

9.12 ES 9b and c: Professional and consumer use of cement**9.12.1 Exposure scenario**

This generic exposure scenario describes the use of ferrous sulfate as an additive for the reduction of chromium (VI) content in cement. Solid ferrous sulfate is present in the dry cement. The addition of water to the dry mix, whereby the soluble ferrous sulfate and Cr(VI) species come into contact, may also be seen as a formulation step. Since this is performed at the location of use of the cement, releases are considered as part of professional/consumer use stages. Professionals or consumers are highly unlikely to formulate ferrous sulfate into cement; however, cement containing ferrous sulfate may be purchased and used by anyone. At the end of the process, ferrous sulfate is no longer present. It is likely that exposure to the air, together with the alkaline nature of cement, results in conversion of any residual ferrous sulfate present to ferric oxides or hydroxides which are insoluble and bound into the cement matrix as it hardens. Any unused, waste dry cement mix is likely to be landfilled and, again, ferrous sulfate will be converted to insoluble ferric salts.

9.12.1.1 Description of activities and processes covered in the exposure scenario

This includes use by professionals and consumers; although repeated exposure will be much less in these cases.

Ferrous sulfate is added to cement at levels of *approx.*0.5%. Its presence is intended to alleviate the problems associated with exposure to soluble Cr(VI) which elicits allergic contact dermatitis. Cement is a hazardous substance in its own right with detailed occupational exposure controls being prescribed (Lafarge 2009). Any hazards to human health or the environment associated with the presence of ferrous sulfate are likely to be trivial compared with the hazards of soluble Cr(VI) or the alkaline nature of, or the dust hazard presented by, cement itself. In addition, it is likely that exposure to the air and the alkaline nature of cement results in conversion of any residual ferrous sulfate present to ferric oxides or hydroxides which are insoluble and bound into the cement matrix as it hardens.

There is some possibility for exposure to dust containing ferrous sulfate in opening bags, transferring, mixing etc. the dry cement mix but once water is added there is little chance for exposure and the likelihood of loss to waste water is negligible.

The distribution of usage and potential for emissions to the wider environment vary depending on the user. Users of cements include: individual consumers, sole tradesmen, small building contractor organisations, up to major construction projects. It is appropriate to define these scenarios differently (see section 9.1.4.5).

9.12.1.2 Operational conditions related to frequency, duration and amount of use

Table 9.12.1: Duration, frequency and amount

Information type	Data field	Explanation
Used amount of substance (as such or in preparation) per worker [workplace] per day	8.3 t cement mix containing approx 41 kg iron salt (approx. 17 kg Fe)	
Duration of exposure per day at workplace [for one worker]	Up to 8 hours	
Frequency of exposure at workplace [for one worker]	Daily	
Total annual amount of substance supplied per relevant preparation category	5.1 T Fe/y	
Emission days per year related to that preparation category	300	

9.12.1.3 Operational conditions and risk management measures related to product⁵⁸ characteristics

Table 9.12.2: Characteristics of the substance or preparation

Information type	Data field	Explanation
Physical state	Liquid (aqueous solution) or Solid salts (assumed to be in granular/flake form rather than powdered)	Physical state at STP.
Risk management measures related to the design of product	Precautions against irritation	As necessary

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

Table 9.12.3: Operational conditions related to respiration and skin contact

Information type	Data field	Explanation
Respiration volume under conditions of use	10 m ³ /d	Default respiration volume for light work.
Area of skin contact with the substance under conditions of use	480 cm ² (PROC5, PROC8B) 960 cm ² (PROC8A, PROC10) 1980 cm ² (PROC19, assumed)	ECETOC assumption for exposed skin surface area.

⁵⁸ “Product” includes substances, preparations and articles

	to apply for 26)	
Body weight	70 kg	Default bodyweight for workers.

Please note that the respiration volume is accounted for when deriving the DNEL. See chapter R8 for details.

9.12.1.5 Other operational conditions of use

Scenario ES9b refers to use by tradesmen on small scale, short term projects and on small local construction work (e.g. small site construction project).

The cement industry (MPA website, Advice on working with Cement page) estimates 10% wastage. Usage will often be outdoors with most waste solids responsibly collected and disposed of via municipal facilities (i.e. to specialist landfill), with some remaining solid wastes passing to local urban/industrial soil at the site of use. It would be expected that the iron would be immobile, not able to reach surface water or the wider environment. The possibility exists that in the worst case some dusts could be washed to waste water via storm drains, and from cleaning of clothing, tools etc.

MPA usage statistics suggest that sales via builders merchants and sales of cement ‘products’ constitute around 40% of consumption of cement. It is presumed that some sales of ‘products’ will pass to consumers and some to small-scale professional users. Consumption by professional users in a small town is expected to total approx. 2.5 kt over a year.

Fmls = 2E-03

Usage (based on exposure via a single WWTP, i.e. equivalent to estimated total usage in a small town)

Number of days = 300

It is anticipated that steps would be taken to avoid such losses, however to characterise the worst case it is assumed that dust formation washed to drain leads to losses of 0.02 from the sites.

Table 9.12.4: 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	
Fraction of applied amount lost from process/use to waste water	0.02	

9.12.1.6 Risk management measures

Comment:

It is noted that the hazards associated with other constituents of cements are generally anticipated to be significantly worse than the iron salts. PPE and other risk management measures mentioned here refer only to measures necessary to manage possible risks from iron salts. In view of the other constituents of formulated cements more rigorous RMM may be necessary and/or already in place.

Table 9.12.5: Risk management measures for wide dispersive use

Information type	Data field	Explanation
Containment and local exhaust ventilation		
Containment plus good work practice required	Yes	
Local exhaust ventilation required plus good work practise	No	
Personal protective equipment (PPE)		
Skin protection	Protective gloves.	
Eye protection	Safety glasses	
Clothing	Working clothing worn.	
Respiratory protection	If handling solid salts , Filter mask P2 (FFP2) must be used	See Comment above
Breathing apparatus	None	See Comment above
Other risk management measures related to workers		
Procedural and control technologies	If handling solid salts, containment and ventilation must be available.	See Comment above
Training. Monitoring/reporting and auditing systems	Equipment must be well maintained and cleaned daily.	See Comment above
Risk management measures related to environmental emissions from wide dispersive professional use		
Municipal or other type of external waste water treatment	Yes	
Effluent (of the waste water treatment plant) discharge rate	2000 m ³ /d	
Recovery of sludge for agriculture or horticulture	Yes	

9.12.1.7 Waste related measures

For professional use, it is assumed that any unused product is disposed of as chemical waste and is not washed to drain. Equipment washing is unlikely to be carried out as standard. Spent packaging may be disposed of to landfill, recycling or by incineration

9.12.2 Exposure estimation

9.12.2.1 Workers exposure

9.12.2.1.1 Short-term exposure

Short-term workers exposure is not relevant.

9.12.2.1.2 Long-term exposure

Modifications to the predicted exposures are only assumed where necessary to manage possible risks. Modifications are predominantly for use of personal protective equipment (PPE). The presence of local exhaust ventilation (LEV) is taken into account in scenarios where this is considered likely. The exposure levels from the ECETOC TRA model (2010) are used to estimate occupational exposure.

Dermal exposure

As described above, dermal exposure is most likely to occur through accidental spillage or during transfer and charging of storage and feed vessels where mechanical handling is not in place.

Dermal exposure estimates derived using the ECETOC TRA model can be found below. Note that the MPA website recommends the wearing of suitable eye protection, waterproof clothing, waterproof footwear and waterproof gloves when mixing and using cement.

Inhalation exposures

Transfer and charging of solid iron salts in powder or granular form could give the potential for inhalation. Inhalation exposure estimates derived using the ECETOC TRA model can be found below. It is assumed that PPE, LEV and mechanical handling would always be in place, given the hazardous nature of other cement ingredients besides FeSO₄.

The dermal and inhalation exposure estimates derived using the ECETOC TRA exposure levels are given in **Error! Reference source not found.12.6**.

Comment:

It is noted that the hazards associated with other constituents of cements are generally anticipated to be significantly worse than the iron salts. PPE and other risk management measures mentioned here refer only to measures necessary to manage possible risks from iron salts. In view of the other constituents of formulated cements more rigorous RMM may be necessary and/or already in place.

Table 9.12.6: Summary of highest long-term exposure concentration to workers

Highest value for relevant tasks.

Routes of exposure	Concentrations	Justification
Dermal local exposure (in $\mu\text{g}/\text{cm}^2$)	400 (PROC5, in absence of LEV)	The wearing of gloves is accounted for in this value
Dermal systemic exposure via contact with substance as such (in mg/kg bw/d)	0.27 (PROC2, 8b)	The limitation of 10% dermal uptake is assumed in deriving this value.
Dermal systemic exposure via aqueous solution (in mg/kg bw/d)	0.027 (PROC2, 8b)	The limitation of <1% dermal uptake is assumed in deriving this value.
Inhalation exposure	Negligible for contributing tasks that do not involve handling of solid products leading to evolution of dusts, or spraying of liquid product See also below	
Inhalation exposure (in mg/m^3)/8h workday ⁵⁹ (refers only to any contributing tasks involving handling of solid products leading to evolution of dusts)	2.0 (PROC8a, 8b; handling solids indoors). Containment and mechanical/natural ventilation; and PPE (Filter mask P2 (FFP2)) must be used to limit exposure and manage risks. Equipment must be well maintained and cleaned daily. 2.2 (PROC8a, 8b; handling solids outdoors). mechanical/natural ventilation; and PPE (Filter mask P2 (FFP2)) must be used to limit exposure and manage risks. Equipment must be well maintained and cleaned daily.	Derived using Stoffenmanager scenario assuming handling of product with low speed or with little force in medium quantities
Inhalation exposure (in mg/m^3)/8h workday ⁶⁰ (refers only to any contributing tasks involving spraying of liquid product)	n/a	Derived using Stoffenmanager scenario assuming Handling of liquids at high pressure resulting in substantial generation of mist or spray/haze

9.12.2.2 Consumer exposure

Usage is likely to be characterised as small scale, short term DIY projects; The scale of use falls within the range defined for small scale professional use below, but it may be anticipated that overall releases could be higher due to best practice not being met in terms of equipment or facilities for appropriate disposal of wastes.

⁵⁹ air concentration at the workplace

⁶⁰ air concentration at the workplace

The cement industry (MPA website, Advice on working with Cement page) estimates 10% wastage, Usage will often be outdoors with most waste solids passing either to local urban/industrial soil or collected for municipal disposal to landfill. By either disposal route, it would be expected that the iron would be immobile, not able to reach surface water or the wider environment. The possibility exists that in the worst case some dusts could be washed to waste water via storm drains, and from cleaning of clothing, tools etc.

MPA usage statistics suggest that sales of cement ‘products’ constitute around 20% of consumption of cement. It is presumed that some sales of such products will pass to consumers and some to small-scale professional users. Consumption by users in a small town is expected to total approx. 900 t over a year.

Fmls = 2E-03

Usage (based on exposure via a single WWTP, i.e. equivalent to estimated total usage in a small town)

Number of days = 365

To characterise the worst case it is assumed that dust formation washed to drain leads to losses of 0.02 from the sites.

Table 9.12.7: Risk management measures related to consumers’ use

Information type	Data field	Explanation
Personal protective equipment (PPE) required under regular conditions of consumer use		
Type of PPE (gloves, etc)	None	Worst case
Instructions addressed to consumers		
	As necessary, consumers should be advised to avoid contact with skin/eyes and/or to Use suitable protection	Classification and labelling of preparations containing $\geq 10\%$ iron salt (or less, depending on what other substances are present) would require hazard communication according to the legislation
Risk management measures related to emissions to the environment		
Municipal or other type of waste water treatment	Yes	Assume standard municipal WWTP with disposal of sludge by agricultural spreading.
Effluent (of the waste water treatment plant) discharge rate	2,000 m ³ /d	Default

Comment:

It is noted that the hazards associated with other constituents of cements are generally anticipated to be significantly worse than the iron salts. PPE and other risk management measures mentioned here refer only to measures necessary to manage possible risks from iron salts. In view of the other constituents of formulated cements more rigorous RMM may be necessary and/or already in place.

Table 9.12.8: Summary of highest short-term exposure concentration to consumers

Routes of exposure	Concentrations	Justification
Dermal local exposure (in $\mu\text{g}/\text{cm}^2$)	250	ConsExpo dermal load. Assuming that gloves are not worn
Dermal systemic exposure (in mg/kg bw/d)	6.8E-05 (mixing stage i.e. exposure to substance as such) ≤ 0.017 (application stage i.e. once prepared as an aqueous mix)	ConsExpo acute internal doses. 100% uptake assumed The limitation of $\leq 1\%$ dermal uptake is assumed in deriving this value.
Inhalation exposure	Negligible for contributing tasks that do not involve handling of solid products leading to evolution of dusts, or spraying of liquid product See also below	
Inhalation exposure (in $\text{mg}/\text{m}^3/\text{day}$) ⁶¹ (refers only to any contributing tasks involving handling of solid products leading to evolution of dusts)	1.1 (handling indoors). Mechanical/natural ventilation ⁶² should be available. Assumes Exposure duration up to 2 h/d and 1 d/w Use of a dust mask would be advisable if suitable ventilation is not available or for longer durations of activity	Derived using Stoffenmanager scenario assuming handling of product with low speed or with little force in medium quantities
Inhalation exposure (in $\text{mg}/\text{m}^3/\text{day}$) ⁶³ (refers only to any contributing tasks involving spraying of liquid product)	n/a	n/a

9.12.2.3 Indirect exposure of humans via the environment (oral)

Refer to Section 9.2.1.

9.12.2.4 Environmental exposure

9.12.2.4.1 Environmental releases

A summary of the local releases of ferrous sulfate to air, waste water and industrial soil is given in Table 9.9 below.

⁶¹ air concentration at the location of consumer use

⁶² open windows/ air conditioning

⁶³ air concentration at the location of consumer use

Table 9.12.9: Summary of environmental releases

Life cycle stage	Consumer use	Professional use – small-scale
Fraction in formulation	0.005	0.005
Number of days	365	300
Amount per day	2.5 t cement mix containing 12 kg iron salt (approx. 5 kg Fe)	8.3 t cement mix containing approx 41 kg iron salt (approx. 17 kg Fe)
Fraction to air	-	-
Amount to air	0	0
Fraction to waste water (prior to WWTP)	0.02	0.02
Fraction to sludge (passing to soil)		
Amount to waste water	0.1 kg/d	0.34 kg/d
WWTP flow (default)	2E+06 l/d	2E+06 l/d
Dilution in surface water (default)	10	10

Table 9.12.10: Releases to the environment

Compartments	Predicted releases (kg/d) - consumer	Predicted releases (kg/d) - professional	Explanation / source of measured data
Aquatic (before WWTP)	0.1 kg/d	0.34 kg/d	These data correspond to release to sewage
Air (direct + STP)	0	0	
Soil (direct only)	0	0	

Standard equations, described in detail in the REACH guidance and implemented within the EUSES 2.1 software, have been used to determine Predicted Environmental Concentrations (PECs) of Iron salts in surface water, seawater, sediment and agricultural soil.

Regional and continental background concentrations are also taken into account.

Table 9.12.11: Predicted Exposure Concentrations (PEC) for consumer use

Compartments	Local PEC	Justification
Surface water (in mg/l)	2.4E-06	Calculated using EUSES 2.1.1 in accordance with the exposure scenario.
Freshwater sediment (in g/kg dwt)	45.0	Calculated using EUSES 2.1.1 in accordance with the exposure scenario.
Agricultural soil (in g/kg dwt)	50.0	Calculated using EUSES 2.1.1 in accordance with the exposure scenario.

Table 9.12.12: Predicted Exposure Concentrations (PEC) for professional use (small scale)

Compartments	Local PEC	Justification
Surface water (in mg/l)	2.4E-06	Calculated using EUSES 2.1.1 in accordance with the exposure scenario.
Freshwater sediment (in g/kg dwt)	45.0	Calculated using EUSES 2.1.1 in accordance with the exposure scenario.
Agricultural soil (in g/kg dwt)	50.0	Calculated using EUSES 2.1.1 in accordance with the exposure scenario.