



9.7. Exposure scenario 7: Use at industrial sites - Use of disilver oxide as catalyst

Sector of use: SU 9: Manufacture of fine chemicals

Environment contributing scenario(s):		
CS 1	Use of disilver oxide as catalyst	ERC 5
Worker contributing scenario(s):		
CS 2	Raw material handling	PROC 26, PROC 21
CS 3	Reaction	PROC 4, PROC 1, PROC 15, PROC 3
CS 4	Packaging	PROC 8b, PROC 21
CS 5	Cleaning and maintenance	PROC 28, PROC 8a

9.7.1. Env CS 1: Use of disilver oxide as catalyst (ERC 5)

Assessment entity group used for the assessment of this contributing scenario: ERA
Use as catalyst remaining in article

9.7.1.1. Conditions of use

Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> Annual use amount at site: ≤ 1 tonnes/year <i>Modelled site tonnage 1 tpa demonstrates safe use. In the event this modelled tonnage is exceeded scaling of the conditions is allowed.</i> <i>All the amounts are expressed as Ag as this is the driver for the environmental risk assessment.</i> Daily use amount at site: ≤ 0.01 tonnes/day
Technical and organisational conditions and measures
<ul style="list-style-type: none"> On site treatment of off-air: Electrostatic precipitators or wet electrostatic precipitators or cyclones or fabric/bag filter or ceramic/metal mesh filter according to the BAT Reference Document in the Non-Ferrous Metals Industry <i>Direct air emissions should be reduced by implementing one or more of the following RMMs (air concentration range for which the RMM is suitable is specified in parenthesis):</i> <ul style="list-style-type: none"> Electrostatic precipitators using wide electrode spacing: $5 - 15 \text{ mg/Nm}^3$ Wet electrostatic precipitators: $< 5 \text{ mg/Nm}^3$ Cyclones, but as primary collector: $< 50 \text{ mg/Nm}^3$ Fabric or bag filters: high efficiency in controlling fine particulate (melting): achieve emission values $< 5 \text{ mg/Nm}^3$. Membrane filtration techniques can achieve $< 1 \text{ mg/Nm}^3$ Ceramic and metal mesh filters. PM10 particles are removed: 0.1 mg/Nm^3 Wet scrubbers: $< 4 \text{ mg/Nm}^3$ On site treatment of wastewater: Chemical precipitation or sedimentation or filtration or electrolysis or reverse osmosis or ion exchange according to the BAT Reference Document in the Non-Ferrous Metals Industry (2017) applying minimum xx% removal efficiency <i>Direct water emissions should be reduced by implementing one or more of the following RMMs:</i> <ul style="list-style-type: none"> Chemical precipitation: used primarily to remove the metal ions (e.g. the use of Ca(OH)_2 to a pH 11: $>99\%$ removal efficiency; the use of Fe(OH)_3 to a pH 11: 96% removal efficiency) Sedimentation (e.g. Na_2S, pH 11, $>99\%$ removal efficiency) • Filtration: used as final clarification step (e.g. ultrafiltration, pH 5.1: 93% removal efficiency, nanofiltration: 97% removal efficiency, reverse osmosis, pH 4-11: 99% removal efficiency) Electrolysis: for low metal concentration at about 2 g/L (e.g. electrodialysis: 13% removal efficiency within 2 hours, membrane electrolysis, electrochemical precipitation, pH 4-10, $>99\%$ removal efficiency) • Reverse osmosis: extensively used for the removal of dissolved metals; Ion exchange: final cleaning step in the removal of heavy metal from process wastewater (e.g. 90% removal efficiency for clinoptinolite and 100% removal efficiency for synthetic zeolite) <i>Following the Integrated Pollution Prevention and Control – BAT Reference note document, the treatment methods are very much dependent on the specific processes and the metals involved. More information can be</i>



<i>found in the BAT Reference Document for the Non-Ferrous Metals Industry (2017).</i>
Conditions and measures related to biological sewage treatment plant
• Biological STP: None [Effectiveness Water: 0%]
Conditions and measures related to external treatment of waste (including article waste)
<p>• Particular considerations on the waste treatment operations: No (low concentration)</p> <p><i>Hazardous wastes from onsite risk management measures and solid or liquid wastes from production, use and cleaning processes should be disposed of separately to hazardous waste incineration plants or hazardous waste landfills as hazardous waste. Releases to the floor, water and soil are to be prevented. If the silver content of the waste is elevated enough, internal or external recovery/recycling might be considered.</i></p> <p><i>Appropriate waste codes: 06 05 02*, 08 01 11, 08 03 12*, 09 01 01*, 09 01 03*, 09 01 04*, 09 01 05*, 09 01 06*, 09 01 13*, 10 06 06*, 10 07 01, 10 07 02, 10 07 03, 10 07 04, 10 07 05, 11 01 09*, 15 01 10*, 15 02 02*, 16 01 18, 16 03 03*, 16 08 01, 16 11 04</i></p> <p><i>Suitable disposal: Hazardous waste produced during the manufacture and downstream use is sent to a recycler only marginal amounts are sent to a landfill or an incinerator. Waste containing silver is recycled for almost a 100%</i></p> <p><i>A detailed assessment has been performed on modelled and measured data and is reported in the Waste report (ARCHE, 2013)</i></p>
Other conditions affecting environmental exposure
• Receiving surface water flow rate: $\geq 1.8E4$ m ³ /day
• Discharge rate of effluent: $\geq 2E3$ m ³ /day

9.7.1.2. Releases

The local releases to the environment are reported in the following table. Note that the releases reported do not account for the removal in the modelled biological STP.

Table 9.45. Local releases to the environment

Release	Assessment entity	Release estimation method	Explanations
Water	Ag dissolved	Estimated release factor (based on SPERC Eurometaux SPERC 2.5 v2.1)	<p>Release factor before on site RMM: 0.01% Release factor after on site RMM: 0.01% Local release rate: 1E-3 kg/day Explanation: No information was available for this use. The assumption is that silver powder is mixed to catalyse a reaction as such the SPERC for formulation of metal compounds has been taken as surrogate for the emissions.</p>
Air	Ag dissolved	Estimated release factor (based on SPERC Eurometaux SPERC 2.5 v2.1)	<p>Release factor before on site RMM: 5E-3% Release factor after on site RMM: 5E-3% Local release rate: 5E-4 kg/day Explanation: No information was available for this use. The assumption is that silver powder is mixed to catalyse a reaction as such the SPERC for formulation of metal compounds has been taken as surrogate for the emissions.</p>
Non agricultural soil	Ag dissolved	Estimated release factor	<p>Release factor after on site RMM: 0% Explanation: No direct release to soil.</p>

9.7.1.3. Exposure and risks for the environment and man via the environment

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table. The



exposure estimates have been obtained with EUSES 2.1.2 unless stated otherwise.

Table 9.46. Exposure concentrations and risks for the environment and man via the environment

Protection target	Assessment entity	Exposure concentration	Risk quantification
Fresh water	Ag dissolved	Local PEC: 1.9E-5 mg/L RCR = 0.413	Final RCR = 0.413
Sediment (freshwater)	Ag dissolved	Local PEC: 3.624 mg/kg dw RCR = 8.27E-3	Final RCR < 0.01
Marine water	Ag dissolved	Local PEC: 3.21E-6 mg/L RCR = 3.73E-3	Final RCR < 0.01
Sediment (marine water)	Ag dissolved	Local PEC: 0.611 mg/kg dw RCR = 1.39E-3	Final RCR < 0.01
Sewage Treatment Plant	Ag dissolved	Local PEC: 0 mg/L RCR = 0	Final RCR < 0.01
Agricultural soil	Ag dissolved	Local PEC: 0.096 mg/kg dw RCR = 0.091	Final RCR = 0.091
Man via environment - Inhalation (systemic effects)	Ag dissolved	Concentration in air: 1.23E-7 mg/m ³ RCR = 8.23E-7	Final RCR < 0.01
Man via environment - Oral	Ag dissolved	Exposure via food consumption: 3.84 µg/kg bw/day (Measured data: See section 9.0.3.6) RCR = 0.035	Final RCR = 0.035
Man via environment - combined routes			Final RCR = 0.035

Remarks on measured exposure:

See section 9.0.3.6 for Ag dissolved:

Identity of the substance used: Ag

Explanation: Worst case exposure of 3.84 µg Ag/kg bw/day from food (section 9.0.3.6) was taken forward to the risk characterisation.

The intake via drinking water calculated with CHESAR was 3-4 orders of magnitudes lower compared to the intake via food and has thus not been taken into account.

9.7.2. Worker CS 2: Raw material handling (PROC 26, PROC 21)

Assessment entity group used for the assessment of this contributing scenario: HHRA manual handling

9.7.2.1. Conditions of use

	Method
Product (article) characteristics	
• Physical form of the used product: Solid (material with high dustiness)	MEASE 1.02.01
• Percentage (w/w) of substance in mixture/article: <= 100 %	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: <= 8 h/day	MEASE 1.02.01
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01



	Method
<ul style="list-style-type: none"> Generic local exhaust ventilation: Lower confidence limit (industrial use) [Effectiveness Inhalation: 78%] <i>Standard efficiency</i> Inhalation explanation: <i>Efficiency for industrial use</i> 	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
<ul style="list-style-type: none"> Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness >= 90%) 	MEASE 1.02.01
<ul style="list-style-type: none"> Face/eye protection: Eye protection 	
<ul style="list-style-type: none"> Respiratory protection: Yes (APF >= 10) 	MEASE 1.02.01
Other conditions affecting workers exposure	
<ul style="list-style-type: none"> Place of use: Indoor 	

9.7.2.2. Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 9.47. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.22 mg/m ³ (MEASE 1.02.01) RCR = 0.169	Final RCR = 0.169
Dermal, systemic, long term	Disilver oxide	0.141 mg/kg bw/day (MEASE 1.02.01) RCR = 0.307	Final RCR = 0.307
Combined routes, systemic, long-term			Final RCR = 0.476

Risk characterisation

Qualitative risk characterisation (Eye, local):
See section 9.0.4.2

9.7.3. Worker CS 3: Reaction (PROC 4, PROC 1, PROC 15, PROC 3)

Assessment entity group used for the assessment of this contributing scenario: HHRA mixing

9.7.3.1. Conditions of use

	Method
Product (article) characteristics	
<ul style="list-style-type: none"> Physical form of the used product: Liquid, including paste/slurry/suspension <i>'Aqueous solution' was selected in MEASE to reflect the very low fugacity.</i> 	MEASE 1.02.01
<ul style="list-style-type: none"> Percentage (w/w) of substance in mixture/article: <= 100 % 	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
<ul style="list-style-type: none"> Duration of activity: <= 8 h/day 	MEASE 1.02.01
Technical and organisational conditions and measures	
<ul style="list-style-type: none"> Occupational Health and Safety Management System: Advanced 	MEASE 1.02.01
<ul style="list-style-type: none"> Pattern of use: Non-dispersive use 	MEASE 1.02.01
<ul style="list-style-type: none"> Pattern of exposure control: Direct handling 	MEASE 1.02.01
<ul style="list-style-type: none"> Contact level: Extensive 	MEASE 1.02.01
<ul style="list-style-type: none"> Local exhaust ventilation: No 	MEASE 1.02.01



	Method
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness $\geq 90\%$)	MEASE 1.02.01
• Face/eye protection: Eye protection	
• Respiratory protection: No	MEASE 1.02.01
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.7.3.2. Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 9.48. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.05 mg/m ³ (MEASE 1.02.01) RCR = 0.038	Final RCR = 0.038
Dermal, systemic, long term	Disilver oxide	0.034 mg/kg bw/day (MEASE 1.02.01) RCR = 0.075	Final RCR = 0.075
Combined routes, systemic, long-term			Final RCR = 0.113

Risk characterisation

Qualitative risk characterisation (Eye, local):

See section 9.0.4.2

9.7.4. Worker CS 4: Packaging (PROC 8b, PROC 21)

Assessment entity group used for the assessment of this contributing scenario: HHRA dispatch

9.7.4.1. Conditions of use

	Method
Product (article) characteristics	
• Physical form of the used product: Liquid, including paste/slurry/suspension 'Aqueous solution' was selected in MEASE to reflect the very low fugacity.	MEASE 1.02.01
• Percentage (w/w) of substance in mixture/article: $\leq 100\%$	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: ≤ 8 h/day	MEASE 1.02.01
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01
• Local exhaust ventilation: No	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: No	MEASE 1.02.01
• Face/eye protection: Eye protection	



	Method
• Respiratory protection: No	MEASE 1.02.01
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.7.4.2. Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 9.49. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.01 mg/m ³ (MEASE 1.02.01) RCR = 7.69E-3	Final RCR < 0.01
Dermal, systemic, long term	Disilver oxide	0.034 mg/kg bw/day (MEASE 1.02.01) RCR = 0.075	Final RCR = 0.075
Combined routes, systemic, long-term			Final RCR = 0.082

Risk characterisation

Qualitative risk characterisation (Eye, local):

See section 9.0.4.2

9.7.5. Worker CS 5: Cleaning and maintenance (PROC 28, PROC 8a)

Assessment entity group used for the assessment of this contributing scenario: HHRA manual cleaning, repair and maintenance operations, removal of residuals from e.g. filters/overspill or as waste

9.7.5.1. Conditions of use

	Method
Product (article) characteristics	
• Physical form of the used product: Solid (material with high dustiness) <i>Dust with high emission potential has been selected as a worst case (compared to aqueous solution).</i>	MEASE 1.02.01
• Percentage (w/w) of substance in mixture/article: <= 100 %	MEASE 1.02.01
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: <= 8 h/day	MEASE 1.02.01
Technical and organisational conditions and measures	
• Occupational Health and Safety Management System: Advanced	MEASE 1.02.01
• Pattern of use: Non-dispersive use	MEASE 1.02.01
• Pattern of exposure control: Direct handling	MEASE 1.02.01
• Contact level: Extensive	MEASE 1.02.01
• Generic local exhaust ventilation: Lower confidence limit (industrial use) [Effectiveness Inhalation: 78%] <i>Standard efficiency</i> Inhalation explanation: <i>Efficiency for industrial use</i>	MEASE 1.02.01
Conditions and measures related to personal protection, hygiene and health evaluation	
• Dermal protection: Chemical resistant dermal protection with basic employee training. (effectiveness >= 90%)	MEASE 1.02.01
• Face/eye protection: Eye protection	
• Respiratory protection: Yes (APF >= 20)	MEASE 1.02.01



	Method
Other conditions affecting workers exposure	
• Place of use: Indoor	

9.7.5.2. Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 9.50. Exposure concentrations and risks for workers

Route of exposure and type of effects	Assessment entity	Exposure concentration	Risk quantification
Inhalation, systemic, long term	Disilver oxide	0.55 mg/m ³ (MEASE 1.02.01) RCR = 0.423	Final RCR = 0.423
Dermal, systemic, long term	Disilver oxide	0.069 mg/kg bw/day (MEASE 1.02.01) RCR = 0.149	Final RCR = 0.149
Combined routes, systemic, long-term			Final RCR = 0.572

Remarks on exposure data from external estimation tools:

MEASE 1.02.01 for Disilver oxide:

Explanation:

As the MEASE 1.02.01 exposure estimation tool for workers does not provide exposure estimates for PROC 28, PROC 8a has been used instead as the input parameter assuming that there are similarities in the exposure.

Risk characterisation

Qualitative risk characterisation (Eye, local):

See section 9.0.4.2