



CHEMICAL UPDATE WORKSHEET

Chemical Name:	Silver
CAS #:	7440-22-4
Revised By:	RRD Toxicology Unit
Revision Date:	August 19, 2015

(A) Chemical-Physical Properties

	Part 201 Value	Updated Value	Reference Source	Comments
Molecular Weight (g/mol)	107.868	107.87	EPI	EXP
Physical State at ambient temp	Inorganic	Inorganic	MDEQ	
Melting Point (°C)	---	960.50	Phys Prop	EXP
Boiling Point (°C)	2212	2162.00	CRC	EXP
Solubility (ug/L)	NA	NA	NA	NA
Vapor Pressure (mmHg at 25°C)	NA	NR	NA	NA
HLC (atm-m³/mol at 25°C)	NR	NR	NA	NA
Log Kow (log P; octanol-water)	NR	NR	NA	NA
Koc (organic carbon; L/Kg)	NR	NR	NA	NA
Ionizing Koc (L/kg)		NR	NA	NA
Diffusivity in Air (Di; cm²/s)	NR	NR	NA	NA
Diffusivity in Water (Dw; cm²/s)	NR	NR	NA	NA
Soil Water Partition Coefficient (Kd; inorganics)	8.3	8.3E+00	SSG	EST

	Part 201 Value	Updated Value	Reference Source	Comments
Flash Point (°F)	NA	NA	NA	NA
Lower Explosivity Level (LEL; unitless)	NA	NA	NA	NA
Critical Temperature (K)		NR	NA	NA
Enthalpy of Vaporization (cal/mol)		NR	NA	NA
Density (g/mL, g/cm ³)		NR	NA	NA
EMSOFT Flux Residential 2 m (mg/day/cm ²)	NA	NR	NR	NA
EMSOFT Flux Residential 5 m (mg/day/cm ²)	NA	NR	NR	NA
EMSOFT Flux Nonresidential 2 m (mg/day/cm ²)	NA	NR	NR	NA
EMSOFT Flux Nonresidential 5 m (mg/day/cm ²)	NA	NR	NR	NA

(B) Toxicity Values/Benchmarks

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
Reference Dose (RfD) (mg/kg/day)	4.7E-3	1.0E-3	OPP, 2009	
RfD details	(IRIS reports 5E-3 mg/kg). 2-9 year human i.v. study; LOAEL = 0.014 mg/kg; No NOAEL; Critical effects = argyria (Gaut & Staud, 1935). UF = 3 ----> minimal effects in a subpopulation which has a propensity for argyria. Argyria is not life threatening. CCD/RRD date -	<p>Tier 1 Source: EPA-OPP: Basis: EPA-OPP is a Tier 1 source. OPP Antimicrobials Division’s “Ionic Silver: Toxicity and Weight of Evidence (5/11/2009), the oral interim endpoint = 0.001 mg/kg-day. An additional safety factor of 3 (for the presence of data gaps) was applied to the drinking water Secondary Maximum Contaminant Level (SMCL) of 0.1 mg/L (0.003 mg/kg-day). Silver and silver salts have antimicrobial applications as algacides, bacteriocides, fungicides, etc.). Per IRIS (3/2015), IRIS does not “currently update assessments for registered pesticides unless the registered pesticides also have non-pesticide uses. The IRIS user should consult OPP Reregistration Eligibility Decision (RED) documents prepared by the Office of Pesticide Programs for additional health assessment information”.</p> <p>For dermal risk assessment, the dermal interim endpoint = 3.0E-3 mg/kg-day. No safety factor was applied to the drinking water SMCL to derive the dermal endpoint as silver ion tends to bind the skin and do not penetrate the skin to cause systemic effects.</p> <p>Tier 1 and 2 Sources: IRIS: Per IRIS (12/01/1996), RfD = 5.0E-3 mg/kg-day derived as follows: Critical Study: Gaul, L.E. and A.H. Staud. 1935. Clinical spectroscopy. Seventy cases of generalized argyrosis following organic and colloidal silver medication. J. Am. Med. Assoc. 104: 1387-1390. Methods: case study report of 70 cases of generalized argyria following intravenous organic and colloidal silver medication Critical effect: argyria, a medically benign but permanent bluish-gray discoloration of the skin resulting from the deposition of silver in the dermis and also from silver-induced production of melanin</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		<p>End point or Point of Departure (POD): LOAEL = 1.4E-2 mg/kg-day (converted from a LOAEL total oral dose of 1 g Uncertainty Factors: UF = 3 for intraspecies variability Source and date: IRIS, Last revision date - 12/01/1996. An EPA screening level review in 2002 did not identify any critical new studies.</p> <p>PPRTV: No PPRTV record is available at this time. MRL: Per ATSDR (1991), no value at this time.</p> <p>Tier 3 Source: MDEQ: RRD adopted the IRIS RfD. Per CCD, WRD (5/23/1997) developed an RfD = 4.7E-3 based on 2 critical studies: 1) Gaul and Staud (1935) and 2) Hill, W.R. and D.M. Pillsbury. 1939. Argyria. The pharmacology of silver. Williams and Wilkins Company, Baltimore, MD. An intravenous dose of 1 gram silver produced mild argyria in sensitive humans. This dose was converted to an oral dose assuming 4% absorption of silver following oral exposure. UF = 3 for interspecies variability. Source: DEQ-CCD, 7/18/1991</p>		
Oral Cancer Slope Factor (CSF) (mg/kg-day)⁻¹	--	NA	MDEQ, 2015	
CSF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: D; not classified as to human carcinogenicity IRIS WOE Basis: In animals, local sarcomas have been induced after implantation of foils and discs of silver. However, these findings have been questioned due to the phenomenon of solid-state carcinogenesis in which even insoluble solids such as plastic have been shown to result in local fibrosarcomas. Also, despite long standing and frequent therapeutic usage in humans, there are no reports of cancer associated with silver Source and Date: IRIS, 1989</p> <p>Tier 1 and 2 Sources: IRIS: No Per IRIS (6/01/1989), no value at this time. An EPA screening-level review in 2003 did not identify any critical new studies pertinent to the cancer</p>		Complete



	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		assessment PPRTV: No PPRTV record is available at this time. MRL: NA; MRLs are for non-cancer effects only. Tier 3 Source: MDEQ: Per DEQ-CCD, no value at this time.		
Reference Concentration (RfC) or Initial Threshold Screening Level (ITSL) ($\mu\text{g}/\text{m}^3$)	1.0E-1	3.0E+0	OPP, 2009	
RfC/ITSL details	ITSL is based on the NIOSH REL of $0.01 \text{ mg}/\text{m}^3$ for silver metal dust and soluble compounds as Ag per 232(1) (c) [UF=100]. Critical effect is argyria. CCD/AQD date: 7/9/1997	Tier 1 Source: EPA-OPP: Basis: OPP is a Tier 1 source. OPP Antimicrobials Division's "Ionic Silver: Toxicity and Weight of Evidence (EPA-HQ-OPP-2009-0334-00004, 5/11/2009), the inhalation interim endpoint = $0.003 \text{ mg}/\text{m}^3$. An additional safety factor of 3 (to address the residual uncertainty relating to missing reproductive, neurotoxicity and chronic toxicology studies) was applied to the OSHA 8-hour TWA of $0.01 \text{ mg}/\text{m}^3$ based on a. Silver and silver salts have antimicrobial applications as algacides, bacteriocides, fungicides, etc.). Per IRIS (3/2015), IRIS does not "currently update assessments for registered pesticides unless the registered pesticides also have non-pesticide uses. The IRIS user should consult OPP Reregistration Eligibility Decision (RED) documents prepared by the Office of Pesticide Programs for additional health assessment information". Tier 1 and 2 Sources: IRIS: Per IRIS (12/01/1996), no value at this time. PPRTV: No PPRTV record is available at this time. MRL: Per ATSDR (12/2014), no inhalation MRL value at this time. Tier 3 Source:		Complete

	Part 201 Value	Updated Value	Source/Reference/Date	Comments/Notes/Issues
		MDEQ: Per CCD/AQD (7/9/1997), ITSL/RfC = 1.0E-1 µg/m ³ . The ITSL is based on the NIOSH REL of 0.01 mg.m3 for silver metal dust and soluble compounds as Ag per 232(1) (c) [UF=100]. Critical effect is argyria.		
Inhalation Unit Risk Factor (IURF) ((µg/m³)⁻¹)	--	NA	MDEQ, 2015	
IURF details	NA	<p>Carcinogen Weight-of-Evidence (WOE) Class: D; not classified as to human carcinogenicity</p> <p>IRIS WOE Basis: In animals, local sarcomas have been induced after implantation of foils and discs of silver. However, these findings have been questioned due to the phenomenon of solid-state carcinogenesis in which even insoluble solids such as plastic have been shown to result in local fibrosarcomas. Also, despite long standing and frequent therapeutic usage in humans, there are no reports of cancer associated with silver</p> <p>Source and Date: IRIS, 6/01/1989</p> <p>Tier 1 and 2 Sources:</p> <p>IRIS: Per IRIS (6/01/1989), no value at this time. An EPA screening-level review in 2003 did not identify any critical new studies pertinent to the cancer assessment</p> <p>PPRTV: No PPRTV record is available at this time.</p> <p>MRL: NA; MRLs are for non-cancer effects only.</p> <p>Tier 3 Source:</p> <p>MDEQ: Per DEQ-CCD, no value at this time.</p>		Complete
Mutagenic Mode of Action (MMOA)? (Y/N)	--	NO	USEPA, 2015	
MMOA Details	--	NA Not listed as a carcinogen with mutagenic MOA in the USEPA OSWER List.		
Developmental or Reproductive Effector? (Y/N)	No	No, the RfD or RfC/ITSL is not based on a reproductive-developmental effect.		MDEQ, 2015



	Part 201 Value	Updated Value	Source/Reference/ Date	Comments/Notes /Issues
Developmental or Reproductive Toxicity Details	NA	NA		
State Drinking Water Standard (SDWS) (ug/L)	--	NA	SDWA, 1976	
SDWS details	NA	MI Safe Drinking Water Act (SDWA) 1976 PA 399		
Secondary Maximum Contaminant Level (SMCL) (ug/L)	100	100	USEPA, 2015	
SMCL details	EPA SMCL list	USEPA SMCL list		
Is there an aesthetic value for drinking water? (Y/N)	YES	YES	USEPA, 2015	
Aesthetic value (ug/L)	100	100	NA	
Aesthetic Value details	EPA SMCL list	USEPA SMCL list		
Phytotoxicity Value? (Y/N)	NO	NO	NA	
Phytotoxicity details	NA	Not evaluated.	NA	
Others				

(C) Chemical-specific Absorption Factors

	Part 201 Value	Update	Source/Reference/ Dates	Comments/Notes /Issues
Gastrointestinal absorption efficiency value (ABS _{gi})	---	1.0	MDEQ, 2015/USEPA RAGS-E, 2004	
ABS _{gi} details		RAGS E (USEPA, 2004) Default Value		
Skin absorption efficiency value (AE _d)	---	0.01	MDEQ, 2015	
AE _d details				
Ingestion Absorption Efficiency (AE _i)		0.5	MDEQ, 2015	
AE _i Details				
Relative Source Contribution for Water (RSC _w)		0.2	MDEQ, 2015	
Relative Source Contribution for Soil (RSC _s)		1.0	MDEQ, 2015	
Relative Source Contribution for Air (RSC _A)		1.0	MDEQ, 2015	
Others				

(D) Rule 57 Water Quality Values and GSI Criteria

Current GSI value (µg/L)	0.2 (M); 0.06
Updated GSI value (µg/L)	0.2 (M); 0.06
Rule 57 Drinking Water Value (µg/L)	130

	Rule 57 Value (µg/L)	Verification Date
Human Non-cancer Values- Drinking water source (HNV-drink)	130	5/1997
Human Non-Cancer Values- Non-drinking water sources (HNV-Non-drink)	11,000	5/1997
Wildlife Value (WV)	NA	NA
Human Cancer Values for Drinking Water Source (HCV-drink)	NA	NA
Human Cancer values for non-drinking water source (HCV-Non-drink)	NA	NA
Final Chronic Value (FCV)	0.06	10/1997
Aquatic maximum value (AMV)	0.54	10/1997
Final Acute Value (FAV)	1.1	10/1997

Sources:

1. MDEQ Surface Water Assessment Section Rule 57 [website](#)
2. MDEQ Rule 57 [table](#)



(E) Target Detection Limits (TDL)

	Value	Source
Target Detection Limit – Soil ($\mu\text{g}/\text{kg}$)	100	MDEQ, 2015
Target Detection Limit – Water ($\mu\text{g}/\text{L}$)	0.2	MDEQ, 2015
Target Detection Limit – Air (ppbv)	NA	MDEQ, 2015
Target Detection Limit – Soil Gas (ppbv)	NA	MDEQ, 2015

CHEMICAL UPDATE WORKSHEET ABBREVIATIONS:

CAS # - Chemical Abstract Service Number.

Section (A) Chemical-Physical Properties**Reference Source(s):**

CRC	Chemical Rubber Company Handbook of Chemistry and Physics, 95th edition, 2014-2015
EMSOFT	USEPA Exposure Model for Soil-Organic Fate and Transport (EMSOFT) (EPA, 2002)
EPA2001	USEPA (2001) Fact Sheet, Correcting the Henry's Law Constant for Soil Temperature. Office of Solid Waste and Emergency Response, Washington, D.C.
EPA4	USEPA (2004) User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings. February 22, 2004.
EPI	USEPA's Estimation Programs Interface SUITE 4.1, Copyright 2000-2012
HSDB	Hazardous Substances Data Bank
MDEQ	Michigan Department of Environmental Quality
NPG	National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards
PC	National Center for Biotechnology Information's PubChem database
PP	Syracuse Research Corporation's PhysProp database
SCDM	USEPA's Superfund Chemical Data Matrix
SSG	USEPA's Soil Screening Guidance: Technical Background Document, Second Edition, 1996
USEPA/EPA	United States environmental protection agency's Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). July, 2004.

W9 USEPA's User Guide for Water9 Software, Version 2.0.0, 2001

Basis/Comments:

EST	estimated
EXP	experimental
EXT	extrapolated
NA	not available or not applicable
NR	not relevant

Section (B) Toxicity Values/Benchmarks**Sources/References:**

ATSDR	Agency for Toxic Substances and Disease Registry
CALEPA	California Environmental Protection Agency
CAL DTSC	California Department of Toxic Substances Control
CAL OEHHA	CAEPA Office of Environmental Health Hazard Assessment
CCD	MDEQ Chemical Criteria Database
ECHA	European Chemicals Agency (REACH)
OECD HPV	Organization for Economic Cooperation and Development HPV Database
HEAST	USEPA's Health Effects Assessment Summary Tables
IRIS	USEPA's Integrated Risk Information System
MADEP	Massachusetts Department of Environmental Protection
MDEQ/DEQ	Michigan Department of Environmental Quality
DEQ-CCD/AQD	MDEQ Air Quality Division
DEQ-CCD/RRD	MDEQ Remediation and Redevelopment Division
DEQ-CCD/WRD	MDEQ Water Resources Division
MNDOH	Minnesota Department of Health

NJDEP	New Jersey Department of Environmental Protection
NYDEC	New York State Department of Environmental Conservation
OPP/OPPT	USEPA's Office of Pesticide Programs
PPRTV	USEPA's Provisional Peer Reviewed Toxicity Values
RIVM	The Netherlands National Institute of Public Health and the Environment
TCEQ	Texas Commission on Environmental Quality
USEPA	United States Environmental Protection Agency
USEPA OSWER	USEPA Office of Solid Waste and Emergency Response
USEPA MCL	USEPA Maximum Contaminant Level
WHO	World Health Organization
WHO IPCS	International Programme on Chemical Safety (IPCS/INCHEM)
WHO IARC	International Agency for Research on Cancers
NA	Not Available.
NR	Not Relevant.

Toxicity terms:

BMC	Benchmark concentration
BMCL	Lower bound confidence limit on the BMC
BMD	benchmark dose
BMDL	Lower bound confidence limit on the BMD
CSF	Cancer slope Factor
CNS	Central nervous system
IURF or IUR	Inhalation unit risk factor
LOAEL	Lowest observed adverse effect level
LOEL	Lowest observed effect level
MRL	Minimal risk level (ATSDR)
NOAEL	No observed adverse effect level
NOEL	No observed effect level

RfC	Reference concentration
RfD	Reference dose
p-RfD	Provisional RfD
aRfD	Acute RfD
UF	Uncertainty factor
WOE	Weight of evidence

Section (C) Chemical-specific Absorption Factors

MDEQ	Michigan Department of Environmental Quality
USEPA RAGS-E	United States Environmental Protection Agency's Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). July, 2004.

Section (D) Rule 57 Water Quality Values and GSI Criteria

GSI	Groundwater-surface water interface
NA	A value is not available or not applicable.
ID	Insufficient data to derive value
NLS	No literature search has been conducted