

## 4. CHEMICAL AND PHYSICAL INFORMATION

### 4.1 CHEMICAL IDENTITY

Aluminum is a naturally occurring element that appears in the second row of Group 13 (IIIA) of the periodic table (O'Neil et al. 2001). Table 4-1 lists common synonyms and other pertinent identification information for aluminum and selected aluminum compounds.

### 4.2 PHYSICAL AND CHEMICAL PROPERTIES

Aluminum is a silvery-white, malleable, and ductile metal. In moist air, a protective oxide coating of aluminum oxide is formed on its surface. In compounds, aluminum typically occurs in its +3 oxidation state (Lide 2005; O'Neil et al. 2001). Table 4-2 lists important physical and chemical properties of aluminum and selected aluminum compounds.

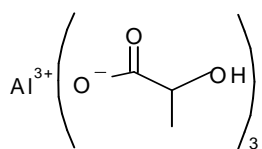
## 4. CHEMICAL AND PHYSICAL INFORMATION

**Table 4-1. Chemical Identity of Aluminum and Compounds<sup>a</sup>**

Characteristic	Information		
Chemical name	Aluminum	Aluminum chloride	Aluminum chlorohydrate (anhydrous)
Synonym(s)	Aluminium <sup>b</sup> ; alumina fibre; metana; aluminium bronze; aluminum dehydrated; aluminium flake; aluminum powder; aluminum-27; Noral aluminum; PAP-1	Aluminum trichloride; aluminum chloride (1:3); Pearsall	Aluminol ACH; aluminum chloride hydroxide oxide, basic; aluminum chloride oxide; aluminum oxychloride; PAC 250A; Astringen; Chlorhydrol; Locron
Chemical formula	Al	AlCl <sub>3</sub>	Unspecified <sup>d</sup>
Chemical structure	Al	Al <sup>3+</sup> (Cl <sup>-</sup> ) <sub>3</sub>	Unspecified
Identification numbers:			
CAS registry	7429-90-5	7446-70-0	1327-41-9
EINECS	231-072-3	231-208-1	215-477-2
NIOSH RTECS	BD330000	BD0525000	No data
EPA hazardous waste code	No data	D003	No data
EPA Pesticide Chemical Code	000111	013901	No data
DOT/UN/NA/IMCO shipping	UN 1309; UN 1396; IMO 4.1; IMO 4.3; NA 9260	UN 1726; UN 2581; IMO 8.0	No data
HSDB	507	607	No data

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**Table 4-1. Chemical Identity of Aluminum and Compounds<sup>a</sup>**

Characteristic	Information		
Chemical name	Aluminum hydroxide	Aluminum lactate	Aluminum nitrate
Synonym(s)	alpha-Alumina trihydrate; alumina hydrate; alumina hydrated; aluminum oxide trihydrate; aluminum oxide hydrate; aluminum (III) hydroxide; hydrated alumina; hydrated aluminum oxide; aluminum hydrate; aluminum trihydrate; hydrated alumina; Alcoa 331/C 30BF/C 330/C 333; Alugel; Alumigel; BACO AF260; British Aluminum AF260; Calmogastrin; Higilite H 31S/ H 32/ H 42; Hychol 705; Hydrafil; Hydral 705/710; Martinal A/A-S/F-A; Reheis F 1000	Aluminum, tris (2-hydroxypropanoate-O <sup>1</sup> ,O <sup>2</sup> ); propanoic acid, 2-hydroxy-, aluminum complex; aluminum tris (α-hydroxypropionate)	Aluminum trinitrate; aluminum (III) nitrate (1:3); nitric acid, aluminum salt; nitric acid, aluminum (3+) salt
Chemical formula	Al(OH) <sub>3</sub>	C <sub>9</sub> H <sub>15</sub> AlO <sub>9</sub>	Al(NO <sub>3</sub> ) <sub>3</sub>
Chemical structure	$Al^{3+} (OH^-)_3$		$Al^{3+} (NO_3^-)_3$
Identification numbers:			
CAS registry	21645-51-2	18917-91-4	13473-90-0
EINECS	244-492-7	242-670-9	236-751-8
NIOSH RTECS	BD0940000	No data	No data
EPA hazardous waste code	No data	No data	No data
EPA Pesticide Chemical Code	No data	No data	No data
DOT/UN/NA/IMCO shipping	No data	No data	UN 1438; IMO 5.1
HSDB	575	No data	574

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**Table 4-1. Chemical Identity of Aluminum and Compounds<sup>a</sup>**

Characteristic	Information		
Chemical name	Aluminum oxide	Aluminum phosphate	Aluminum phosphide
Synonym(s)	Activated aluminum oxide; $\alpha$ -alumina; aluminum sesquioxide; $\beta$ -aluminum oxide; $\gamma$ -alumina; Almite; Alon; Aloxite; Alumite; Alundum; Campalox; Dispal Alumina; Exolon XW 60; Faserton; Hypalox II; Ludox CL; Martoxin; Microgrit WCA; Poraminar	Aluminum ortho-phosphate; phosphoric acid; aluminum salt (1:1); Aluphos; Phosphaljel; Phosphalugel; aluminum monophosphate	Aluminum monophosphide; AL-Phos; AIP; Celphos; Delicia; Delicia Gastoxin; Detia; Phostoxin; Quickphos
Chemical formula	$Al_2O_3$	$AlPO_4$	AIP
Chemical structure	$(Al^{3+})_2 (O^{2-})_3$	$Al^{3+} PO_4^{3-}$	$Al \equiv P$
Identification numbers:			
CAS registry	1344-28-1	7784-30-7	20859-73-8
EINECS	215-691-6	232-056-9	244-088-0
NIOSH RTECS	BD1200000	TB6450000	BD1400000 <sup>c</sup>
EPA hazardous waste code	No data	No data	P006
EPA Pesticide Chemical Code	No data	No data	066501
DOT/UN/NA/IMCO shipping	No data	No data	UN 1397; UN 3048; IMO 4.3; IMO 6.1
HSDB	506	No data	6035

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**Table 4-1. Chemical Identity of Aluminum and Compounds<sup>a</sup>**

Characteristic	Information		
Chemical name	Aluminum fluoride	Aluminum sulfate	Aluminum carbonate
Synonym(s)	Aluminum trifluoride	Alum; aluminum sulfate (2:3); cake alum; filter alum; papermaker's alum; pearl alum; pickle alum; aluminum trisulfate; sulfuric acid, aluminum salt (3:2)	No data
Chemical formula	AlF <sub>3</sub>	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub> •CO <sub>2</sub> ; normal aluminum carbonate Al <sub>2</sub> (CO <sub>3</sub> ) <sub>3</sub> is not known as an individual compound <sup>e</sup>
Chemical structure	Al <sup>3+</sup> (F <sup>-</sup> ) <sub>3</sub>	(Al <sup>3+</sup> ) <sub>2</sub> (SO <sub>4</sub> <sup>2-</sup> ) <sub>3</sub>	No data
Identification numbers:			
CAS registry	7784-18-1	10043-01-3	53547-27-6
EINECS	232-051-1	233-135-0	238-440-2
NIOSH RTECS	BD0725000	BD1700000	No data
EPA hazardous waste code	No data	No data	No data
EPA Pesticide Chemical Code	No data	013906	No data
DOT/UN/NA/IMCO shipping	No data	NA 9078; NA 1760	No data
HSDB	600	5067	No data

## 4. CHEMICAL AND PHYSICAL INFORMATION

**Table 4-1. Chemical Identity of Aluminum and Compounds<sup>a</sup>**

Characteristic	Information	
Chemical name	Aluminum potassium sulfate	Alchlor
Synonym(s)	Alum potassium; burnt alum; sulfuric acid, aluminum potassium salt (2:1:1); Tai-Ace K 150; Tai-Ace K 20	Aluminum chloride hydroxide propylene glycol complex
Chemical formula	$\text{AlK}_2\text{O}_8\text{S}_2$	Unspecified
Chemical structure	$\text{K}^+ \text{Al}^{3+} (\text{SO}_4^{2-})_2$	Unspecified
Identification numbers:		
CAS registry	10043-67-1	52231-93-3
EINECS	233-141-3	No data
NIOSH RTECS	No data	No data
EPA hazardous waste code	No data	No data
EPA pesticide chemical code	No data	No data
DOT/UN/NA/IMCO shipping	No data	No data
HSDB	No data	No data

<sup>a</sup>All information obtained from ChemIDplus 2006, ChemFinder 2006, and HSDB 2006, except where noted.

<sup>b</sup>British spelling (Lewis 2001)

<sup>c</sup>NIOSH 2006

<sup>d</sup>Aluminum chlorohydrate: CAS No. 12042-91-0; Chemical formula:  $\text{Al}_2\text{ClH}_5\text{O}_5 \cdot x\text{H}_2\text{O}$  (ChemIDplus 2006)

<sup>e</sup>Lewis 2001

CAS = Chemical Abstracts Service; DOT/UN/NA/IMO = Department of Transportation/United Nations/North America/Intergovernmental Maritime Dangerous Goods Code; EINECS = European Inventory of Existing Commercial Chemical Substances; EPA = Environmental Protection Agency; HSDB = Hazardous Substances Data Bank; NIOSH = National Institute for Occupational Safety and Health; RTECS = Registry of Toxic Effects of Chemical Substances

## 4. CHEMICAL AND PHYSICAL INFORMATION

**Table 4-2. Physical and Chemical Properties of Aluminum and Compounds<sup>a</sup>**

Property	Information		
Chemical name	Aluminum	Aluminum chloride	Aluminum chlorohydrate
Molecular weight	26.98	133.34	No data
Color	Silver white	White when pure, ordinarily gray or yellow to greenish	Glassy <sup>b</sup>
Physical state	Malleable, ductile metal; cubic crystal	White hexagonal deliquescent or moisture sensitive plates	Solid <sup>b</sup>
Melting point	660 °C	192.6 °C	No data
Boiling point	2,327 °C	182.7 °C at 752 mm Hg (sublimation temperature)	No data
Density (g/cm <sup>3</sup> )	2.70	2.48	No data
Odor	Odorless	Strong odor of hydrogen chloride	No data
Odor threshold:			
Water	No data	0.5 mg/L (calculating on the aluminum ion)	No data
Air	No data	No data	No data
Solubility:			
Water	Insoluble in water	Reacts violently with water producing hydrochloric acid and heat	Dissolves in H <sub>2</sub> O, forming slightly turbid colloidal solutions (up to 55% w/w) <sup>b</sup>
Other solvents	Soluble in HCl, H <sub>2</sub> SO <sub>4</sub> , hot water, and alkalis	Soluble in benzene, carbon tetrachloride, chloroform	No data
Partition coefficients:			
Log K <sub>ow</sub>	No data	No data	No data
Log K <sub>oc</sub>	No data	No data	No data
pH	No data	No data	~4.3 (15% aqueous solution) <sup>b</sup>
Vapor pressure	1 mmHg at 1,284 °C	1 mmHg at 100 °C	No data
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	Finely divided aluminum dust is easily ignited	Not combustible, but heating may produce irritants and toxic gases	No data
Explosive limits	No data	No data	No data

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**Table 4-2. Physical and Chemical Properties of Aluminum and Compounds<sup>a</sup>**

Property	Information		
Chemical name	Aluminum hydroxide	Aluminum lactate	Aluminum nitrate
Molecular weight	78.01	294.19 <sup>b</sup>	213.00
Color	White	Colorless <sup>c</sup>	Colorless <sup>d</sup>
Physical state	Bulky, amorphous powder	Powder <sup>c</sup>	Rhombic crystals <sup>d</sup>
Melting point	300 °C	No data	73 °C <sup>d</sup>
Boiling point	No data	No data	Decomposes at 135 °C <sup>d</sup>
Density (g/cm <sup>3</sup> )	2.42	No data	No data
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	Insoluble in water	Freely soluble in water <sup>b</sup>	Very soluble in water <sup>d</sup>
Other solvents	Soluble in alkaline solutions, acid	No data	Very soluble in alcohol; very slightly soluble in acetone; almost insoluble in ethyl acetate, pyridine <sup>d</sup>
Partition coefficients:			
Log K <sub>ow</sub>	No data	No data	No data
Log K <sub>oc</sub>	No data	No data	No data
pH	No data	No data	Aqueous solution is acidic
Vapor pressure	No data	No data	No data
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	No data	No data	No data
Explosive limits	No data	No data	No data



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**Table 4-2. Physical and Chemical Properties of Aluminum and Compounds<sup>a</sup>**

Property	Information		
Chemical name	Aluminum oxide	Aluminum phosphate	Aluminum phosphide
Molecular weight	101.94	121.95 <sup>b</sup>	57.95
Color	White	White <sup>b</sup>	Dark gray or dark yellow
Physical state	Crystalline powder	Infusible powder <sup>b</sup>	Cubic crystals
Melting point	approx. 2,000 °C	>1,460 °C <sup>a</sup>	2,550 °C
Boiling point	2,980 °C	No data	No data
Density (g/cm <sup>3</sup> )	4.0 at 20 °C	2.56 <sup>a</sup>	2.85 at 15 °C
Odor	Odorless	No data	Garlic odor
Odor threshold:			
Water	No data	No data	No data
Air	No data	No data	No data
Solubility:			
Water	Soluble in cold water, 0.000098 g/100 cc; insoluble in hot water	Practically insoluble in water <sup>a</sup>	Decomposes <sup>b</sup>
Other solvents	Very slightly soluble in acid, alkali	Practically insoluble in acetic acid; very slightly soluble in concentrated HCl and HNO <sub>3</sub> acids <sup>b</sup>	No data
Partition coefficients:			
Log K <sub>ow</sub>	No data	No data	No data
Log K <sub>oc</sub>	No data	No data	No data
pH	No data	No data	No data
Vapor pressure	1 mmHg at 2,158 °C	No data	No data
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	No data	No data	No data
Explosive limits	No data	No data	No data

## 4. CHEMICAL AND PHYSICAL INFORMATION

**Table 4-2. Physical and Chemical Properties of Aluminum and Compounds<sup>a</sup>**

Property	Information		
Chemical name	Aluminum fluoride	Aluminum sulfate	Aluminum carbonate
Molecular weight	83.98	342.14	No data
Color	White	White, lustrous	White <sup>c</sup>
Physical state	Hexagonal crystals	Crystals, pieces, granules or powder	Lumps or powder <sup>c</sup>
Melting point	1,291 °C	Decomposes at 770 °C	No data
Boiling point	Sublimes at 1,272 °C and 760 mm Hg	No data	No data
Density (g/cm <sup>3</sup> )	3.10	1.61	No data
Odor	No data	Odorless	No data
Odor threshold:			No data
Water	No data	No data	
Air	No data	No data	
Solubility:			
Water	0.559 g/100 mL at 25 °C	Soluble in 1 part H <sub>2</sub> O	Insoluble <sup>c</sup>
Other solvents	Sparingly soluble in acids and alkalis; insoluble in alcohol and acetone	Insoluble in ethanol	Dissolves in hot HCl or H <sub>2</sub> SO <sub>4</sub> acid <sup>c</sup>
Partition coefficients:			
Log K <sub>ow</sub>	No data	No data	No data
Log K <sub>oc</sub>	No data	No data	No data
pH	No data	Aqueous solution (1 g/mL) not less than 2.9	No data
Vapor pressure	1 mmHg at 1,238 °C	Essentially zero	No data
Henry's law constant	No data	No data	No data
Autoignition temperature	No data	No data	No data
Flashpoint	No data	No data	No data
Flammability	No data	No data	No data
Explosive limits	No data	No data	No data

## 4. CHEMICAL AND PHYSICAL INFORMATION

**Table 4-2. Physical and Chemical Properties of Aluminum and Compounds<sup>a</sup>**

Property	Information	
Chemical name	Aluminum potassium sulfate	Alchlor
Molecular weight	258.20	No data
Color	White	No data
Physical state	Powder	No data
Melting point	92 °C <sup>e</sup>	No data
Boiling point	Loses 18 H <sub>2</sub> O at 64.5 °C; anhydrous at 200 °C <sup>e</sup>	No data
Density (g/cm <sup>3</sup> )	1.75 <sup>e</sup>	No data
Odor	Odorless <sup>e</sup>	No data
Odor threshold:		
Water	No data	No data
Air	No data	No data
Solubility:		
Water	1 gram dissolves in about 20 mL of cold water, about 1 mL of boiling water	No data
Other solvents	Practically insoluble in alcohol	No data
Partition coefficients:		
Log K <sub>ow</sub>	No data	No data
Log K <sub>oc</sub>	No data	No data
pH	Aqueous solutions are acidic	No data
Vapor pressure	No data	No data
Henry's law constant	No data	No data
Autoignition temperature	No data	No data
Flashpoint	No data	No data
Flammability limits	Noncombustible <sup>e</sup>	No data
Explosive limits	No data	No data

<sup>a</sup>All information obtained from HSDB 2006, except where noted.

<sup>b</sup>O'Neil et al. 2001

<sup>c</sup>Lewis 2001

<sup>d</sup>Aluminum nitrate nonahydrate

<sup>e</sup>Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·K<sub>2</sub>SO<sub>4</sub>·24H<sub>2</sub>O (Lewis 2001)