

3. CHEMICAL AND PHYSICAL INFORMATION

3.1 CHEMICAL IDENTITY

Information regarding the chemical identity of chromium is located in Table 3-1.

The synonyms, trade name, chemical formula, and identification numbers of chromium and selected salts are reported in Table 3-1.

3.2 PHYSICAL AND CHEMICAL PROPERTIES

Information regarding the physical and chemical properties of chromium is located in Table 3-2.

Chromium is a metallic element with oxidation states ranging from chromium(-II) to chromium(+VI). The important valence states of chromium are II, III, and VI. Elemental chromium, chromium(0), does not occur naturally. The divalent state (II or chromous) is relatively unstable and is readily oxidized to the trivalent (III or chromic) state. Chromium compounds are stable in the trivalent state and occur in nature in this state in ores, such as ferrochromite (FeCr_2O_4). The hexavalent (VI or chromate) is the second most stable state. However, hexavalent chromium rarely occurs naturally, but is produced from anthropogenic sources (EPA 1984a). Chromium in the hexavalent state occurs naturally in the rare mineral crocoite (PbCrO_4) (Hurlburt 1971).

Trivalent chromium compounds, with the exception of acetate, hexahydrate of chloride, and nitrate salts, are generally insoluble in water (Table 3-2). Some hexavalent compounds, such as chromium(VI) oxide (or chromic acid), and the ammonium and alkali metal salts (e.g., sodium and potassium) of chromic acid are readily soluble in water. The alkaline metal salts (e.g., calcium, strontium) of chromic acid are less soluble in water. The zinc and lead salts of chromic acid are practically insoluble in cold water (Table 3-2). The hexavalent chromium compounds are reduced to the trivalent form in the presence of oxidizable organic matter. However, in natural waters where there is a low concentration of reducing materials, hexavalent chromium compounds are more stable (EPA 1984a).

In humans and animals, chromium(III) is an essential nutrient that plays a role in glucose, fat, and protein metabolism by potentiating action of insulin. Chromium picolinate, a trivalent form of chromium complexed with picolinic acid, is used as a dietary supplement, because it is claimed to speed metabolism

Table 3-1. Chemical Identity of Chromium and Compounds

Characteristic	Chromium(0)	Chromium(III) acetate, monohydrate	Chromium(III) nitrate, nonahydrate	Chromium(III) chloride
Synonym(s)	Chrome; Chrom (German); Chrome (French)	Acetic acid, chromium salt, hydrate; chromic acetate, hydrate	Nitric acid, chromium (III) salt, nonahydrate; chromium nitrate, nonahydrate	Chromium trichloride
Registered trade name(s)	Chrome	No data	No data	C177295
Chemical formula	Cr	$\text{Cr}(\text{CH}_3\text{COO})_3 \cdot \text{H}_2\text{O}$	$\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	CrCl_3
Chemical structure	Cr			
Identification numbers:				
CAS registry	7440-47-3	25013-82-5	7789-02-8	10025-73-7
NIOSH RTECS	GB420000	AG3053333	GB6300000	GB5425000
EPA hazardous waste	D007	No data	No data	No data
OHM/TADS	7216647	No data	No data	No data
DOT/UN/NA/IMCO shipping	Not assigned	No data	No data	No data
HSDB	910	No data	No data	No data
NCI	Not assigned	No data	No data	No data

Table 3-1. Chemical Identity of Chromium and Compounds (continued)

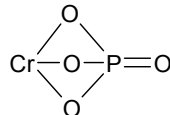
Characteristic	Chromium(III) chloride hexahydrate	Ferrocromite (Chromium(III))	Chromium(III) oxide	Chromium(III) phosphate
Synonym(s)	Hexaaquachromium (III) chloride	Chromite	Chromium sesquioxide; dichromium trioxide	Chromumorthophosphate; phosphoric acid, chromium (III) salt
Registered trade name(s)	No data	No data	No data	Amaudon's Green
Chemical formula	$\text{Cr}(\text{Cl})_3 \cdot 6\text{H}_2\text{O}$	FeCr_2O_4	Cr_2O_3	CrPO_4
Chemical structure	$\text{Cr}[\text{Cl}_2(\text{H}_2\text{O})_4]\text{Cl} \cdot 2\text{H}_2\text{O}$	FeOCr_2O_3	$\text{O}=\text{Cr}-\text{O}-\text{Cr}=\text{O}$	
Identification numbers:				
CAS registry	10060-12-5	1308-31-2	1308-38-9	7789-04-0
NIOSH RTECS	GB5450000	GB4000000	GB6475000	GB6840000
EPA hazardous waste	No data	D007	D007	No data
OHM/TADS	No data	No data	Not assigned	No data
DOT/UN/NA/IMCO shipping	No data	No data	Not assigned	No data
HSDB	No data	2963	1619	No data
NCI	No data	No data	Not assigned	No data

Table 3-1. Chemical Identity of Chromium and Compounds (continued)

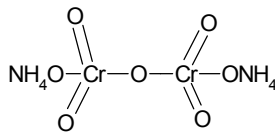
Characteristic	Chromium(III) sulfate	Sodium chromite (Chromium(III))	Chromium(IV) oxide	Ammonium dichromate (Chromium(VI))
Synonym(s)	Sulfuric acid, chromium (III) salt	No data	Chromium dioxide	Chromic acid, diamonium salt
Registered trade name(s)	Chromitan B	No data	No data	No data
Chemical formula	$\text{Cr}_2(\text{SO}_4)_3$	NaCrO_2	CrO_2	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7$
Chemical structure	$\text{SO}_4=\text{Cr}-\text{SO}_4-\text{Cr}=\text{SO}_4$	$\text{NaO}-\text{Cr}=\text{O}$	$\text{O}=\text{Cr}=\text{O}$	
Identification numbers:				
CAS registry	10101-53-8	12314-42-0	12018-01-8	7789-09-5
NIOSH RTECS	GB7200000	No data	GB6400000	HX7650000
EPA hazardous waste	D0007	No data	D007	Not assigned
OHM/TADS	7800052	No data	No data	7217321
DOT/UN/NA/IMCO shipping	Not assigned	No data	No data	UN1439; IM05.1
HSDB	2543	No data	1620	481
NCI	Not assigned	No data	No data	No data

Table 3-1. Chemical Identity of Chromium and Compounds (continued)

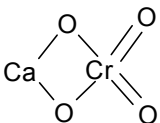
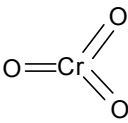
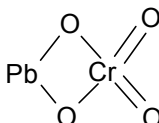
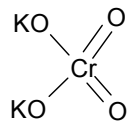
Characteristic	Calcium chromate (Chromium(VI))	Chromium(VI) trioxide	Lead chromate (Chromium(VI))	Potassium chromate (Chromium(VI))
Synonym(s)	Chromic acid, calcium salt	Chromic acid, chromium anhydride	Chromic acid, lead salt	Chromic acid, dipotassium salt
Registered trade name(s)	Calcium Chrome Yellow	No data	Chrome Yellow G	No data
Chemical formula	CaCrO ₄	CrO ₃	PbCrO ₄	K ₂ CrO ₄
Chemical structure				
Identification numbers:				
CAS registry	13765-19-0	1333-82-0	7758-97-6	7789-00-6
NIOSH RTECS	GB2750000	GB6650000	GB2975000	GB2940000
EPA hazardous waste	U032; D007	D007	D007; D008	No data
OHM/TADS	7800051	Not assigned	Not assigned	7217277
DOT/UN/NA/IMCO shipping	NA9096	YB1463/UN15.1; IM05.1	Not assigned	NA9142
HSDB	248	518; NA1463	1650	1249
NCI	Not assigned	UN1463	Not assigned	Not assigned

Table 3-1. Chemical Identity of Chromium and Compounds (continued)

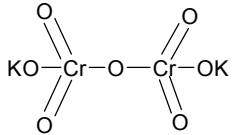
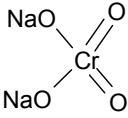
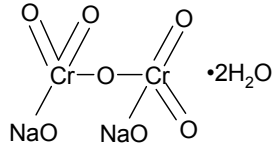
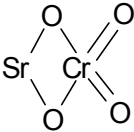
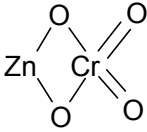
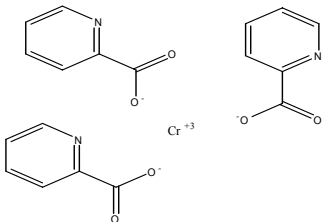
Characteristic	Potassium dichromate (Chromium(VI))	Sodium chromate (Chromium(VI))	Sodium dichromate, dihydrate (Chromium(VI))
Synonym(s)	Chromic acid, dipotassium salt	Chromic acid, disodium salt	Chromic acid, disodium salt; dihydrate
Registered trade name(s)	No data	Caswell No. 757	No data
Chemical formula	$K_2Cr_2O_7$	Na_2CrO_4	$NaCr_2O_7 \cdot 2H_2O$
Chemical structure			
Identification numbers:			
CAS registry	7778-50-9	7775-11-3	7789-12-0
NIOSH RTECS	HX7680000	GB2955000	HX7750000
EPA hazardous waste	No data	D007	No data
OHM/TADS	7217278	7216891	No data
DOT/UN/NA/IMCO shipping	NA1479; IM09.0	No data	No data
HSDB	1238	2962	No data
NCI	Not assigned	Not assigned	No data

Table 3-1. Chemical Identity of Chromium and Compounds (continued)

Characteristic	Strontium chromate (Chromium(VI))	Zinc chromate (Chromium(VI))	Chromium(III) picolinate
Synonym(s)	Chromic acid, strontium salt	Chromic acid, zinc salt	CrPic; Chromium 2-pyridinecarboxylate; Chromium; tris(picolinato)-; Picolinic acid; chromium salt
Registered trade name(s)	No data	CI Pigment Yellow	No data
Chemical formula	SrCrO ₄	ZnCrO ₄	C ₁₈ H ₁₂ CrN ₃ O ₆
Chemical structure			
Identification numbers:			
CAS registry	7789-06-2	13530-65-9	14639-25-9
NIOSH RTECS	GB3240000	GB3290000	No data
EPA hazardous waste	D007	D007	No data
OHM/TADS	780058	7217401	No data
DOT/UN/NA/IMCO	NA9149	Not assigned	No data
HSDB	2546	6188	No data
NCI	Not assigned	Not assigned	No data

Source: HSDB 1998; NIOSH 1997

CAS=Chemical Abstracts Services; DOT/UN/NA/IMCO=Department of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; EPA=Environmental Protection Agency; HSDB=Hazardous Substances Data Bank; NCI=National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS=Oil and Hazardous Materials/Technical Assistance Data System; RTECS=Registry of Toxic Effects of Chemical Substances

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Table 3-2. Physical and Chemical Properties of Chromium and Compounds^a

Property	Chromium(0)	Chromium(III) acetate, monohydrate	Chromium(III) nitrate, nonahydrate	Chromium(III) chloride
Molecular weight	51.996	247.15	400.15	158.36
Color	Steel-gray	Gray-green or bluish-green	Purple or violet	Violet or purple
Physical state	Solid	Solid	Solid	Solid
Melting point	1,857 EC	No data	60 EC	1,150 EC
Boiling point	2,672 EC	No data	Decomposes at 100 EC	Sublimes at 1,300 EC
Density, g/cm ³	7.20 (28 EC) ^b	No data	No data	2.76 (15 EC) ^b
Odor	No data	No data	No data	No data
Odor threshold:				
Water	No data	No data	No data	No data
Air	No data	No data	No data	No data
Solubility:				
Water	Insoluble	Soluble	Soluble	Slightly soluble in hot water
Organic- solvent(s)	Insoluble in common organic solvents	Insoluble in ethanol	Soluble in ethanol and acetone	Insoluble in common organic solvents
Partition coefficients:				
Log K _{ow}	Not applicable	Not applicable	Not applicable	Not applicable
Log K _{oc}	Not applicable	Not applicable	Not applicable	Not applicable
Vapor pressure	1 mmHg at 1,616 EC	No data	No data	No data
Henry's law constant	Not applicable	Not applicable	Not applicable	Not applicable
Autoignition temperature	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data
Flammability limits	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data

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Table 3-2. Physical and Chemical Properties of Chromium and Compounds (*continued*)

Property	Chromium(III) chloride, hexahydrate	Ferrochromite (Chromium(III))	Chromium(III) oxide	Chromium(III) phosphate
Molecular weight	266.45	223.84	151.99	146.97
Color	Violet	Brown-black	Green	Gray-brown to black ^d
Physical state	Solid	Solid	Solid	Solid
Melting point	83 EC	No data	2,266 EC	>1,800 EC
Boiling point	No data	No data	4,000 EC	No data
Density g/cm ³	1.76 ^c	4.97 (20 EC)	5.21 ^c	2.94 (32.5 EC) ^{b,d}
Odor	No data	No data	No data	No data
Odor threshold:				
Water	No data	No data	No data	No data
Air	No data	No data	No data	No data
Solubility:				
Water	58.5 g/100 cc at 25 EC	Insoluble	Insoluble	Insoluble ^d
Organic solvent(s)	Soluble in ethanol	No data	Insoluble in ethanol	No data in ethanol
Partition coefficients:				
Log K _{ow}	No data	Not applicable	Not applicable	Not applicable
Log K _{oc}	No data	Not applicable	Not applicable	Not applicable
Vapor pressure	No data	No data	No data	No data
Henry's law constant	No data	Not applicable	Not applicable	Not applicable
Autoignition temperature	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data
Flammability limits	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data

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Table 3-2. Physical and Chemical Properties of Chromium and Compounds (*continued*)

Property	Chromium(III) sulfate	Sodium chromite (Chromium(III))	Chromium(IV) oxide	Ammonium dichromate (Chromium(VI))
Molecular weight	392.16	106.98	83.99	252.06
Color	Violet or red	No data	Brown-black	Orange
Physical state	Solid	No data	Solid	Solid
Melting point	No data	No data	Decomposes at 300 EC	Decomposes at 170 EC
Boiling point	No data	No data	Not applicable	Not applicable
Density g/cm ³	3.012 ^c	No data	No data	2.15 (25 EC) ^b
Odor	No data	No data	No data	No data
Odor threshold:				
Water	No data	No data	No data	No data
Air	No data	No data	No data	No data
Solubility:				
Water	Insoluble	No data	Insoluble	30.8 g/100 cc at 15 EC
Organic solvent(s)	Slightly soluble in ethanol	No data	No data	Soluble in ethanol
Partition coefficients:				
Log K _{ow}	Not applicable	Not applicable	Not applicable	Not applicable
Log K _{oc}	Not applicable	Not applicable	Not applicable	Not applicable
Vapor pressure	No data	No data	No data	No data
Henry's law constant	Not applicable	Not applicable	Not applicable	Not applicable
Autoignition temperature	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data
Flammability limits	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data

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Table 3-2. Physical and Chemical Properties of Chromium and Compounds (*continued*)

Property	Calcium chromate (ChromiumVI)	Chromium(VI) trioxide	Lead chromate (Chromium(VI))	Potassium chromate (Chromium(VI))
Molecular weight	156.01	99.99	323.18	194.20
Color	Yellow	Red	Yellow	Yellow
Physical state	Solid	Solid	Solid	Solid
Melting point	No data	196 EC	844 EC	968 EC
Boiling point	No data	Decomposes	Decomposes	No data
Density g/cm ³	2.89 ^c	2.70 (25 EC)	6.12 (15 EC)	2.732 (18 EC)
Odor	No data	No data	No data	No data
Odor threshold:				
Water	No data	No data	No data	No data
Air	No data	No data	No data	No data
Solubility:				
Water	2.23 g/100 mL ^c	61.7 g/100 cc at 0 EC	5.8 µg/100 mL	62.9 g/100 at 20 EC
Organic solvent(s)	No data	Soluble in ethanol and ether	Insoluble in acetic acid	Insoluble in ethanol
Partition coefficients:				
Log K _{ow}	Not applicable	Not applicable	Not applicable	Not applicable
Log K _{oc}	Not applicable	Not applicable	Not applicable	Not applicable
Vapor pressure	No data	No data	No data	No data
Henry's law constant	Not applicable	Not applicable	Not applicable	Not applicable
Autoignition temperature	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data
Flammability limits	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data

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Table 3-2. Physical and Chemical Properties of Chromium and Compounds (*continued*)

Property	Potassium dichromate (Chromium(VI))	Sodium chromate (Chromium(VI))	Sodium dichromate, dihydrate (Chromium(VI))
Molecular weight	294.18	161.97	298.00
Color	Red	Yellow	Red
Physical state	Solid	Solid	Solid
Melting point	398 EC	792 EC	356.7 EC
Boiling point	Decomposes at 500 EC	No data	Decomposes at 400 EC
Density g/cm ³	2.676 (25 EC)	2.710–2.736°	2.52 (13 EC)
Odor	No data	No data	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	4.9 g/100 cc at 0 EC	87.3 g/100 cc at 30 EC	230 g/100 cc at 0 EC
Organic solvent(s)	Insoluble in ethanol and acetone	Soluble in methanol	Insoluble in ethanol
Partition coefficients:			
Log K _{ow}	Not applicable	Not applicable	Not applicable
Log K _{oc}	Not applicable	Not applicable	Not applicable
Vapor pressure	No data	No data	No data
Henry's law constant	Not applicable	Not applicable	Not applicable
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	No data	No data	No data
Explosive limits	No data	No data	No data

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Table 3-2. Physical and Chemical Properties of Chromium and Compounds (*continued*)

Property	Strontium chromate (Chromium(VI))	Zinc chromate (Chromium(VI))	Chromium(III) picolinate
Molecular weight	203.61	181.97	418.3 ^e
Color	Yellow	Lemon-yellow	Ruby red ^e
Physical state	Solid	Solid	Crystal ^e
Melting Point	No data	No data	No data
Boiling Point	No data	No data	No data
Density g/cm ³	3.895 (15 EC)	3.40 ^c	No data
Odor	No data	Odorless	No data
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	0.12 g/100 cc at 15 EC	Insoluble	1 ppm at 25 EC ^e
Organic solvent(s)	Soluble in acetyl acetone	Insoluble in acetone	>6 g/L (DMSO) ^e
Partition coefficients:			
Log K _{ow}	Not applicable	Not applicable	1.753 ^f
Log K _{oc}	Not applicable	Not applicable	No data
Vapor pressure	No data	No data	No data
Henry's law constant	Not applicable	Not applicable	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability limits	No data	No data	No data
Conversion factors	No data	No data	No data
Explosive limits	No data	No data	No data

^aHartford 1979; Weast 1985, except when noted

^bTemperature at which the densities were measured has been given only when such data is available

^cTemperature at which density was measured was not specified

^dWindholz 1983

^eBroadhurst et al. 1997

^fChakov et al. 1999

DMSO=dimethylsulfoxide

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and may have anti-diabetic effects (Broadhurst et al. 1997). It has also been shown to be absorbed more readily than chromium obtained from food sources (Gargas et al. 1994). Unfortunately, the mechanism of transport and absorption of chromium picolinate has not been determined. Recently, a spectroscopic analysis of this compound has shown that chromium picolinate is a very stable complex in the body and its absorption properties may be due to its ability to cross membranes readily (Chakov et al. 1999).