

### **3. CHEMICAL AND PHYSICAL INFORMATION**

#### **3.1 CHEMICAL IDENTITY**


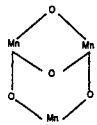
Table 3-1 lists common synonyms, trade names, and other relevant information regarding the chemical identity of manganese and several of its most important compounds.

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

#### **3.2 PHYSICAL AND CHEMICAL PROPERTIES**

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

Table 3-1. Chemical Identity of Manganese and Compounds<sup>a</sup>

| Characteristic                  | Manganese   | Manganese (II)<br>Chloride                                | Manganous<br>Sulfate  | Manganese (II, III)<br>Oxide  |
|---------------------------------|---|---|---|---|
| Synonyms                        | Elemental manganese <sup>b</sup> ;<br>colloidal manganese <sup>b</sup> ; cutaval <sup>b</sup> | Manganese chloride <sup>b</sup> ;<br>manganese dichloride | Manganese sulfate   | Trimanganese tetroxide;<br>mangano-manganic oxide <sup>c</sup>                      |
| Registered trade name(s)        | Cutaval <sup>b</sup> ; Mangan <sup>b</sup>  | No data   | Sorba-Spray Manganese <sup>b</sup>  | No data   |
| Chemical formula                | Mn  | MnCl <sub>2</sub>   | MnSO <sub>4</sub>   | Mn <sub>3</sub> O <sub>4</sub>  |
| Chemical structure <sup>d</sup> | Mn  | Cl <sup>-</sup><br>Mn <sup>+2</sup><br>Cl <sup>-</sup>    |  |  |
| Identification numbers:         |   |   |   |   |
| CAS                             | 7439-96-5   | 7773-01-5   | 7785-87-7   | 1317-35-7   |
| NIOSH RTECS                     | 009275000 <sup>b</sup>  | 009625000 <sup>b</sup>                                    | OP1050000 <sup>b</sup>  | OP0900000 <sup>b</sup>  |
| EPA hazardous waste             | No data   | No data   | No data   | No data   |
| OHM/TADS                        | No data   | No data   | No data   | No data   |
| DOT/UN/NA/IMCO shipping         | No data   | No data   | No data   | No data   |
| HSDB                            | 00550 <sup>b</sup>  | 02154 <sup>b</sup>  | 02187 <sup>b</sup>  | No data   |
| NCI                             | No data   | No data   | No data   | No data   |

<sup>a</sup>All information obtained from Sax and Lewis 1987, except where noted.

<sup>b</sup>HSDB 1998

<sup>c</sup>Windholz 1983

<sup>d</sup>RTECS 1999

<sup>e</sup>HSDB 1999

<sup>f</sup>Chemfinder 1999

CAS = Chemical Abstracts Service; 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

**Table 3-1. Chemical Identity of Manganese and Compounds<sup>a</sup> (continued)**

| Characteristic           | Manganese Dioxide  | Potassium Permanganate  | Manganese (II) Carbonate   |
|--------------------------|--|---|--|
| Synonyms                 | Manganese peroxide; manganese binoxide; manganese black; battery manganese | Permanganic acid, potassium salt <sup>c</sup> ; chameleon mineral   | Carbonic acid, manganese (2+) salt <sup>b</sup> ; manganous carbonate <sup>b</sup> ; natural rhodochrosite <sup>b</sup>    |
| Registered trade name(s) | No data  | No data   | No data  |
| Chemical formula         | MnO <sub>2</sub>   | KMnO <sub>4</sub>   | MnCO <sub>3</sub>  |
| Chemical structure       | O = Mn = O   | $\begin{array}{c} \text{O} \\    \\ \text{K}^+ \text{O} - \text{Mn} = \text{O} \\    \\ \text{O} \end{array}$ | $\begin{array}{c} \text{O} \\    \\ \text{O} \text{---} \text{C} \text{---} \text{O}^- \\   \\ \text{Mn}^{++} \end{array}$ |
| Identification numbers:  |  |   |  |
| CAS                      | 1313-13-9  | 7722-64-7   | 598-62-9   |
| NIOSH RTECS              | No data  | SD6475000 <sup>b</sup>  | No data  |
| EPA hazardous waste      | No data  | No data   | No data  |
| OHM/TADS                 | No data  | 7217279 <sup>b</sup>  | No data  |
| DOT/UN/NA/IMCO shipping  | No data  | UN1490 <sup>b</sup><br>IMCO 5.1 <sup>b</sup>  | No data  |
| HSDB                     | No data  | 01218 <sup>b</sup>  | 00790 <sup>b</sup>   |
| NCI                      | No data  | No data   | No data  |

**Table 3-1. Chemical Identity of Manganese and Compounds<sup>a</sup>  
(continued)**

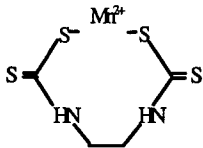
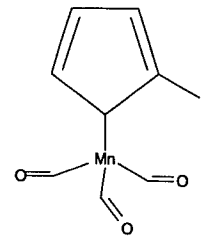
| Characteristics          | Mangafodipir   | Maneb   | Mancozeb  | Methylcyclopentadienyl Manganese Tricarbonyl (MMT)  |
|--------------------------|--|---|---|---|
| Synonyms                 | Mangafodipir trisodium <sup>d</sup> ; MnDPDP <sup>d</sup>  | Ethylenebis(dithiocarbamate manganese) <sup>e</sup> ; Ethylenebis(dithiocarbamic acid) manganous salt <sup>e</sup> ; 1,2-Ethylenediylbis(carbamodithioato) manganese <sup>e</sup> | Zinc manganese ethylenebis(dithiocarbamate); (1,2-Ethanediyllbis(carbamodithioato)) <sup>2</sup> manganese zinc complex; Manganese ethylenebis(dithiocarbamate) (polymeric) complex with zinc salt <sup>e</sup> | MMT; Manganese, tricarbonyl ((1,2,3,4,5-eta)-1-methyl-2,4-cyclopentadienyl-); Methylcymantrene; Tricarbonyl (2-methylcyclopentadienyl) manganese <sup>e</sup> |
| Registered trade name(s) | Teslascan <sup>d</sup> ; Win 59010 <sup>d</sup>  | Maneb 80; Manzate Maneb; Dithane M22; Akzo Chemie Maneb; Polygram M; Sup'R Flo; Trimangol; Tubothane <sup>e</sup>   | Dithane M-45; Dithane Ultra; Acaric M; Blecar MN; Manzin 80; FORE; Penncozeb; Manzate 200; Policar MZ; Vondozeb Plus <sup>e</sup>   | AK-33X; Antiknock-33; CI-2; Combustion Improver-2 <sup>e</sup>  |
| Chemical formula         | C <sub>22</sub> H <sub>24</sub> MnN <sub>4</sub> O <sub>14</sub> P <sub>2</sub> H <sub>3</sub> Na <sub>3</sub> | C <sub>4</sub> H <sub>6</sub> MnN <sub>2</sub> S <sub>4</sub>   | C <sub>4</sub> H <sub>6</sub> MnN <sub>2</sub> S <sub>4</sub> .C <sub>4</sub> H <sub>6</sub> MnN <sub>2</sub> S <sub>4</sub> -Zn <sup>d</sup>   | C <sub>9</sub> H <sub>7</sub> MnO <sub>3</sub>  |
| Chemical structure       | No data  |    | This substance is a mixture of many individual substances and cannot be adequately represented by a single molecular structure. <sup>f</sup>  |   |
| ID numbers               |  |   |   |   |
| CAS                      | 140678-14-4  | 12427-38-2  | 8018-01-7   | 12108-13-3  |
| NIOSH RTECS              | OO9163250  | OP0700000   | ZB3200000   | 48184   |
| EPA hazardous waste      | No data  | U114  | U114  | No data   |
| OHM/TADS                 | No data  | No data   | No data   | No data   |
| DOT/UN/NA/IMCO           | No data  | UN 2210; NA 2210; UN 2968; IMO 4.2; IMO 4.3   | UN 2771; UN 2772; UN 3005; UN 3006; IMO 3.2; IMO 6.1  | No data   |
| HSDB                     | No data  | 4063  | 6792  | 2014  |
| NCI                      | No data  | No data   | No data   | No data   |

Table 3-2. Physical and Chemical Properties of Manganese and Compounds<sup>a</sup>

| Property                 | Manganese   | Manganese (II)<br>Chloride             | Manganous<br>Sulfate  | Manganese (II, III)<br>Oxide |
|--------------------------|---|--|---|------------------------------|
| Molecular weight         | 54.94 <sup>c</sup>  | 125.85 <sup>c</sup>                    | 151.00 <sup>c</sup>   | 228.81 <sup>d</sup>          |
| Color                    | Gray-white <sup>d</sup>   | Pink <sup>d</sup>                      | Pale rose-red   | Black <sup>d</sup>           |
| Physical state           | Solid   | Solid                                  | Solid   | Solid                        |
| Melting point            | 1,244 °C <sup>d</sup>   | 650 °C                                 | 700 °C  | 1,564 °C                     |
| Boiling point            | 1,962 °C <sup>d</sup>   | 1,190 °C <sup>d</sup>                  | 850 °C (decomposes)   | No data                      |
| Density                  | 7.21-7.44 g/cc <sup>d</sup>   | 2.977 g/cc <sup>d</sup>                | 3.25 g/cc <sup>d</sup>  | 4.856 g/cc <sup>d</sup>      |
| Odor                     | No data   | No data                                | Odorless  | No data                      |
| Odor threshold:          |   |  |   |                              |
| Water                    | No data   | No data                                | No data   | No data                      |
| Air                      | No data   | No data                                | No data   | No data                      |
| Solubility:              |   |  |   |                              |
| Water                    | Decomposes  | 723 g/L (25 °C) <sup>d</sup>           | 520 g/L (5 °C) <sup>d</sup> ;<br>700 g/L (70 °C) <sup>d</sup> | Insoluble                    |
| Acids                    | Dissolves in dilute mineral acids <sup>d</sup>  | No data                                | No data   | Soluble in hydrochloric acid |
| Organic solvent(s)       | No data   | Soluble in alcohol, insoluble in ether | Soluble in alcohol, insoluble in ether                        | No data                      |
| Partition coefficients:  |   |  |   |                              |
| Log K <sub>ow</sub>      | No data   | No data                                | No data   | No data                      |
| Log K <sub>oc</sub>      | No data   | No data                                | No data   | No data                      |
| Vapor pressure           | 1 mmHg at 1,292 °C <sup>b</sup>   | 10 mmHg at 778 °C <sup>b</sup>         | No data   | No data                      |
| Henry's law constant     | No data   | No data                                | No data   | No data                      |
| Autoignition temperature | No data   | Noncombustible                         | 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       | Not applicable  | Not applicable                         | Not applicable  | Not applicable               |
| Explosive limits         | 125 oz/1000 cu ft <sup>e</sup>  | No data                                | No data   | No data                      |
| Reactivity               | Hydrogen. <sup>g</sup> When heated above 200 °C in presence of nitrogen, forms nitrode. | No data                                | No data   | No data                      |

<sup>a</sup>All information obtained from Sax and Lewis 1987, except where noted.<sup>b</sup>HSDB 1998<sup>c</sup>Windholz 1983<sup>d</sup>Lide 1993<sup>e</sup>Sax 1988<sup>f</sup>Budavari 1989<sup>g</sup>NIOSH 1997 unless noted<sup>h</sup>HSDB 1999<sup>i</sup>US DOT 1996<sup>j</sup>RTECS 1999

**Table 3-2. Physical and Chemical Properties of Manganese and Compounds<sup>a</sup> (continued)**

| Property                 | Manganese Dioxide                  | Potassium Permanganate                                  | Manganese (II) Carbonate  |
|--------------------------|------------------------------------|---|---|
| Molecular weight         | 86.94 <sup>c</sup>                 | 158.04 <sup>c</sup>                                     | 114.95  |
| Color                    | Black                              | Purple  | Rose <sup>d</sup>   |
| Physical state           | Solid                              | Solid   | Solid   |
| Melting point            | Loses oxygen at 535°C <sup>d</sup> | <240° (decomposes)                                      | Decomposes  |
| Boiling point            | No data                            | No data   | No data   |
| Density                  | 5.026 <sup>d</sup>                 | 2.703   | 3.125 <sup>d</sup>  |
| Odor                     | No data                            | Odorless  | No data   |
| Odor threshold:          |                                    |   |   |
| Water                    | No data                            | No data   | No data   |
| Air                      | No data                            | No data <sup>a</sup>                                    | No data   |
| Solubility:              |                                    |   |   |
| Water                    | Insoluble                          | 63.8 g/L (20°C) <sup>d</sup>                            | Insoluble   |
| Acids                    | Soluble in hydrochloric acid       | Soluble in sulfuric acid <sup>a</sup>                   | Soluble in dilute acid <sup>d</sup> , soluble in aqueous CO <sub>2</sub> <sup>d</sup> |
| Organic solvent(s)       | No data                            | Soluble in acetone                                      | Insoluble in alcohol <sup>d</sup> , insoluble in NH <sub>3</sub> <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   |
| 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 limits      | No data                            | No data   | No data   |
| Conversion factors       | Not applicable                     | Not applicable  | Not applicable  |
| Explosive limits         | No data                            | No data   | No data   |
| Reactivity               | No data                            | Spontaneously flammable on contact with ethylene glycol | No data   |

**Table 3-2. Physical and Chemical Properties of Manganese and Compounds<sup>a</sup> (continued)**

| Characteristic           | Mangafodipir<br>Trisodium      | Maneb <sup>b</sup>   | Mancozeb <sup>b</sup>   | Methylcyclopentadienyl<br>Manganese Tricarbonyl <sup>g</sup>             |
|--------------------------|--------------------------------|--|---|--|
| Molecular weight         | 757.4 <sup>i</sup>             | 265.3  | 541.03 <sup>j</sup>   | 218.1  |
| Color                    | No data                        | Yellow powder <sup>f</sup> , Brown powder <sup>e</sup>   | Greyish-yellow powder   | Yellow to dark orange  |
| Physical State           | Liquid (Solution for infusion) | Solid <sup>f</sup>   | Solid, wettable powder  | Liquid, Solid below 36° F  |
| Melting Point            | No data                        | Decomposes before melting  | Decomp. w/o melting at 192-194° C   | 1.5° C <sup>f</sup>  |
| Boiling Point            | No data                        | Decomposes at about 100° C   | No data   | 449° F   |
| Density                  | No data                        | 1.92   | No data   | 1.39 @ 20° C <sup>h</sup>  |
| Odor                     | No data                        | Faint  | No data   | Faint, pleasant  |
| Odor threshold           | No data                        | No data  | No data   | No data  |
| Solubility:              | No data                        |  |   |  |
| Water                    |                                | Moderate <sup>a</sup> , Slightly   | Insoluble <sup>f</sup>  | Insoluble  |
| Acids                    |                                | Decomposes rapidly   |   | No data  |
| Organic solvent(s)       |                                | Soluble in chloroform, pyridine <sup>f</sup> ;<br>Insoluble in most common organic solvents  | Practically insoluble in most organic solvents; sol. in chelating agents  | Completely sol. in jet fuels and other hydrocarbon solvents <sup>h</sup> |
| Partition coefficients:  | No data                        | No data  | No data   | No data  |
| Vapor pressure           | No data                        | Zero, negligible, <7.5 mm x10 <sup>-8</sup> mm Hg at 20° C   | Practically zero, <1x10 <sup>-5</sup> mm Hg at 20° C  | at 212° F, 7mm Hg  |
| Henry's law constant     | No data                        | < 4.63x10 <sup>-9</sup> atm-cu m/mole  | No data   | No data  |
| Autoignition temperature | No data                        | No data  | No data   | No data  |
| Flashpoint               | No data                        | No data  | 137.8° C  | 230° F   |
| 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  |
| Reactivity               | No data                        | Decomposes on prolonged exposure to air or moisture,<br>Flammable/combustible, may ignite on contact with air or moist air, may decompose explosively when heated or involved in fire <sup>i</sup> | Slowly decomposed by heat and moisture <sup>c</sup> ,<br>Flammable/combustible, may ignite on contact with air or moist air, may decomp. explosively when heated or involved in fire <sup>i</sup> | Light (decomposes)   |

