Containment plus good work practice required	Yes	General good hygiene and housekeeping
Local exhaust ventilation required plus good work practice.	Yes	Typical practice of chemical industry.

Personal protective equipment (PPE)

Information type	Data field	Explanation
Skin protection	Protective gloves	
Eye protection	Safety glasses	
Clothing	Working clothing worn.	

Risk management measures related to environmental emissions from industrial sites:

Information type	Data field	Explanation
Onsite pre-treatment of waste water	Yes	Removal of solids in settling tanks
Resulting fraction of initially applied amount	No measured data	

		in waste water released from site to the external sewage system		
		Air emission abatement	No measured data	
		Resulting fraction of applied amount in waste gas released to environment	No measured data	See text
		Onsite waste treatment	No	Worst-case assumption as no specific information available.
		Fraction of initially applied amount sent to external waste treatment. This is the sum of direct losses from processes to waste, and the residues from onsite waste water and waste gas treatment.	No measured data	
		Municipal or other type of external waste water treatment	Yes	Typical practise in the chemical industry
		Effluent (of the waste water treatment plant) discharge rate	$1 * 10^7$ L/d	Default for a large industrial site.
		Recovery of sludge for agriculture or horticulture	Yes	Worst-case assumption as no specific information available.
2.2	Control of environmental exposure			
	Frequency and duration of use			
	Duration, frequency and amount	Information type	Data field	Explanation
		Used amount of substance per day	6000 tonnes	
		Duration of exposure per day at workplace [for one worker]	>4 hours (all PROCs)	For some applications/setting exposure times may be significantly less
		Frequency of exposure at workplace [for one worker]	Once per day	For some applications/settings with shorter duration exposures, multiple exposures may occur in

				a single day	
		Annual amount used per site	20 tonnes		
		Emission days per site	300 days		

	Information on estimated exposure and Downstream-user guidance
3	Exposure estimation and reference to its source:
	Occupational exposure:

Dermal

Process category	Description	Dermal exposure?	Predicted exposure (µg/cm^2/day)	Exposed skin surface area (cm^2)	Dermal exposure (mg/kg/day)[a]
PROC1	Use in closed process, no likelihood of exposure	Yes	100	240	0.3
PROC2	Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	Yes	20	480	0.14
PROC3	Use in closed batch process (synthesis or formulation)	Yes	10	240	0.034
PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	Yes	100	480	0.69
PROC5	Mixing or blending in batch processes (multistage and/or significant contact)	Yes	200	480	1.37
PROC7	Industrial spraying	Yes	200	1500	4.29
PROC8a	Transfer from/to large vessels (non-dedicated).	Yes	100	960	1.37
PROC8b	Transfer from/to large vessels (dedicated)	Yes	100	480	0.69
PROC9	Transfer to small containers	Yes	100	480	0.69
PROC13	Treatment of articles by dipping and pouring	Yes	100	480	0.69

	PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation	Yes	50	480	0.34	
	PROC15	Use of laboratory reagents in small scale laboratories	Yes	10	240	0.034	
	PROC19	Hand-mixing with intimate contact (only PPE available	Yes	500	1980	14.1	

Inhalation	Process category	Description	LEV present ?	Predicted exposure (ppm)	Predicted exposure (mg/m^3)[c]	Inhalation Exposure (mg/kg/day)[d]
	PROC1	Use in closed process, no likelihood of exposure	No[b]	0.0013	0.01	0.0014
	PROC2	Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	Yes	0.0125	0.1	0.014
	PROC3	Use in closed batch process (synthesis or formulation)	Yes	0.0125	0.1	0.014
	PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	Yes	0.31	2.5	0.36
	PROC5	Mixing or blending in batch processes (multistage and/or significant contact)	Yes	0.31	2.5	0.36
	PROC7	Industrial spraying	Yes	1.25	10	1.43
	PROC8a	Transfer from/to large vessels (non-dedicated)	Yes	0.63	5	0.71
	PROC8b	Transfer from/to large vessels (dedicated)	Yes	0.31	2.5	0.36
	PROC9	Transfer to small	Yes	0.25	2	0.29

		containers				
	PROC13	Treatment of articles by dipping and pouring	Yes	0.0013	0.01	0.0014
	PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation	Yes	0.13	1	0.14
	PROC15	Use of laboratory reagents in small scale laboratories	Yes	0.063	0.5	0.071
	PROC19	Hand-mixing with intimate contact (only PPE available	Yes	0.0063	0.05	0.0071

b) Results are calculated as mg/m3 for solids and ppm for non-solids
c) Calculated assuming a default bodyweight of 70 kg for workers and a default respiratory volume of 10 m3, light activity, for an 8 hour work shift

long-term exposure concentration to workers

Routes of exposure	Concentration	Justification
Dermal local exposure (in µg/cm2)	3	ECETOC TRA prediction for PROC19, multiplied by an uptake factor of 0.006.
Dermal systemic exposure (in mg/kg bw/d)	0.08	ECETOC TRA prediction for PROC19, multiplied by an uptake factor of 0.006.
Inhalation exposure (in mg/m3)/8h workday	10	ECETOC TRA prediction for PROC7
Inhalation exposure (in mg/kg/d)/8h workday	1.43	ECETOC TRA prediction for PROC7

Predicted Exposure Concentrations (PEC3

	PEC	**unit**
AIR		
Annual average local PEC in air (total)	1.4×10^{-15}	[$mg.m^{-3}$]
WATER, SEDIMENT		
Local PEC in surface water during emission episode (dissolved)	0.0158	[$mg\ l^{-1}$]
Annual average local PEC in surface water (dissolved)	0.0157	[$mg\ l^{-1}$]
Local PEC in fresh-water sediment during emission episode	0.27	[$mg\ kg\ wwt^{-1}$]

		Local PEC in seawater during emission episode (dissolved)	0.0194	[mg l^{-1}]
		Annual average local PEC in seawater (dissolved)	0.0162	[mg l^{-1}]
		Local PEC in marine sediment during emission episode	0.331	[mg kg wwt^{-1}]
		SOIL, GROUNDWATER		
		Local PEC in agric. soil (total) averaged over 30 days	0.106	[mg kg wwt^{-1}]
		Local PEC in agric. soil (total) averaged over 180 days	0.347	[mg kg wwt^{-1}]
		Local PEC in grassland (total) averaged over 180 days	0.0139	[mg kg wwt^{-1}]
		Local PEC in pore water of agricultural soil	5.23×10^{-4}	[mg l^{-1}]
		Local PEC in pore water of grassland	2.09×10^{-4}	[mg l^{-1}]
		Local PEC in groundwater under agricultural soil	5.23×10^{-4}	[mg l^{-1}]

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	4、Personal care use
	Processes and activities covered by the exposure scenario	SU20,SU21,SU22, PROC 10, PROC 11, PROC 19
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	solid
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	The EU TGD A-Table A4.1 gives the releases of cosmetics to air and wastewater as 0 and 100% respectively. This seems reasonable, given that citrates are non-volatile and highly water soluble. It is also in agreement with Colipa's assessment of the fate of non-volatile components of cosmetics (Colipa 2008). The TGD defaults and REACH environmental release category (ERC8a) assume that if a substance is used widely across the EU, the fraction of the production volume used in the standard EU Region is 10%. For cosmetics, the fraction of the main local source (fmainsource) is 0.0005 (HERA, 2005, page 27). This is equivalent to saying that use in a region is evenly distributed. The number of days of use is 365 per year. Therefore, for 7500 tpa of citric acid in personal care products used widely across the EU, the estimated release of citric acid to a particular default-sized local waste water treatment plant is at most: 7 500 000 kg/y x 0.1 x 0.0005 / 365 d/y = 1.03 kg/d
	Risk management measures:	
2.1	Control of worker exposure	
	Technical conditions and measures at process level (source) to prevent release	No risk management measures are possible for personal care use in respect of the environment.
	Technical conditions and measures to control dispersion from source towards the worker	No risk management measures are possible for personal care use in respect of the environment.
	Engineering controls:	No risk management measures are possible for personal care use in respect of the environment.
	Organisational measures to prevent/limit releases, dispersion and exposure	No risk management measures are possible for personal care use in respect of the environment.
	Conditions and measures related to personal protection, hygiene and health evaluation	No risk management measures are possible for personal care use in respect of the environment.
	Information on estimated exposure and Downstream-user guidance	
3	Environmental releases	Predicted Environmental Concentrations have been determined using EUSES 2.1.1. The EUSES program implements the environmental exposure models described in REACH Technical Guidance Chapter R16. Default model parameters

have been used with the following exceptions:
The basis of local and regional production tonnages is to consider the sizes of the largest sites in the EU relative to the total tonnage as follows:
Production volume in EU: 7,500,000 tonnes

Regional tonnage: 750,000 tonnes

Fraction of main local source: 0.0005

Local tonnage: 1.03 tonnes per day

Number of days: 365

The contribution of local releases to the regional concentration has been considered using the appropriate calculation in EUSES 2.1.1. Table 9.33 shows the Predicted Environmental Concentrations. Due to the ready-biodegradability of citric acid it has not been considered necessary to define a PEC. The low log Kow and ready biodegradability indicate that bioaccumulation is not a concern for citric acid. Therefore, the assessment of secondary poisoning is not considered further.

Summary of Predicted Exposure Concentrations

	PEC	unit
AIR		
Annual average local PEC in air (total)	5.45×10^{-16}	$[mg.m^{-3}]$
WATER, SEDIMENT		
Local PEC in surface water during emission episode (dissolved)	1.59×10^{-2}	$[mg\ l^{-1}]$
Annual average local PEC in surface water (dissolved)	1.59×10^{-2}	$[mg\ l^{-1}]$
Local PEC in fresh-water sediment during emission episode	2.71×10^{-1}	$[mg\ kg\ wwt^{-1}]$
Local PEC in seawater during emission episode (dissolved)	1.48×10^{-3}	$[mg\ l^{-1}]$
Annual average local PEC in seawater (dissolved)	1.48×10^{-3}	$[mg\ l^{-1}]$
Local PEC in marine sediment during emission episode	2.53×10^{-2}	$[mg\ kg\ wwt^{-1}]$
SOIL, GROUNDWATER		
Local PEC in agric. soil (total) averaged over 30 days	3.02×10^{-2}	$[mg\ kg\ wwt^{-1}]$
Local PEC in agric. soil (total) averaged over	9.89×10^{-3}	$[mg\ kg\ wwt^{-1}]$

		180 days		
		Local PEC in grassland (total) averaged over 180 days	3.95×10^{-3}	[mg kg wwt^{-1}]
		Local PEC in pore water of agricultural soil	1.49×10^{-4}	[mg l^{-1}]
		Local PEC in pore water of grassland	5.97×10^{-5}	[mg l^{-1}]
		Local PEC in groundwater under agricultural soil	1.49×10^{-4}	[mg l^{-1}]
	Other environmental releases	The EUSES model uses the Simple Treat sewage treatment model to predict the fate of a substance in the STP, based on the physicochemical and biodegradation properties. For citric acid, SimpleTreat predicts the following: 12.6 % to water: 0.112 % to air: 0.0154 % to sludge: 87.3 % degraded. Sludge from WWTPs may be spread on agricultural soil. The dilution factor of 900 and 1000 (in the receiving water) have been applied for fresh water and marine water respectively, as there is no information on specific hydrodynamic conditions. There is no direct release to the terrestrial compartment on a local scale as biosludge from on-site waste water treatment is disposed of via incineration or landfill. However, due to use of municipal WWTP by some EU production sites, spreading of sludge on agricultural soil is included as a reasonable worst case.		

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	5、Use of citric acid in cleaning products
	Processes and activities covered by the exposure scenario	SU3, SU21, SU22, PROC1, PROC 2, PROC 4, PROC 5, PROC 7, PROC 8a, PROC 8b, PROC 9, PROC 10, PROC 11, PROC 13, PROC 19
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	May be liquid or solid.
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	No measured data are available for releases to air and waste water during the use of citric acid in cleaning products. Releases are therefore estimated on the basis of information in the public domain. Citric acid and citrates are used in a variety of cleaning products but generally in aqueous solution. The most likely release route will, therefore, be to waste water via rinsing to drain in-use, spillage, clean out or discharge of cleaning baths or liquors. Indeed, releases to waste water can be assumed to be 100%, since all the citric acid/citrate will eventually be washed to drain. This may be an overestimate since it does not allow for any of the substance to be either released to air (extremely unlikely) during the process or to adsorb to a surface on drying or to a cleaning implement (e.g., cloth) which may be landfilled. The release of citrates from use in cleaning products in industrial, professional and consumer use can be estimated. The TGD defaults and REACH environmental release category (ERC8a) assume that if a substance is used widely across the EU, the fraction of the production volume used in the standard EU Region is 10%. For cleaning products, the fraction of the regional tonnage discharging to a particular waste water treatment plant can be estimated as 0.0005 (HERA, 2005). The number of days of use is 365 per year. Therefore, for 100,000 tpa of citric acid in cleaning products used widely across the EU, the estimated release of citrates to a particular default-sized local waste water treatment plant is at most: 100,000,000 kg/y x 0.1 x 0.0005 / 365 d/y = 13.7 kg/d = (Amount of citrates used in cleaning products per year x fraction to water x fraction in the region x fraction of main local source) / number of days per year The research carried out by the HERA project was thorough and accepted by the EU authorities as valid.
	Risk management measures:	
2.1	Control of worker exposure	
	Containment and local exhaust ventilation	

Information type	Data field	Explanation
Containment plus good work practice required	Yes	General good hygiene and housekeeping
Local exhaust ventilation required plus good work practise	No	

	Personal protective equipment (PPE)	

Information type	Data field	Explanation
Skin protection	Protective gloves	
Eye protection	Safety glasses	
Clothing	Working clothing worn.	

Other risk management measures related to workers	N/A

Risk management measures related to environmental emissions from industrial sites

Information type	Data field	Explanation
Onsite pre-treatment of waste water	Yes	Neutralisation
Resulting fraction of initially applied amount in waste water released from site to the external sewage system		On-site biological waste treatment is expected to remove a high proportion of citric acid, as the substance is highly biodegradable.
Air emission abatement	No measured data	
Resulting fraction of applied amount in waste gas released to environment	No measured data	
Onsite waste treatment	No measured data	Secondary biological treatment
Fraction of initially applied amount sent to external waste treatment. This is the sum of direct losses from processes to waste, and the residues from onsite waste water and waste gas treatment.	No measured data	
Municipal or other type of external waste water treatment	None	None
Effluent (of the waste water treatment plant) discharge rate	2000000 l/d	Default for a standard WWTP
Recovery of sludge for agriculture or horticulture	Yes	Dried sludge may be sold as an approved agricultural fertiliser
Onsite pre-treatment of waste water	Yes	Neutralisation

2.2	Control of environmental exposure

<table>
<tr><td></td><td colspan="2">Frequency and duration of use</td></tr>
<tr><td></td><td>Duration, frequency and amount</td><td>
<table>
<tr><th>Information type</th><th>Data field</th><th>Explanation</th></tr>
<tr><td>Used amount of substance per day</td><td>200,000 kg/d</td><td>Generic information</td></tr>
<tr><td>Duration of exposure per day at workplace [for one worker]</td><td>>4 hours (all PROCs)</td><td>For some applications/setting exposure times may be significantly less</td></tr>
<tr><td>Frequency of exposure at workplace [for one worker]</td><td>Once per day</td><td>For some applications/settings with shorter duration exposures, multiple exposures may occur in a single day</td></tr>
<tr><td>Annual amount used per site</td><td>10 kg/d</td><td>0.00005 (10% in region, plus 0.0005 fraction of main local source from HERA)</td></tr>
<tr><td>Emission days per site</td><td>365 d/y</td><td>Default for ERC8</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="2">Information on estimated exposure and Downstream-user guidance</td></tr>
<tr><td>3</td><td colspan="2">Exposure estimation and reference to its source:</td></tr>
</table>

Dermal exposure estimates (based on ECETOC TRA model) for cleaning and maintenance

Process category	Description	Predicted exposure (µg/cm^2/day)	Exposed skin surface area (cm^2)	Dermal exposure (mg/kg/day)[a]
PROC8a	Transfer from/to large vessels (non-dedicated)	1000	960	13.7
PROC8b	Transfer from/to large vessels(dedicated)	1000	480	6.9
PROC9	Transfer to small containers	1000	480	6.9
PROC7	Industrial spraying	100	1500	2.14
PROC10	Roller application or brushing	2000	960	27.4
PROC13	Dipping or pouring	2000	480	13.7

(a) Calculated assuming a default bodyweight of 70 kg for workers

Inhalation exposure estimates (based on ECETOC TRA model) for cleaning and maintenance products

Process category	Description	Predicted exposure (µg/cm^2/day)	Exposed skin surface area (cm^2)	Dermal exposure (mg/kg/day)[a]
PROC8a	Transfer from/to large vessels (non-dedicated)	0.063	0.5	0.07
PROC8b	Transfer from/to large vessels (dedicated)	0.012	0.1	0.014
PROC9	Transfer to small containers	0.012	0.1	0.01
PROC7	Spraying in industrial settings and applications	0.63	5	0.71
PROC10	Roller application or brushing	0.063	0.5	0.07
PROC13	Dipping or pouring	0.012	0.1	0.014

Summary of long-term exposure concentration to workers

Routes of exposure	Concentrations	Justification
Dermal local exposure (in µg/cm2)	12	ECETOC TRA prediction for PROC10; multiplied by a dermal uptake factor of 0.006.
Dermal systemic exposure (in mg/kg bw/d)	0.16	ECETOC TRA prediction for PROC10; multiplied by a dermal uptake factor of 0.006.
Inhalation exposure (in mg/m3)/8h workday	5	ECETOC TRA prediction for PROC7
Inhalation exposure (in mg/kg/d)/8h workday	0.71	ECETOC TRA prediction for PROC7

4 Operational conditions related to available dilution capacity and characteristics of exposed humans

Occupational exposure Operational conditions related to respiration and skin contact

Information type	Data field	Explanation
Respiration volume under conditions of use	10 m^3/d	Default for workers, light activity

		Area of skin contact with the substance under conditions of use	480 cm^2 1500 cm^2 960 cm^2 480 cm^2 480 cm^2 960 cm^2 1500 cm^2 480 cm^2 1980 cm^2	ECETOC TRA default: PROC5: PROC7: PROC8a: PROC8b: PROC9 PROC10 PROC11 PROC13 PROC19
		Body weight	70 kg	Default for workers
	Operational conditions related to respiration, skin contact and ingestion for the general public	Information type	Data field	Explanation
		Skin contact area	960 cm2	ConsExpo default
		Mouth contact area	-	Not applicable – no oral exposure
		Respiration volume under conditions of use	26 m3	Default: Light activity 26 m3/24 h
		Room size and ventilation rate	20m3 ; exchange per hour 0.6 h-1	ConsExpo defaults
		Body weight	65 kg	Default adult bodyweight
	Predicted Exposure Concentrations of Environmental releases		PEC	unit
		AIR		
		Annual average local PEC in air (total)	1.30×10^{-15}	$[mg.m^{-3}]$
		WATER, SEDIMENT		
		Local PEC in surface water during emission episode (dissolved)	2.48×10^{-2}	$[mg\ l^{-1}]$
		Annual average local PEC in surface water (dissolved)	2.48×10^{-2}	$[mg\ l^{-1}]$
		Local PEC in fresh-water sediment during emission episode	4.23×10^{-1}	$[mg\ kg\ wwt^{-1}]$
		Local PEC in seawater during emission episode (dissolved)	2.37×10^{-3}	$[mg\ l^{-1}]$
		Annual average local PEC in seawater (dissolved)	2.37×10^{-3}	$[mg\ l^{-1}]$
		Local PEC in marine sediment during	4.05×10^{-2}	$[mg\ kg\ wwt^{-1}]$

		emission episode		
		SOIL, GROUNDWATER		
		Local PEC in agric. soil (total) averaged over 30 days	4.02×10^{-1}	[mg kg wwt^{-1}]
		Local PEC in agric. soil (total) averaged over 180 days	1.32×10^{-1}	[mg kg wwt^{-1}]
		Local PEC in grassland (total) averaged over 180 days	5.27×10^{-2}	[mg kg wwt^{-1}]
		Local PEC in pore water of agricultural soil	1.99×10^{-3}	[mg l^{-1}]
		Local PEC in pore water of grassland	7.95×10^{-4}	[mg l^{-1}]
		Local PEC in groundwater under agricultural soil	1.99×10^{-3}	[mg l^{-1}]

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	6、 Use in paper
	Processes and activities covered by the exposure scenario	SU3, SU6 PROC 5, PROC 8a
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	solid
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	N/A
	Risk management measures:	
2.1	Control of worker exposure	Following the REACH descriptor system, the following product type is covered by this generic scenario: Paper and board dye, finishing and impregnation products: including bleaches and other processing aids (PC26).
	Technical conditions and measures at process level (source) to prevent release	N/A
	Technical conditions and measures to control dispersion from source towards the worker	N/A
	Engineering controls:	N/A
	Organisational measures to prevent/limit releases, dispersion and exposure	N/A
	Conditions and measures related to personal protection, hygiene and health evaluation	N/A
2.2	Control of environmental exposure	
	Frequency and duration of use	
	Waste water flow Dilution factor	N/A
	Emission factor to waste water Release fraction	N/A
	Conditions and measures related to external recovery of waste	N/A

	Information on estimated exposure and Downstream-user guidance	
3	Exposure estimation and reference to its source:	
		N/A
4	Guidance to DU to evaluate whether he works inside the boundaries set by the ES	
	Occupational exposure	N/A
	Environmental emissions	Citric acid is used in the cleaning of papermaking machines and to prevent build up of deposits. It is added to the pulp slurry prior to bleaching to control paper staining by sequestering metal ions. Cleaning applications are covered under another exposure scenario; this document covers use of citrate as a processing aid in the paper-making industry. This generic scenario makes use of the following documents: OECD Emission Scenario Documents on Kraft, Non-Integrated and Recovered Pulp Mills. This covers the use of citrate as a process aid in the paper-making industry. It is possible that a small amount of citrate is incorporated into the finished paper products. However, it is considered that the amount of citrate that ends up in articles and could be released (resulting in consumer exposure) is likely to be negligible. The amount of citric acid believed to be used in this application is at most 1000 tpa. The industrial use per site is unknown. However, a default approach would be to consider 10 paper mills in a single region, operating over 300 days per year. The substance is not mixed into pulp, but is applied to machinery. A loss of 2% is a realistic maximum. This gives a daily release of 100 t x 1000 kg/t x 0.02 / 300 d = 6.7 kg/d For the environment, the amounts passing to waste are very likely to be less than those from the ES 1-5. Therefore there is no need to complete an exposure assessment at a local scale with full details of PEC values etc. However, a regional release of 67 kg/d to waste water will be added to the model. For human health worker exposure at paper mills will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	7、Use in construction
	Processes and activities covered by the exposure scenario	SU3, SU21, SU22, SU2, SU10, SU19, PROC 2, PROC 4, PROC 5, PROC 7, PROC 8a, PROC 8b, PROC 10, PROC 11. PROC 13, PROC 14, PROC 19, PROC 21, PROC 24
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	solid
	Concentration of substance in preparation or article	N/A
	Other relevant operational conditions of use	N/A
	Risk management measures:	
2.1	Control of worker exposure	Following the REACH descriptor system, the following product types are covered by this generic scenario: PC10 (Building and construction preparations not covered elsewhere). The following substances are used in construction materials: citric acid and trisodium citrate. Citrates can be used to retard the setting rate of cement and reduce the amount of water needed. They may therefore be added to concrete, mortar, plaster and render formulations. The concentration in these products is generally low (<1%).
	Technical conditions and measures at process level (source) to prevent release	N/A
	Conditions and measures related to personal protection, hygiene and health evaluation	N/A
2.2	Control of environmental exposure	
	Frequency and duration of use	
	Use per site Duration of emission Waste water flow Dilution factor	N/A
	Emission factor to waste water Release fraction	N/A
	Environment factors not influenced by	N/A

	risk management	
	Other given operational conditions affecting environmental exposure	
	Technical conditions and measures at process level (source) to prevent release	No specific measures are considered.
	Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	N/A
	Organizational measures to prevent/limit release from site	N/A
	Conditions and measures related to municipal sewage treatment plant	N/A
	Conditions and measures related to external treatment of waste for disposal	N/A
	Conditions and measures related to external recovery of waste	none
	Information on estimated exposure and Downstream-user guidance	
3	Exposure estimation and reference to its source:	
	Occupational exposure: Dermal Inhalation	N/A
4	Guidance to DU to evaluate whether he works inside the boundaries set by the ES	
	Occupational exposure	N/A
	Environmental emissions	This document provides an environmental generic exposure scenario for substances used in construction materials. This generic scenario makes use of the following documents: EU Technical Guidance Document (TGD) emission scenario document. REACH Technical Guidance. The amount of citric acid believed to be used in this application is at most 1500 tpa. The industrial use per site is unknown, but should be considered as a widely dispersed use. In the worst case a release of the entire tonnage to the region could be included, i.e. 1500 tpa. Of this, part will be released to industrial soil (90%) and part to waste water (10%). A regional release of 150 x 1000/365 = 411 kg/d to waste water will be added to the model, and 3699 kg/d to industrial soil will be included. For human health worker exposure at construction sites will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	8、Use in polymers and plastics
	Processes and activities covered by the exposure scenario	SU3,SU11,SU12, PROC 3, PROC 5, PROC 8a, PROC 8b
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Physical form of substance: under conditions of use it is used as a liquid.	solid
	Concentration of substance in preparation or article	N/A
	Other relevant operational conditions of use	Please also note that under acidic conditions (pH<7), sulfur dioxide can be formed. Please ensure compliance with the existing occupational exposure limit as recommended by SCOEL (2008) for sulfur dioxide of 0.5 ppm (TWA, 8h) respectively 1 ppm (STEL, 15 min). Polyolefin foams are used for a variety of applications such as automotive, construction, food packaging, sport and leisure, and many other industrial and consumer uses. They usually have a high strength to weight ratio and are manufactured in a variety of processes and in low density (25 - 250 kg/m3) or high density (250 - 700 kg/m3) versions, or even in densities as low as 16 kg/m3 for polystyrene. All current extrusion processes involve the following steps: melting, mixing with blowing agents, cooling of melt, expansion and degassing/aging. The steps in this process can be realized in different configurations of equipment, e.g., with long single-screw extruders, twin-screw extruders, or tandem extruder lines. Both citric acid (or citrate salt) and (bi)carbonate may be surface-treated with, for example, a fatty acid ester to make them compatible with the polyolefin. A concentrated master batch of the formulated foaming agent in polymer at loading levels of from about 5% to about 50% actives may then be prepared. The master batch is added to the polymer melt which is to be foamed such that the blowing agents are at 0.1 to 2.0% active levels in the final formulation [US 5,302,455 and refs. therein]. By-products of this reaction are mono-, di-, and/or trisodium citrate, in combination with other sodium salts, which will still be present within the foamed polymer. These residues are typically present at around 50 wt.% of the initial foaming agent formulation, which is equivalent to <1 wt.% of the total foamed polymer in most cases [RAPRA, 2004].
	Risk management measures:	
2.1	Control of worker exposure	
	Technical conditions and measures at process level (source) to prevent release	N/A
	Technical conditions and measures to control dispersion from source towards the worker	N/A
	Engineering controls:	
	Organisational measures to prevent/limit releases, dispersion and	N/A

	exposure	
	Conditions and measures related to personal protection, hygiene and health evaluation	
2.2	Control of environmental exposure	
	Use per site Duration of emission Waste water flow Dilution factor	N/A
	Release of citric acid	Losses from conversion, service life and disposal for chemical blowing agents are considered to be zero as the additive is destroyed during the conversion process. Thus, for 200 tpa of citrates used in plastics applications, assumed to be used at 10 sites across Europe, the local losses to water air and solid waste are: The REACH defaults for ERC6d are for the production on 300 days per year if the tonnage of the product is >5000 tpa [ECHA, 2009]. Citrate is present at <1% in plastics applications (see Section 2.1.1), therefore, the total production volume is approx. 100,000 tpa. Therefore, the maximum daily releases are as follows: Water: 20 t x 1000 kg/t x (0.0065) / 300 = 0.43 kg/d Air: 0 For the environment, the amounts passing to waste are very likely to be less than those from the ES 1-5. Therefore there is no need to complete an exposure assessment at a local scale with full details of PEC values etc. However, a regional release of 0.35 kg/d to waste water will be added to the model, and similarly 3.18 kg/d to the continental scale.
	Environment factors not influenced by risk management	N/A
	Other given operational conditions affecting environmental exposure	N/A
	Technical conditions and measures at process level (source) to prevent release	N/A
	Conditions and measures related to external recovery of waste	none
	Information on estimated exposure and Downstream-user guidance	
3	Exposure estimation and reference to its source:	
	Occupational exposure: Dermal Inhalation	Not relevant
4	Guidance to DU to evaluate whether he works inside the boundaries set by the ES	
	Occupational exposure	For human health worker exposure at construction sites will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.

	Environmental emissions	N/A

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	9、Use in the oil industry
	Processes and activities covered by the exposure scenario	SU3，SU2 PROC 3, PROC 4, PROC 5,
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Physical form of substance: under conditions of use it is used as a liquid.	solid
	Concentration of substance in preparation or article	20-50%
	Other relevant operational conditions of use	In the oil industry, citric acid is often used for oil-well acidizing to prevent the hydroxide [APAC]. Oil well acidizing is the term used for the application of ho 9 149°C) to remove tough wellbore scale [McGraw-Hill]. Oxidation reactions, which occur in wells injected with HCl, cause formation of inso The pumping operations are thus interrupted by these gels, and hence, citric acid preventing gel formation [APAC]. Oil producing well formations can become plugged with acid soluble minerals an production [Gewanter, Herman L. et al]. Production can be increased by forcing dissolve the minerals [Gewanter, Herman L. et al]. The acids readily dissolve the ir from the well casing and the formation [Gewanter, Herman L. et al]. However, wate acid in the formation, which allows for the re-precipitation of the iron to ferric hydro Herman L. et al]. Certain chemicals must be added at this point to maintain it in a s et al].
	Risk management measures:	
2.1	Control of consumers exposure	Not relevant
	Human factors not influenced by risk management	Not relevant
	Other given operational conditions affecting consumers exposure	Not relevant
	Conditions and measures related to information and behavioural advice to consumers	Not relevant
	Conditions and measures related to personal protection, hygiene and health evaluation	Not relevant
2.2	Control of environmental exposure	
	Frequency and duration of use	
	waste water Release	Control of the re-precipitation of iron and the pH, as the acid is spent, can be achieved by the sequestration by organic chelants and the reduction to soluble ferrous iron [Gewanter, Herman L. et al]. Citric acid is a useful organic chelant and is used for this purpose [Gewanter, Herman L. et al]. Other chelants may include gluconic acid, the tetrasodium salt of ethylenediaminetetraacetic acid (EDTA), and the trisodium salt of nitrilotriacetic acid (NTA) [Gewanter, Herman L. et al]. This is a widely dispersed use but in the worst case it can be envisaged that the

		entire tonnage could pass to surface marine water. This equates to 100 t x 1000 kg/t /365 = 274 kg/d to the regional surface water 900 t x 1000 kg/t /365 = 2740 kg/d to the continental surface water
	Environment factors not influenced by risk management	None
	Conditions and measures related to external treatment of waste for disposal	None
	Conditions and measures related to external recovery of waste	none
	Information on estimated exposure and Downstream-user guidance	
3	Exposure estimation and reference to its source:	
	Human exposure:	For human health worker exposure at oil production sites will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.
4	Guidance to DU to evaluate whether he works inside the boundaries set by the ES	
	Consumer exposure	N/A
	Environmental emissions	N/A

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	10、Use in textiles
	Processes and activities covered by the exposure scenario	SU3,SU5 PROC8a,PROC8b, PROC10, PROC13, PROC22
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	No measured data are available for releases of citric acid to air and waste water from textile production sites. Releases are therefore estimated on the basis of information in the public domain. Potential exposure to humans and especially the environment is dependent on the intended function of the substance, as well as the substrates and processes used. Functional finishing agents and other chemically reactive substances are intended to be consumed during use, therefore the amount released is related to efficiency of the process. On the other hand, non-reacting substances (e.g. processing aids) are not consumed and will ultimately be lost to air or waste water, depending on their function and physicochemical properties. In virtually all cases, it is expected that citric acid or citrate salts, as process aids, will be lost to waste water. The annual tonnage of 300 t is considered to be used at 40% in the region. The largest site is estimated to use around 6 tpa. If all passed to waste water this is: 6 t x 1000 kg/t / 300 = 20 kg/d.
	Risk management measures:	
2.1	Control of worker exposure	For human health worker exposure at textile production sites will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.
	Risk management measures for industrial site	

Information type	Data field	Explanation
Onsite pre-treatment of waste water	Yes	Neutralisation
Resulting fraction of initially applied amount in waste water released from site to the external sewage system		On-site biological waste treatment (where present) is expected to remove a high proportion of citric acid, as the substance is highly biodegradable. However, on-site biological waste treatment is not assumed as it is not known that this is always present.

		Air emission abatement	No measured data	
		Resulting fraction of applied amount in waste gas released to environment	No waste gases	
		Onsite waste treatment	No measured data	Secondary biological treatment may be present but this is not assumed in the scenario
		Fraction of initially applied amount sent to external waste treatment. This is the sum of direct losses from processes to waste, and the residues from onsite waste water and waste gas treatment.	No measured data	
		Municipal or other type of external waste water treatment	None	None
		Effluent (of the waste water treatment plant) discharge rate	2000000 l/d	Default for a standard WWTP
		Recovery of sludge for agriculture or horticulture	Yes	
	Personal protective equipment (PPE)	N/A		
	Other risk management measures related to workers	N/A		
2.2	Control of environmental exposure			
	Frequency and duration of use			
	Duration, frequency and amount			
	Information on estimated exposure and Downstream-user guidance			
3	Exposure estimation and reference to its source:			
	Releases to air	As the citrates are solids with high water solubility, losses to air are considered to be negligible.		

	Releases to waste water	Citric acid and citrates are used in textile and leather treatment in aqueous solution. The most likely release route will be to waste water via spillage, clean out and discharge of spent treatment baths and liquors recovered in handling fabrics after treatment. Indeed, releases to waste water can be assumed to be 100%, since all the citric acid/citrate may be washed to drain.
	Technical fate of substance and losses from process/use to waste, waste water and air	

Information	Data field	Explanation
Fraction of applied amount lost from process/use to waste gas	0 kg/kg	See text
Fraction of applied amount lost from process/use to waste water	1 kg/kg	See text

Predicted Exposure Concentrations of Environmental releases

	PEC	unit
AIR		
Annual average local PEC in air (total)	1.56×10^{-15}	$[mg.m^{-3}]$
WATER, SEDIMENT		
Local PEC in surface water during emission episode (dissolved)	2.92×10^{-2}	$[mg\ l^{-1}]$
Annual average local PEC in surface water (dissolved)	2.67×10^{-2}	$[mg\ l^{-1}]$
Local PEC in fresh-water sediment during emission episode	4.98×10^{-1}	$[mg\ kg\ wwt^{-1}]$
Local PEC in seawater during emission episode (dissolved)	1.01×10^{-1}	$[mg\ l^{-1}]$
Annual average local PEC in seawater (dissolved)	8.35×10^{-2}	$[mg\ l^{-1}]$
Local PEC in marine sediment during emission episode	1.73	$[mg\ kg\ wwt^{-1}]$
SOIL, GROUNDWATER		
Local PEC in agric. soil (total) averaged over 30 days	5.87×10^{-1}	$[mg\ kg\ wwt^{-1}]$
Local PEC in agric. soil (total) averaged over 180 days	1.93×10^{-1}	$[mg\ kg\ wwt^{-1}]$

		Local PEC in grassland (total) averaged over 180 days	7.70×10^{-2}	[mg kg wwt^{-1}]
		Local PEC in pore water of agricultural soil	2.91×10^{-3}	[mg l^{-1}]
		Local PEC in pore water of grassland	1.16×10^{-3}	[mg l^{-1}]
		Local PEC in groundwater under agricultural soil	2.91×10^{-3}	[mg l^{-1}]
	Exposure concentration in sewage treatment plants (STP)	No measured data are available for the concentration of citric acid in sewage treatment plants (STP). The concentration of the citrate has been estimated using EUSES 2.1.1. The EUSES model uses the Simple Treat sewage treatment model to predict the fate of a substance in the STP, based on the physicochemical and biodegradation properties. For citric acid, SimpleTreat predicts the following: 12.6 % to water: 0.112 % to air: 0.0154 % to sludge: 87.3 % degraded. Sludge from WWTPs may be spread on agricultural soil.		

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	11、Use in paints and coatings
	Processes and activities covered by the exposure scenario	SU3, SU21, SU22, SU17, SU18, SU19 PROC 7, PROC 8a, PROC 8b, PROC 10, PROC 11, PROC 19, PROC 21, PROC 24
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	N/A
	Formulation of exposure scenario:	
2.1	Formulation of exposure scenario	A paint factory formulating 10000 tpa of formulated paint could need around 10000 x 0.001 = 10 tpa of citric acid. Paint formulation is a widespread activity and this estimate is consistent with a total market size of 300 tpa. It is taken that the regional tonnage is 40 tpa. Assuming a worst case of 2% handling loss this is a local release of 200 kg per year. Such a wastage rate is less than for scenarios considered earlier and there is no need to calculate local exposures. The releases will be added as regional and continental losses to waste water: Regional = 200 x (40/10) / 365 = 2.2 kg/d Continental 2.2 x (260/40) = 14.3 kg/d
	Use	The coating process used by both professionals and consumers is typically by brush or roller application. For releases to waste water during consumer use, the OECD Emission Scenario Document for coatings assumes that an estimated 1% of the volatile fraction of the coating will be lost as brush residues and then end up in the sewer. The same fraction (1%) of the volatile fraction is assumed to be lost during professional use, but this is properly disposed and does not end up in the sewer [OECD, 2007]. Therefore the amount of citric acid in the application passing to waste is estimated to be widely dispersed: Regional wastewater: 0.1 x 300 tpa x 1000 kg/t x 0.01 /365 = 0.82 kg/d Continental wastewater: 0.9 x 300 tpa x 1000 kg/t x 0.01 /365 = 7.40 kg/d

		Therefore, for simplicity, for this application area, the totals are: Regional wastewater: + 0.82 = 3.0 kg/d Continental wastewater: 14.3 + 7.4 = 21.7 kg/d For human health worker exposure at paint production sites will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.

	Substance / User identity	
	Registration number(s)	01-2119520510-57-0002
	Substance identity	CAS# 7775-14-6 ,EC#231-890-0
1	Short title of the exposure scenario	12、Use in photography
	Processes and activities covered by the exposure scenario	SU20,SU21,SU22 PROC5, PROC 13
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	Other relevant operational conditions of use	N/A
	Formulation of exposure scenario:	
2.1	Exposure scenario	Citric acid is one of a range of complexing agents used in photography to control the effects of calcium and magnesium hardness, and to keep iron soluble in solution as part of redox processes. Due to the rapid growth of digital photography, use of chemicals in film processing is now limited almost entirely to a small number of professional providers. The chemicals used are collected by photochemical companies in order to recover silver and disposal to drain does not take place. Citrate may also be used as a stop bath in professional or consumer settings as part of the process for the manual development of photographic film. Releases to the environment from this application are insignificant compared to those from considered in other exposure scenarios (cleaning products for example). Therefore this scenario need not be considered further in respect of the environment.
	human health	For human health, the processes applied during both professional and consumer uses are: PROC 9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 5 Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) PROC 13 Treatment of articles by dipping and pouring

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	13、Use in paints and coatings
	Processes and activities covered by the exposure scenario	SU3 PROC 1, PROC 2, PROC 4, PROC 8a
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	relevant operational conditions of use	Following the REACH descriptor system [ECHA, 2009] the following sector of use is covered by this scenario: SU3 Industrial uses The relevant product category is PC21 Laboratory chemicals Citric acid may be used at low levels within laboratories. Exposures will take place but under highly controlled conditions. Therefore this scenario need not be considered further for human health or the environment.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	14、Use in water treatment
	Processes and activities covered by the exposure scenario	SU3, SU14, SU15, SU16, SU17, PROC 1, PROC 2, PROC 3, PROC 4, PROC 7, PROC 8a, PROC 8b, PROC 9, PROC 10, PROC 13, PROC 17, PROC 18, PROC 20, PROC 23, PROC xyz[1]
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	relevant operational conditions of use	This scenario covers use in smaller-scale circulating water treatment in industrial settings, which typically use high substance concentration at low discharges and would usually have a waste water treatment plant (WWTP) in place. The degradability of citric acid in power station cooling systems makes in not suitable for such purposes.
	Formulation of exposure scenario:	
2.1	Industrial cooling systems	Industrial cooling systems can be categorized by their design and by using water as coolants. The exchange of heat between process medium and coolant is enhanced by heat exchangers. From the heat exchangers the coolant transports the heat into the environment. Usage of water treatments containing citrates would be continuous for the correct functioning of the cooling water system. Re-loading may be needed more or less frequently, for open and closed cooling water systems respectively, to refresh the system. The worst-case for the local environment is to assume treatment of a large industrial plant, open cooling system, which requires the use of large volumes of a high concentration product on a continuous basis and involves the direct release of blow down effluent to the river or receiving water.
	In open recirculating systems	In open recirculating systems, alkaline conditions (pH of 8-9), in combination with organic complexing agents are effective against corrosion and scaling. Most currently used corrosion programmes are based on phosphates, and zinc is added if water conditions require this. Typical concentrations of scale control agents (polyphosphates, phosphonates, polyacrylates, copolymers and ter-polymers) range from 2 to 20 mg/l, as active compound. Hardness stabilisers prevent the formation of crystals and are used in recirculating systems, but rarely or never in once-through systems. Citrates may be used to enhance the performance of the other additives. In most downstream uses treatment chemicals are applied in water-based processes. The final concentration in the water used in scale inhibition is typically from less than 1 to 10 ppm. Depending on the exact nature of the process, the complexing agents may remain present in the aqueous effluent and the discharge streams. These streams will be treated on the user's site, discharged to sewer

		systems or discharged to waterways (wide dispersive use). Given the low volatility and the high water solubility of the substances, direct releases to air and soil can be considered negligible.
	Wastewater	In the UK, the capacity of 50% of installed base cooling towers is in the range of 22.7 m^3 and 227 m^3 (OECD, 2004). The water circulation rate of a typical open cooling system (with capacity of 100 m3), for an industrial plant, is assumed to be 350 m^3/h (3.5 times the capacity). The blowdown of open cooling systems is related to the rate of evaporation (1% of the circulation rate) and the concentration cycle, which is the ratio (typically 3) of the maximum concentration of dissolved solids in the recirculating water to the concentration in the make up water (OECD, 2004). For the purpose of this calculation, a scaling inhibitor product with an active content of citrate at 25% is assumed. Therefore, for a blowdown of 1.75 m^3/h from an open cooling system; the estimated release of citrates to water is 0.25 x 20 mg/l x 1.75 m^3/h x 1000 l/m^3 x 24 h/d x 10-6 kg/mg = 0.44 kg/day. This is lower than ES considered above and there is therefore no need to develop the scenario further. In the nature of the use it must be assumed that all the citric acid used in water treatment could pass to waste water. Therefore: Regional wastewater: x 1000 tpa x 1000 kg/t /365 = 274 kg/d Continental wastewater: 0.9 x 1000 tpa x 1000 kg/t x /365 = 2470 kg/d
	human health	For human health worker exposure at industrial sites will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	15、Use in metal surface treatment
	Processes and activities covered by the exposure scenario	SU3, SU14, SU15, SU16, SU17, SU21,SU22 PROC 2, PROC 3, PROC 4, PROC 7, PROC 8a, PROC 8b, PROC 9, PROC 10, PROC 13, PROC 17, PROC 18, PROC 23
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	relevant operational conditions of use	Citric acid may be used as a complexing agent during metal surface treatment operations. This includes cleaning, brightening and passivation of fabricated stainless steel components, and other metal components, cleaning of circuit boards prior to soldering, and metal cleaning or chemical polishing for the surface treatment of aluminium, copper and other metals. The following applications should be taken as representative rather than the sole example of where and why citric acid or citrates may be used in the treatment of metal surfaces. Some industries using citric acid include fasteners, medical devices, semi-conductors, automotive and aerospace.
	Passivation	Citric acid may be used in stainless steel passivation to remove iron from the surface of the stainless steel and prevent later corrosion. After thorough cleaning, the stainless steel part is immersed in a passivating acid bath. Any one of three approaches can be used: nitric acid passivation, nitric acid with sodium dichromate passivation and citric acid passivation. Which approach to use depends on the grade of stainless steel and prescribed acceptance criteria. When citric acid passivation is used, typical solutions range from 4 to 10% citric acid by weight.
	Electroless plating	Plating describes the coating of surfaces with metals, either through an electrolysis or electroless plating processes. Electroless plating is also known as 'autocatalytic' plating; deposition of the metal starts on metal nuclei such as palladium and continues autocatalytically. Electroless plating is favoured over electrolysis for most component production (EA 2009). There are usually three stages in the electroless plating process: de-smearing, activation and electroless copper plating. The plating solution has a copper content of 2 – 5 g/l, with sodium hydroxide (15 – 20 g/l), complexing agents (10 – 15 g/l) or tartrates (5 – 10 g/l) and reducing agents, such as formaldehyde (3 – 5 g/l). The process solution lifetime is limited by the build-up of reaction products and is proportional to the rate of throughput of components (EA 2009). Citrate may be used as a complexing agent. Electroless plating involves the large-scale use of water in both providing the medium for the process itself and for the subsequent rinsing and washing of components. There is a degree of recycling of rinse water through use to top-up the plating tanks, but there is ultimately loss through carry-over on components. Spent fluids can only be topped up a limited number of times before the media needs replacing. Water-soluble waste is discharged in waste water for basic on-site

		treatment (settling and pH adjustment) before discharge to municipal treatment works, controlled by local discharge consent agreements (EA 2009).
	Exposure scenario:	
2.1	Environment exposure	The use of citrate in metal-surface treatment is estimated as approx. 1000 tpa. Therefore, environmental releases are not dissimilar to those discussed in the cleaning scenario (ES5) but on a much smaller scale. Therefore, it is not considered necessary to further assess environmental exposure.
	human health	For workers, exposures are not expected to be greater than those discussed in other industrial use scenarios. The basic risk management measures discussed for these scenarios are considered sufficient to ensure safe use. Human health exposure is not discussed further.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	16、Use in agriculture
	Processes and activities covered by the exposure scenario	SU1, SU3, SU21, SU22 PROC 3, PROC 5, PROC 8a, PROC 8b, PROC 10, PROC 11, PROC 14, PROC 15, PROC 19
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	relevant operational conditions of use	This scenario covers use in smaller-scale circulating water treatment in industrial settings, which typically use high substance concentration at low discharges and would usually have a waste water treatment plant (WWTP) in place. The degradability of citric acid in power station cooling systems makes in not suitable for such purposes.
	Formulation of exposure scenario:	
	Wastewater	The amount of citric acid believed to be used in this application is at most 1500 tpa. The use per site is unknown, but this should be considered as a widely dispersed use. In the worst case a release of the entire tonnage to the region could be included, i.e. 1500 tpa. Of this, part will be released to agricultural soil (90%) and part to waste water (10%). A regional release of 150 x 1000/365 = 411 kg/d to waste water will be added to the model, and 3699 kg/d to soil will be included.
	human health	For human health worker exposure will be to aqueous formulations for which no hazard has been identified. In addition, relevant exposures have been calculated for life cycle stages with higher exposures. Therefore no attempt at quantification will be made nor is needed.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	17、Use in medical devices
	Processes and activities covered by the exposure scenario	SU3, SU20, SU22 PROC 1
2	Operational conditions and risk management measures	
	Duration an frequency of use	
	Worker All applicable PROCs	>4h
	Physical form of substance: under conditions of use it is used as a liquid.	Solid.
	Concentration of substance in preparation or article	
	relevant operational conditions of use	Citrates may be used in medical devices, for example, citrate is added to human blood to prevent coagulation. The whole blood collection process is a closed process as sterility must be maintained. Procedures are carried out by trained personnel in a controlled environment. Therefore, exposures from this use are expected to be minimal and the scenario is not considered further for human health or the environment.

	Substance / User identity	
	Registration number(s)	01-2119457026-42-0004
	Substance identity	CAS#77-92-9; EC#201-069-1
1	Short title of the exposure scenario	18、Regional exposure concentrations
	Processes and activities covered by the exposure scenario	N/A
2	Regional exposure concentrations	

	Predicted regional Exposure Concentrations		**Measured regional exposure concentrations**		**Explanation / source of measured data**
	value	**unit**	**value**	**unit**	
Freshwater	1.52×10^{-2}	mg/l	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1
Marine water	1.41^{-3}	mg/l	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1
Freshwater sediments	3.32×10^{-1}	mg/kg d.w.	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1
Marine sediments	2.60×10^{-2}	mg/l	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1
Agricultural soil	3.19×10^{-3}	mg/kg wwt	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1
Grassland	7.47×10^{-12}	mg/kg wwt	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1
Air	1.24×10^{-19}	(mg/m^3)	No data		The value represents the sum of the regional PECs calculated by EUSES 2.1.1

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