Potassium

Contents

1 – Introduction :

Potassium is the chemical element with the symbol **K** (Latin : *kalium* , from Arabic : القَلْيَه *al - qalyah* “ plant ashes ”, cf . Alkali from the same root) , atomic number 19 , and atomic mass 39. Potassium was first isolated from potash . Elemental potassium is a soft silvery - white metallic alkali metal that oxidizes rapidly in air and is very reactive with water, generating sufficient heat to ignite the evolved hydrogen .

Potassium in nature occurs only as ionic salt . As such, it is found dissolved in seawater, and as part of many minerals. Potassium ion is necessary for the function of all living cells, and is thus present in all plant and animal tissues. It is found in especially high concentrations in plant cells, and in a mixed diet, it is most highly concentrated in fruits .

In many respects , potassium and sodium are chemically similar , although they have very different functions in organisms in general , and in animal cells in particular.

Name , symbol , number	Potassium , K , 19
Group , period , block	1 , 4 , s
Standard atomic weight	39 g · mol $^{-1}$
Electron configuration	[Ar] $4s^1$
Electrons per shell	2 , 8 , 8 , 1
Phase	Solid
Density (near r . t .)	0.89 g · cm $^{-3}$
Liquid density at m . p .	0.828 g · cm $^{-3}$
Melting point	336.53 K , 63 .38 °C , 146.08 °F
Boiling point	1032 K , 759 °C , 1398 °F
Triple point	336.35 K (63°C) , kPa
Heat of fusion	2.33 kJ · mol $^{-1}$
Heat of vaporization	76.9 kJ · mol $^{-1}$
Specific heat capacity	(25 °C) 29.6 J · mol $^{-1}$ · K $^{-1}$
Oxidation states	1 , (strongly basic oxide)
Electro negativity	0.82 (Pauling scale)
Ionization energies	1st : 418.8 kJ · mol $^{-1}$ 2nd : 3052 kJ · mol $^{-1}$ 3rd : 4420 kJ · mol $^{-1}$
Atomic radius	227 pm
Covalent radius	203 ± 12 pm
Van der Waals radius	275 pm
Thermal conductivity	(300 K) 102.5 W · m $^{-1}$ · K $^{-1}$

Thermal expansion	(25 °C) 83.3 µm · m $^{-1}$ · K $^{-1}$
Speed of sound (thin rod)	(20 °C) 2000 m / s
Young's modulus	3.53 GPa
Shear modulus	1.3 GPa
Bulk modulus	3.1 GPa
Mohs hardness	0.4
Brinell hardness	0.363 MPa

2 - Occurrence

Elemental potassium does not occur in nature because it reacts violently with water . As various compounds, potassium makes up about 1.5 % of the weight of the Earth's crust and is the seventh most abundant element. As it is very electropositive, potassium metal is difficult to obtain from its minerals .

3 - History of the free element

Elemental potassium was not known in Roman times, and its names are not Classical Latin but rather neo - Latin. The name **kalium** was taken from the word " alkali ", which came from Arabic *al qalīy* = " the calcined ashes ". The name **potassium** was made from the word " potash " , which is English , and originally meant an alkali extracted in a *pot* from the *ash* of burnt wood or tree leaves . The structure of potash was not then known , but is now understood to be mostly potassium carbonate. By heating, the carbonate could be freed of carbon dioxide, leaving " caustic potash ", so called because it caused chemical burns in contact with human tissue .

Potassium metal was discovered in 1807 in England by Sir Humphry Davy , who derived it from caustic potash (KOH) , by the use of electrolysis of the molten salt with the newly discovered voltaic pile. Before the 18th century, no distinction was made between potassium and sodium. Potassium was the first metal that was isolated by electrolysis.[2] Davy extracted sodium by a similar technique, demonstrating the elements to be different .

4 - Production

Pure potassium metal may be isolated by electrolysis of its hydroxide in a process that has changed little since Davy.[1] Thermal methods also are employed in potassium production, using potassium chloride

Potassium salts such as carnallite , langbeinite , polyhalite , and sylvite form extensive deposits in ancient lake and seabeds, making extraction of potassium salts in these environments commercially viable. The principal source of potassium, potash, is mined in Saskatchewan, California, Germany, New Mexico, Utah, and in other places around the world. It is also found abundantly in the Dead Sea. Three thousand feet below the surface of Saskatchewan are large deposits of potash which are important sources of this element and its salts, with several large mines in operation since the 1960s. Saskatchewan pioneered the use of freezing of wet sands (the Blairmore formation) in order to drive mine shafts through them. The main mining company is the Potash Corporation of Saskatchewan . The oceans are another source of potassium, but the quantity present in a given volume of seawater is relatively low compared with sodium.

5 - Isotopes of Potassium :

There are 24 known isotopes of potassium . Three isotopes occur naturally : ^{39}K (93.3%) , ^{40}K (0.0117 %) and ^{41}K (6.7 %) . Naturally occurring ^{40}K decays to stable ^{40}Ar (11.2 % of decays) by electron capture or positron emission , or decays to stable ^{40}Ca (88.8 % of decays) by beta decay ; ^{40}K has a half - life of 1.250×10^{9} years . The decay of ^{40}K to ^{40}Ar enables a commonly used method for dating rocks . The conventional K - Ar dating method depends on the assumption that the rocks contained no argon at the time of formation and that all the subsequent radiogenic argon (i.e., ^{40}Ar) was quantitatively retained. Minerals are dated by measurement of the concentration of potassium and the amount of radiogenic ^{40}Ar that has accumulated. The minerals that are best suited for dating include biotite, muscovite, plutonic / high grade metamorphic hornblende, and volcanic feldspar; whole rock samples from volcanic flows and shallow instrusives can also be dated if they are unaltered.

Outside of dating, potassium isotopes have been used extensively as tracers in studies of weathering. They have also been used for nutrient cycling studies because potassium is a macronutrient required for life .

^{40}K occurs in natural potassium (and thus in some commercial salt substitutes) in sufficient quantity that large bags of those substitutes can be used as a radioactive source for classroom demonstrations. In healthy animals and people, ^{40}K represents the largest source of radioactivity, greater even than ^{14}C. In a human body of 70 kg mass, about 4,400 nuclei of ^{40}K decay per second .

The activity of natural potassium is 31 Bq / g .

6 - Properties

6 – 1 : Physical

Potassium is the second least dense metal ; only lithium is less dense . It is a soft , low - melting solid that can easily be cut with a knife. Freshly cut potassium is silvery in appearance, but in air it begins to tarnish toward grey immediately .

In a flame test , potassium and its compounds emit a pale violet color , which may be masked by the strong yellow emission of sodium if it is also present. Cobalt glass can be used to filter out the yellow sodium color . Potassium concentration in solution is commonly determined by flame photometry, atomic absorption spectro photometry, inductively coupled plasma, or ion selective electrodes .

6 – 2 : Chemical

Potassium must be protected from air for storage to prevent disintegration of the metal from oxide and hydroxide corrosion . Often samples are maintained under a hydrocarbon medium which does not react with alkali metals , such as mineral oil or kerosene .

Like the other alkali metals, potassium reacts violently with water, producing hydrogen. The reaction is notably more violent than that of lithium or sodium with water, and is sufficiently exothermic that the evolved hydrogen gas ignites .

$$2K\,(s) + 2H_2O\,(l) \rightarrow H_2\,(g) + 2KOH\,(aq)$$

Because potassium reacts quickly with even traces of water, and its reaction products are nonvolatile, it is sometimes used alone, or as Na K (an alloy with sodium which is liquid at room temperature) to dry solvents prior to distillation. In this role, it serves as a potent desiccant .

Potassium hydroxide reacts strongly with carbon dioxide to produce potassium carbonate, and is used to remove traces of CO_2 from air .

Potassium compounds generally have excellent water solubility, due to the high hydration energy of the K^+ ion. The potassium ion is colorless in water .

Methods of separating potassium by precipitation, sometimes used for gravimetric analysis, include the use of sodium tetra phenyl borate, hexa chloro platinic acid , and sodium cobalti nitrite

7 - Potassium cations in the body :

7 – 1 : Biochemical function

Potassium cations are important in neuron (brain and nerve) function , and in influencing osmotic balance between cells and the interstitial fluid, with their distribution mediated in all animals (but not in all plants) by the so - called Na^+ / K^+ -ATPase pump .

Potassium may be detected by taste because it triggers three of the five types of taste sensations, according to concentration. Dilute solutions of potassium ion taste sweet (allowing moderate concentrations in milk and juices) , while higher concentrations become increasingly bitter / alkaline , and finally also salty to the taste. The combined bitterness and saltiness of high potassium content solutions makes high - dose potassium supplementation by liquid drinks a palatability challenge .

7 – 2 : Membrane polarization

Potassium is also important in allowing muscle contraction and the sending of all nerve impulses in animals through action potentials . By nature of their electrostatic and chemical properties, K^+ ions are larger than Na^+ ions, and ion channels and pumps in cell membranes can distinguish between the two types of ions, actively pumping or passively allowing one of the two ions to pass, while blocking the other.

A shortage of potassium in body fluids may cause a potentially fatal condition known as hypo kalemia, typically resulting from diarrhea, increased diuresis and vomiting. Deficiency symptoms include muscle weakness, paralytic ileus, ECG abnormalities, decreased reflex response and in severe cases respiratory paralysis, alkalosis and cardiac arrhythmia .

7 – 4 : Filtration and excretion

Potassium is an essential mineral micronutrient in human nutrition; it is the major cation (positive ion) inside animal cells, and it is thus important in maintaining fluid and electrolyte balance in the body. Sodium makes up most of the cations of blood plasma at a reference range of about 145 milli equivalents per liter (3345 milli grams) and potassium makes up most of the cell fluid cations at about 150 milli equivalents per liter (4800 milligrams). Plasma is filtered through the glomerulus of the kidneys in enormous amounts, about 180 liters per day . Thus 602,000 milligrams of sodium and 33,000 milligrams of potassium are filtered each day. All but the 1000 - 10,000 milligrams of sodium and the 1000 - 4000 milligrams of potassium likely to be in the diet must be reabsorbed. Sodium must be reabsorbed in such a way as to keep the blood volume exactly right and the osmotic pressure correct; potassium must be reabsorbed in such a way as to keep serum concentration as close as possible to 4.8 milli equivalents (about 190 milligrams) per liter . Sodium pumps in the kidneys must always operate to conserve sodium. Potassium must sometimes be conserved also, but as the amount of potassium in the blood plasma is very small and the pool of potassium in the cells is about thirty times as large, the situation is not so critical for potassium. Since potassium is moved passively in counter flow to sodium in response to an apparent (but not actual) Donnan equilibrium , the urine can never sink below the concentration of potassium in serum except sometimes by actively excreting water at the end of the processing. Potassium is secreted twice and reabsorbed three times before the urine reaches the collecting tubules.[16] At that point, it usually has about the same potassium concentration as plasma. If potassium were removed from the diet, there would remain a minimum obligatory kidney excretion of about 200 mg per day when the serum declines to 3.0 - 3.5 milli equivalents per liter in about one week , and can never be cut off completely. Because it cannot be cut off completely, death will result when the whole body potassium declines to the vicinity of one - half full capacity. At the end of the processing , potassium is secreted one more time if the serum levels are too high .

The potassium moves passively through pores in the cell wall. When ions move through pumps there is a gate in the pumps on either side of the cell wall and only one gate can be open at once. As a result, 100 ions are forced through per second. Pores have only one gate, and there only one kind of ion can stream through, at 10 million to 100 million ions per second.[18] The pores require calcium in order to open[19] although it is thought that the calcium works in reverse by blocking at least one of the pores . Carbonyl groups inside the pore on the amino acids mimics the water hydration that takes place in water solution by the nature of the electrostatic charges on four carbonyl groups inside the pore .

7 – 4 : Potassium in the diet and by supplement

7 – 4 – 1 : Adequate intake

A potassium intake sufficient to support life can generally be guaranteed by eating a variety of foods, especially plant foods. Clear cases of potassium deficiency (as defined by symptoms, signs and a below-normal blood level of the element) are rare in healthy individuals eating a balanced diet. Foods with high sources of potassium include orange juice, potatoes, bananas, avocados, tomatoes, broccoli, soybeans, brown rice, garlic and apricots, although it is also common in most fruits, vegetables and meats .

7 – 4 – 2 : Optimal intake

Epidemiological studies and studies in animals subject to hypertension indicate that diets high in potassium can reduce the risk of hypertension and possibly stroke (by a mechanism independent of blood pressure) , and a potassium deficiency combined with an inadequate thiamine intake has produced heart disease in rats.[24] With these findings, the question of what is the intake of potassium consistent with optimal health, is debated. For example, the 2004 guidelines of the Institute of Medicine specify a DRI of 4,000 mg of potassium (100 mEq) , though most Americans consume only half that amount per day, which would make them formally deficient as regards this particular recommendation . Similarly, in the European Union, particularly in Germany and Italy, insufficient potassium intake is somewhat common .

7 – 4 – 3 : Medical supplementation and disease

Supplements of potassium in medicine are most widely used in conjunction with loop diuretics and thiazides , classes of diuretics which rid the body of sodium and water, but have the side effect of also causing potassium loss in urine. A variety of medical and non - medical supplements are available. Potassium salts such as potassium chloride may be dissolved in water, but the salty/bitter taste of high concentrations of potassium ion make palatable high concentration liquid supplements difficult to formulate.[9] Typical medical supplemental doses range from 10 milli equivalents (400 mg, about equal to a cup of milk or 6 oz. of orange juice) to 20 milli equivalents (800 mg) per dose . Potassium salts are also available in tablets or capsules, which for therapeutic purposes are formulated to allow potassium to leach slowly out of a matrix, as very high concentrations of potassium ion (which might occur next to a solid tablet of potassium chloride) can kill tissue, and cause injury to the gastric or intestinal mucosa. For this reason, non - prescription supplement potassium pills are limited by law in the U.S. to only 99 mg of potassium .

Individuals suffering from kidney diseases may suffer adverse health effects from consuming large quantities of dietary potassium. End stage renal failure patients undergoing therapy by renal dialysis must observe strict dietary limits on potassium intake, as the kidneys control potassium excretion, and buildup of blood concentrations of potassium (hyper kalemia) may trigger fatal cardiac arrhythmia .

8 - Applications

About 93 % of the world potassium production was consumed by the fertilizer industry .

[8-1 : Biological applications

Potassium ions are an essential component of plant nutrition and are found in most soil types. Its primary use in agriculture, horticulture and hydroponic culture is as a fertilizer as the chloride (K Cl) , sulfate ($K_2 SO_4$) or nitrate (KNO_3) .

n animal cells, potassium ions are vital to keeping cells alive.

In the form of potassium chloride , it is used to stop the heart , e.g. in cardiac surgery and in a solution used in executions by lethal injection .

8 - 2 : Food applications

Potassium ion is a nutrient necessary for human life and health. Potassium chloride is used as a substitute for table salt by those seeking to reduce sodium intake so as to control hypertension. The USDA lists tomato paste, orange juice, beet greens, white beans, potatoes, bananas and many other good dietary sources of potassium, ranked according to potassium content per measure shown .

Potassium sodium tartrate , or Rochelle salt ($K Na C_4H_4O_6$) is the main constituent of baking powder. Potassium bromate ($KBrO_3$) is a strong oxidizer, used as a flour improver (E924) to improve dough strength and rise height .

The sulfite compound , potassium bi sulfite ($KHSO_3$) is used as a food preservative , for example in wine and beer -making (but not in meats) . It is also used to bleach textiles and straw , and in the tanning of leathers .

8 – 3 : Industrial applications

Potassium vapor is used in several types of magnetometers .

An alloy of sodium and potassium , Na K (usually pronounced " nack ") , that is liquid at room temperature, is used as a heat-transfer medium. It can also be used as a desiccant for producing dry and air - free solvents.

Potassium metal reacts vigorously with all of the halogens to form the corresponding potassium halides , which are white , water - soluble salts with cubic crystal morphology . Potassium bromide (K Br) , potassium iodide (K I) and potassium chloride (K Cl) are used in photographic emulsion to make the corresponding photosensitive silver halides .

Potassium hydroxide KOH is a strong base , used in industry to neutralize strong and weak acids and thereby finding uses in pH control and in the manufacture of potassium salts. Potassium hydroxide is also used to saponify fats and oils and in hydrolysis reactions , for example of esters and in industrial cleaners .

Potassium nitrate $K NO_3$ or saltpeter is obtained from natural sources such as guano and evaporates or manufactured by the Haber process and is the oxidant in gunpowder (black powder) and an important agricultural fertilizer . Potassium cyanide K CN is used industrially to dissolve copper and precious metals particularly silver and gold by forming complexes ; applications include gold mining, electroplating and electroforming of these metals . It is also used in organic synthesis to make nitriles . Potassium carbonate $K_2 CO_3$, also known as potash , is used in the manufacture of glass and soap and as a mild desiccant .

Potassium chromate ($K_2 CrO_4$) is used in inks , dyes , and stains (bright yellowish - red colour) , in explosives and fire works , in safety matches, in the tanning of leather and in fly paper. Potassium fluorosilicate ($K_2 SiF_6$) is used in specialized glasses, ceramics, and enamels . Potassium sodium tartrate , or Rochelle salt ($K Na C_4H_4O_6$) is used in the silvering of mirrors.

The superoxide $K O_2$ is an orange-colored solid used as a portable source of oxygen and as a carbon dioxide absorber . It is useful in portable respiration systems. It is widely used in submarines and spacecraft as it takes less volume than O_2 (g) .

$4K O_2 + 2CO_2 \rightarrow 2K_2 CO_3 + 3O_2$

Potassium chlorate $K ClO_3$ is a strong oxidant , used in percussion caps and safety matches and in agriculture as a weed killer. Glass may be treated with molten potassium nitrate $K NO_3$ to make toughened glass, which is much stronger than regular glass .

9 - Precautions

Potassium reacts very violently with water producing hydrogen gas which then usually catches fire. Potassium is usually kept under a hydro carbon oil such as mineral oil or kerosene to stop the metal from reacting with water vapour present in the air. Unlike lithium and sodium, however, potassium should not be stored under oil indefinitely. If stored longer than 6 months to a year, dangerous shock-sensitive peroxides can form on the metal and under the lid of the container, which can detonate upon opening . It is recommended that potassium , rubidium or cesium not be stored for longer than three months unless stored in an inert (oxygen free) atmosphere , or under vacuum .

As potassium reacts with water to produce highly flammable hydrogen gas, a potassium fire is only exacerbated by the addition of water , and only a few dry chemicals are effective for putting out such a fire .

Potassium also produces potassium hydroxide (K OH) in the reaction with water . Potassium hydroxide is a strong alkali and so is a caustic hazard, causing burns .

Due to the highly reactive nature of potassium metal, it must be handled with great care , with full skin and eye protection being used and preferably an explosive resistant barrier between the user and the potassium .

Potassium minerals

1 – Afghanite

	
Afghanite	*Afghanite on marble, Sar-e-Sang, Badakhshan, Afghanstain.*

Afghanite, $(Na,Ca,K)_8[Al_6Si_6O_{24}](SO_4,Cl_2,CO_3)_3 \cdot 0.5H_2O$, is a hydrous sodium, calcium, potassium, sulfate, chloride, carbonate alumino-silicate mineral. Afghanite is a feldspathoid of the cancrinite group and typically occurs with sodalite group minerals. It forms blue to colorless, typically massive crystals in the hexagonal crystal system. It has a Mohs hardness of 5.5 to 6 and a specific gravity of 2.55 to 2.65. It has refractive index values of $n\omega=1.523$ and $n\varepsilon=1.529$. It has one direction of perfect cleavage and exhibits conchoidal fracture. It fluoresces a bright orange.

It was discovered in 1968 in the Lapis-lazuli Mine, Sar-e-Sang, Badakhshan Province, Afghanistan and takes its name from that country. It has also been described from localities in Germany, Italy, the Pamir Mountains, Tajikistan, near Lake Baikal in Siberia, New York and Newfoundland. It occurs as veinlets in lazurite crystals in the Afghan location and in altered limestone xenoliths within pumice in Pitigliano, Tuscany, Italy.

tegory	Tectosilicates
Chemical Formula	$\mathbf{(Na,Ca,K)_8[Al_6Si_6O_{24}](SO_4,Cl_2,CO_3)_3 \cdot 0.5H_2O}$

Unit cell	a = 12.77Å, c = 21.35Å
Color	light blue, dark blue
Crystal system	Hexagonal
Mohs scale hardness	5½ - 6
Luster	Vitreous
Streak	White
Diaphaneity	Transparent

2 - Potassium alum

Contents :

1- Introduction :

Potassium alum, **potash alum** or **tawas** is the potassium double sulfate of aluminium. Its chemical formula is $K Al (SO_4)_2$ and it is commonly found in its dodeca hydrate form as $K Al (SO_4)_2 \cdot 12 (H_2O)$. Alum is the common name for this chemical compound, given the nomenclature of potassium aluminum sulfate dodeca hydrate. It is commonly used in water purification, leather tanning, fireproof textiles, and baking powder · It also has cosmetic uses as a deodorant and as an aftershave treatment.

IUPAC Name : Aluminium potassium sulfate	
Other names : Potassium alum , Potash alum , Tawas	
Molecular Formula	$K Al (SO_4)_2$
Molar mass	258 g / mol
Density	1.76 g / cm^3
Melting Point	92 – 93 °C
Boiling Point	200 °C
Solubility in water	14.00 g / 100 ml (20 °C) 36.80 g / 100 ml (50 °C)

2 - Characteristics :

Potassium alum crystallizes in regular octahedra with flattened corners, and is very soluble in water. The solution reddens litmus and is an astringent. When heated to nearly a red heat it gives a porous, friable mass which is known as "burnt alum." It fuses at 92 °C in its own water of crystallization. "Neutral alum" is obtained by the addition of as much sodium carbonate to a solution of alum as will begin to cause the separation of alumina. Alum finds application as a mordant, in the preparation of lakes for sizing hand-made paper and in the clarifying of turbid liquids.

3 - Mineral form and occurrence :

Potassium alum is a naturally occurring sulfate mineral which typically occurs as encrustations on rocks in areas of weathering and oxidation of sulfide minerals and potassium-bearing minerals. In the past, alum was obtained from alunite , a mineral mined from sulfur-containing volcanic sediments source . Alunite is an associate and likely potassium and aluminium source . It has been reported at Vesuvius, Italy , east of Springsure , Queensland, Alum Cave, Tennessee, and Alum Gulch, Arizona in the United States and the island of Cebu (Philippines) locally known as tawas. A related mineral is kalunite (rock form) and *kalinite*, a fibrous mineral with formula $K\,Al\,(SO_4)_2 \cdot 11(H_2O)$.

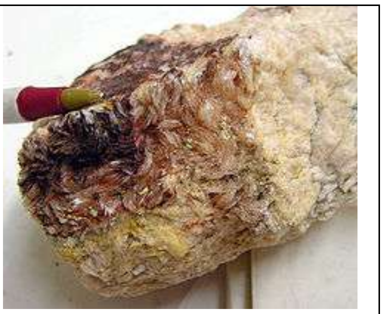
4 – Uses :

Potassium alum is an astringent / styptic and antiseptic. For this reason, it can be used as a natural deodorant by inhibiting the growth of the bacteria responsible for body odor. Use of mineral salts in such a fashion does not prevent perspiration. Its astringent/styptic properties are often employed after shaving and to reduce bleeding in minor cuts and abrasions, nosebleeds, and hemorrhoids. It is frequently used topically and internally in traditional systems of medicine including Ayurveda, where it is called phitkari or saurashtri, and Traditional Chinese Medicine, where it is called *ming fan*.[5] It is also used as a hardener for photographic emulsions (films and papers), usually as part of the fixer, although modern materials are adequately hardened and this practice has fallen out of favor.

5 - Toxicology & safety

Deodorant crystals containing synthetically made potassium alum are a weak irritant to the skin .

3 – Alunite

 *Alunite Marysvale, Utah*	 Alunite from Slovakia	 *Alunite from Utah - USGS*

Alunite is a sulfate mineral that was first observed in the 15th century in Monti della Tolfa, north of Rome, where it was mined for the manufacture of alum. First called *aluminilite* by J.C. Delamétherie in 1797, this name was contracted by François Beudant in 1824 to alunite . Distinct crystals of alunite are rarely found in cavities in the massive material. Alunite crystallizes in the hexagonal system with crystals forming trigonal pyramids that resemble rhombohedra with interfacial angles of 90° 50', so that they resemble cubes in appearance. Minute glistening crystals have also been found loose in cavities in altered rhyolite. Alunite varies in color from white to yellow gray. The hardness is 4 and the specific gravity is between 2.6 and 2.8. The mineral is a hydrated aluminium potassium sulfate, $KAl_3(SO_4)_2(OH)_6$. Sodium substitutes for potassium and when high in sodium it is called natroalunite. It is insoluble in water or weak acids, but soluble in sulfuric acid. Jarosite is an iron analogue in which Fe^{3+} replaces the aluminium. It occurs as a secondary mineral on iron sulfate ores.

Alunite occurs as veins and replacement masses in trachyte, rhyolite, and similar potassium rich volcanic rocks. It is formed by the action of sulfuric acid bearing solutions on these rocks during the oxidation and leaching of metal sulfide deposits. Alunite also is found near volcanic fumaroles. The white, finely granular masses closely resemble finely granular limestone, dolomite, anhydrite, and magnesite in appearance. The more compact kinds from Hungary are so hard and tough that they have been used for millstones.

Historically extensive deposits were mined in Tuscany and Hungary, and at Bulahdelah, Australia. Currently found at Tolfa, Italy. In the United States it is found in the San Juan district of Colorado; Goldfield, Nevada; the ghost town of Alunite, Utah near Marysvale; and Red Mountain near Patagonia, Arizona. The Arizona occurrence lies appropriately above a canyon named *Alum Gulch*. Alunite is mined as an ore of both potassium and aluminium at Marysvale.[4] Some of the ore deposits were located by airborne and satellite multispectral imaging.

Category	Sulfate minerals
Chemical Formula	$K\,Al_3\,(SO_4)_2\,(OH)_6$
Unit cell	a = 6.98 Å, c = 17.32 Å; Z=3
Color	Yellow, red, to reddish brown, colorless if pure; may be white, pale shades of gray,
Crystal habit	fibrous to columnar, porcelaneous , commonly granular to dense massive
Crystal system	Trigonal
Mohs scale hardness	3.5 - 4
Streak	White
Diaphaneity	Transparent to translucent
Specific gravity	2.6 - 2.9
Refractive index	$n_\omega = 1.572$ $n_\varepsilon = 1.592$
Other characteristics	Strongly pyro electric

4 – Annite

Annite sample

1 - Introduction :

Annite is a phyllosilicate mineral in the mica family. It has a chemical formula of $KFe_3^{2+}AlSi_3O_{10}(OH,F)_2$. Annite is the iron end member of the biotite mica group, the iron rich analogue of magnesium rich phlogopite. Annite is monoclinic and contains tabular crystals and cleavage fragments with pseudo hexagonal outlines .

Annite was first described in 1868 for the first noted occurrence in Cape Ann, Rockport, Essex County, Massachusetts, US. It also occurs on Pikes Peak, El Paso County, Colorado . It occurs in igneous and metamorphic rocks that are deficient in magnesium. It occurs associated with fluorite and zircon in the type locality.

2 - Properties

The relief of a mineral refers to the way a mineral may stand out in plane polarized light. A mineral may be referred to as having a low or high relief. Minerals with a high relief, such as annite , have sharp grain boundaries and display good fracture and cleavage. When viewed under a microscope, this mineral may appear to stick out of the other minerals in the thin section. Relief primarily depends on the index of refraction of the mineral. The index of refraction of a mineral is a measure of the speed of light in the mineral. It is expressed as a ratio of the speed of light in vacuum relative to that in the given mineral. Annite has three indices of refraction known to be $n_\alpha = 1.625 - 1.631$ $n_\beta = 1.690$ $n_\gamma = 1.691 - 1.697$. It is also an anisotropic mineral, meaning under the cross polars of a microscope the mineral will become extinct every 90°. However, in plane polarized light, annite appears as a brown or green platy form and is pleochroic, meaning the mineral changes colors under a microscope without the polars being crossed.

3 - Uses ;

Annite is a member of the mica group and has very similar properties as other micas such as muscovite and biotite. More importantly, annite is interesting to geologists because it can be used for potassium - argon dating. Because annite contains large amounts of potassium, it can be used to find the absolute age of articles older than 1000 years. This type of dating also preserves a record of the direction and intensity of the local magnetic field, giving field geologists better knowledge of their surroundings.

5 - Aphthitalite

Aphthitalite is a potassium sulfate mineral with the chemical formula: $(K, Na)_3Na(SO_4)_2$.

It was first described in 1835 for an occurrence on Mt. Vesuvius, Italy. The name is from the Greek ,"unalterable", and , "salt", for its stability in air. It occurs as fumarolic incrustations in volcanic environments, as small crystals and masses in evaporite deposits and in guano deposits.[2][3] It occurs associated with thenardite, jarosite, sylvite and hematite in fumaroles; with blodite, syngenite, mirabilite, picromerite, borax and halite in evaporites; and with syngenite, whitlockite, monetite, niter and gypsum in guano deposits.

Category	Sulfate mineral
Chemical Formula	$(K , Na)_3 Na (SO_4)_2$
Unit cell	a = 5.67 Å, c = 7.33 Å Z = 1
Color	White, colorless; gray, blue, green due to inclusions and impurities
Crystal habit	Tabular crystals (with distorted pseudo - orthorhombic habit) ; as bladed aggregates and in crusts
Crystal system	Trigonal
Mohs scale hardness	3
Diaphaneity	Transparent to opaque
Specific gravity	2.66 – 2.71
Optical properties	Uniaxial (+) (anomalously biaxial)
Refractive index	n_ω = 1.487 - 1.491 - n_ε = 1.492 - 1.499
Solubility	In water

6 – Apophyllite

1 – Introduction :

The name **apophyllite** refers to a specific group of phyllo silicates , a class of minerals that also includes the micas. Originally, the group name referred to a specific mineral, but was redefined in 1978 to stand for a class of minerals of similar chemical makeup that comprise a solid solution series, and includes the members apophyllite-(KF), apophyllite-(KOH), and apophyllite-(NaF). The name apophyllite is derived from the Greek ἀπόΦυλλίςο *apophylliso,* meaning "it flakes off", a reference to this class's tendency to flake apart when heated, due to water loss. These minerals are typically found as secondary minerals in holes in basalt or other igneous rocks. They can also be called "fisheye stone". A recent change in the nomenclature system used for this group was approved by the International Mineralogical Association, removing the prefixes from the species names and using suffixes to designate the species. [2]

Though relatively unfamiliar to the general public, apophyllites are fairly prevalent around the world, with specimens coming from some of the world's most well - known mineral localities. These localities include: Poona, India ; the Harz Mountains of Germany, Mont Saint-Hilaire in Canada, and Kongsberg, Norway, with other locations in Scotland, Ireland, Brazil, Japan, and throughout the United States.

Category	Silicate minerals
Chemical Formula	(K ,Na) $Ca_4 Si_8 O_{20}$ (F , OH) • 8 H_2O
Color	Usually white , colorless ; also blue , green , brown , yellow , pink , violet
Crystal habit	prismatic, tabular, massive
Crystal system	Tetragonal ; Orthorhombic
Mohs scale hardness	4.5 - 5
Luster	Vitreous ; Pearly
Streak	White
Diaphaneity	Transparent to translucent
Specific gravity	2.3 – 2.4
Refractive index	1.536

2 - Uses :

Apophyllites are popular as collector's minerals. This popularity is due to a combination of factors, including their abundance, color variety, and well-defined crystals. Naturally forming pyramidal structures, they refract light in obvious rainbows, and can form "natural pyramids" when subjected to rock tumbling.

3 - Species of Apophyllite :

- Apophyllite - (K F) (formerly fluor apophyllite) , $(K, Na)Ca_4Si_8O_{20}(F, OH) \cdot 8H_2O$ - white, colorless, yellow, green, violet
- Apophyllite - (KOH) (formerly hydroxy apophyllite), $KCa_4Si_8O_{20}(OH, F) \cdot 8H_2O$ - white, colorless
- Apophyllite - (Na F) (formerly natro apophyllite) , $(K, Na) Ca_4Si_8O_{20}F \cdot 8H_2O$ - brown, yellow, colorless

7 - Arcanite

Arcanite is a potassium sulfate mineral with formula: K_2SO_4.

Arcanite was first described in 1845 for an occurrence in old pine railroad ties in the Santa Ana tin mine, Trabuco Canyon, Santa Ana Mountains, Orange County, California, USA . It has also been reported from hydrothermal deposits in the Cesano geothermal field, Latium, Italy; in guano on the Chincha Islands of Peru; and in caves in Western Australia, South Africa and Namibia.

Category	Sulfate mineral
Chemical Formula	$K_2 SO_4$
Crystal symmetry	Orthorhombic
Unit cell	a = 5.77 Å , b = 10.07 Å , c = 7.48 Å ; Z = 4
Color	White to colorless , yellow
Crystal habit	Tabular crystals, typically in crusts and coatings
Crystal system	Orthorhombic
Mohs scale hardness	2
Streak	White
Diaphaneity	Transparent to translucent
Specific gravity	2.66
Optical properties	Biaxial (+)
Refractive index	$n_\alpha = 1.494$ $n_\beta = 1.495$ $n_\gamma = 1.497$

8 - Birnessite

1 – Introduction :

Birnessite $(Na_{0.3}Ca_{0.1}K_{0.1})(Mn^{4+},Mn^{3+})_2O_4 \cdot 1.5\ H_2O$ is an oxide mineral of manganese along with calcium, potassium and sodium. It has a dark brown to black color with a sub metallic luster. It is also very soft, with a Mohs hardness of 1.5. Birnessite is formed by precipitation in lakes, oceans and groundwater and is a major component of desert varnish and deep sea manganese nodules.

Category	Oxide mineral
Chemical formula	$(Na_{0.3}Ca_{0.1}K_{0.1})(Mn^{4+},Mn^{3+})_2O_4 \cdot 1.5H_2O$
Color	Dark brown to black
Crystal habit	Rarely in platelets, to 50 µm; commonly extremely finely crystalline, spherulitic, cellular.
Crystal system	Monoclinic prismatic
Mohs scale hardness	1.5
Luster	Sub – metallic , dull
Diaphaneity	Nearly opaque
Specific gravity	3.0
Optical properties	Uniaxial (-)
Refractive index	nω = 1.730 nε = 1.690

Other characteristics	Identification by optical properties is impossible.

2 - History :

It was first described in 1956 and named for an occurrence in Birness, Aberdeenshire, Scotland. Birnessite is found as an oxidation product of several other minerals, including rhodonite, rhodochrosite, and as a weathering product of franklinite-wilminite ore. It has also been found as a coating along joint planes and fractures within a trachyte sill. However, it has been most commonly seen as a constituent of oceanic nodules of manganese.

A recent study found that the mineral is able to break down prions via oxidation. How well this process works outside the laboratory is unclear.

3 - Geologic occurrence :

Levinson noted the presence of Birnessite in one or more mines from the region around Zacatecas, Mexico, while other notations have been made in Canada, at Cummington, Massachusetts, from the aforementioned nodules in both the Atlantic and Pacific Oceans, from the Tachaki Mine in Japan, the Treburland Mine in Cornwall, England, and from a bog in Norway.

4 - Composition and structure :

Birnessite is a phyllomanganate, which is a type of ferro alloy that contains a high proportion of manganese. While natural forms generally contain foreign ions (i.e. Na, Ca, K) they are considered non-essential and synthetic forms of the mineral can be produced without them. However, most of the synthetic versions of the mineral undergo significant water loss at temperatures below 100ºC. Its structure is thought to be similar to that of chalcophanite , and has been modeled as such by Burns . The structure itself consists of sheets of water molecules found between sheets of edge-sharing molecules of MnO_6 octahedra, and repeated on an average of every 7.2 Å , doing so along the c - axis. Of the six octahedral sites in the

MnO_6 octahedral layer, one is left unoccupied; Mn^{2+} and Mn^{3+} lie above each vacant slot on the octahedral . These Mn ions are low-valence, and associate with O, in both the octahedral and in the water sheets.

9 – Boleite

Boleite and atacamite from the Boleo mine

1 – Introduction :

Boleite is a complex halide mineral with formula: $KPb_{26}Ag_9Cu_{24}(OH)_{48}Cl_{62}$. It was first described in 1891 as an oxy chloride mineral. It is an isometric mineral which forms in deep blue cubes. There are numerous minerals related to boleite, such as pseudo boleite and cumengite , and these all have the same complex crystal structure (Martens 2003). They all contain bright blue cubic forms and are formed in altered zones of lead and copper deposits, produced during the reaction of chloride bearing solutions with primary sulfide minerals (Rouse, 1973).

Category	Halide mineral
Chemical Formula	$KPb_{26}Ag_9Cu_{24}(OH)_{48}Cl_{62}$
Crystal symmetry	Cubic , hexoctahedral
Unit cell	a = 15.29 Å; Z = 1
Color	Deep prussian blue to indigo
Crystal habit	Cubic crystals

Crystal system	Isometric
Mohs scale hardness	3.0 – 3.5
Luster	Vitreous to pearly
Streak	Greenish blue
Diaphaneity	Translucent
Specific gravity	5.054
Optical properties	Isotropic
Refractive index	n = 2.05

2 - Physical properties :

The external property of a boleite crystal structure indicates its cubic structure. It is classified under the isometric crystal class. Boleite has a perfect cleavage in the [001] direction, and has a very dark glossy blue color with a light greenish-blue color streak. Twinning is best shown in this mineral by notches along the interpenetrated angles, which results in a crystal habit of pseudocubic penetration twinning along three different angles perpendicular to one another. Boleite has cubes over half an inch on each side, which consist of pseudo - octahedral tetragonal di pyramids (Weber 1974).

3 - Geologic occurrence :

Boleite was first collected as a very minor ore of silver, copper and lead at Boleo, Mexico (Rouse, 1973). Boleite was named after its place of discovery, Boleo, Mexico, on the Baja Peninsula, near Santa Rosalia.

Minerals associated with boleite include pseudoboleite, cumengeite, atacamite, anglesite, cerussite, phosgenite and gypsum at the type locality in Boleo, Mexico. In the Mammoth-St. Anthony mine of Arizona associated minerals include pseudoboleite, anglesite, cerussite, atacamite, paratacamite, leadhillite, paralaurionite, caledonite, phosgenite, matlockite and bideauxite.

10 - Carnallite

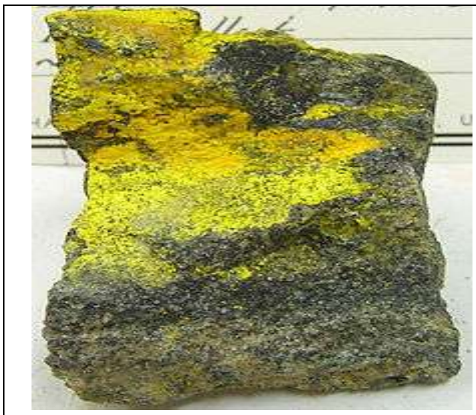
Carnallite is an evaporite mineral, a hydrated potassium magnesium chloride with formula: $KMgCl_3 \cdot 6(H_2O)$. It is variably colored yellow to white, reddish, and sometimes colorless or blue. It is usually massive to fibrous with rare pseudo hexagonal ortho rhombic crystals. The mineral is deliquescent (absorbs moisture from the surrounding air) and specimens must be stored in an airtight container.

Carnallite occurs with a sequence of potassium and magnesium evaporite minerals sylvite, kainite, picromerite, poly halite and kieserite. Carnallite is a somewhat rare double chloride mineral which only forms under a specific environmental conditions in an evaporating sea or sedimentary basin. It is mined for both potassium and magnesium and occurs in the evaporite deposits of Carlsbad, New Mexico; the Paradox Basin in Colorado and Utah; Stassfurt, Germany; the Perm Basin, Russia; and the Williston Basin in Saskatchewan, Canada. These deposits date from the Devonian through the Permian Periods. In contrast, both Israel and Jordan produce potash from the Dead Sea by using evaporation pans to further concentrate the brine until carnallite precipitates, dredging the carnallite from the pans, and processing to remove the magnesium chloride from the potassium chloride.

Carnallite was first described in 1856 from its type location of Stassfurt Deposit, Saxony-Anhalt, Germany. It was named for the Prussian mining engineer, Rudolf von Carnall (1804 – 1874) .

Category	Halide mineral
Chemical Formula	$K\ Mg\ Cl_3 \cdot 6(H_2O)$
Molar mass	278
Color	Blue, colorless, yellow, white, red
Crystal habit	Fibrous
Crystal system	Orthorhombic
Fracture	Conchoidal
Mohs scale hardness	2.5
Luster	Greasy
Streak	White
Diaphaneity	Transparent to translucent
Specific gravity	1.6
Optical properties	Biaxial (+)
Refractive index	$n_\alpha = 1.467$ $n_\beta = 1.476$ $n_\gamma = 1.494$
Other characteristics	Non - fluorescent

11 – Carnotite



Carnotite from the Happy Jack Mine, Utah

Carnotite in fossilized wood from St. George, Utah

1 – Introduction :

Carnotite is a potassium uranium vanadate radioactive mineral with chemical formula: $K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$. The water content can vary and small amounts of calcium, barium, magnesium, iron, and sodium are often present.

Category	Vanadate mineral
Chemical Formula	$K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$
Crystal symmetry	Monoclinic
Unit cell	a = 10.47 Å, b = 8.41 Å, c = 6.91 Å; β = 103.83°; Z = 2
Color	Bright yellow to lemon-yellow, may be greenish yellow.
Crystal habit	Crusts, earthy masses, foliated and granular aggregates.

Crystal system	Monoclinic;
Fracture	uneven
Mohs scale hardness	2
Luster	Dull, earthy; silky when crystalline
Streak	yellow
Diaphaneity	Semi transparent
Specific gravity	4.70
Optical properties	Biaxial (-)
Refractive index	n_α=1.750 - 1.780, n_β=1.901 - 2.060, n_γ=1.920 - 2.080
Other characteristics	Radioactive, not fluorescent

2 - Occurrence :

Carnotite is a bright to greenish yellow mineral that occurs typically as crusts and flakes in sandstones. Amounts as low as one percent will color the sandstone a bright yellow. The high uranium content makes carnotite an important uranium ore and also radioactive. It is a secondary vanadium and uranium mineral usually found in sedimentary rocks in arid climates. It is an important ore of uranium in the Colorado Plateau region of the United States where it occurs as disseminations in sandstone and concentrations around petrified logs. Occurs in the U.S. states of Wyoming; Colorado; Arizona; Utah. It also occurs incidentally in Grants, New Mexico and Carbon County, Pennsylvania. It is also reported in Zaire; Morocco; Radium Hill, Australia; and Kazakhstan.

3 - Name and discovery :

The mineral was first described in 1899 by French scientists M. M. C. Freidel and E. Cumenge, who identified it in specimens from Roc Creek in Montrose County, Colorado, United States.[5] It is named for Marie Adolphe Carnot (1839 - 1920), French mining engineer and chemist.

4 - Related mineral species :

Several related mineral species exist, including :

margaritasite ($(Cs,K,H_3O)_2(UO_2)(VO_4)_2 \cdot H_2O$) and

tyuyamunite, ($Ca(UO_2)_2(VO_4)_2 \cdot 5\text{-}8H_2O$).

12 – Chabazite – Ca

Orange chabazite rhombs with white heulandite from Nova Scotia

Chabazite is a tectosilicate mineral of the zeolite group, closely related to gmelinite, with formula $(Ca,Na_2,K_2,Mg)Al_2Si_4O_{12}\cdot 6H_2O$. Recognized varieties include Chabazite - Ca, Chabazite-K, Chabazite-Na, and Chabazite-Sr, depending on the prominence of the indicated cation.

Chabazite crystallizes in the triclinic crystal system with typically rhombohedral shaped crystals that are pseudo-cubic. The crystals are typically twinned, and both contact twinning and penetration twinning may be observed. They may be colorless, white, orange, brown, pink, green, or yellow. The hardness ranges from 3 to 5 and the specific gravity from 2.0 to 2.2. The luster is vitreous.

It was named chabasie in 1792 by Bosc d'Antic and later changed to the current spelling . Chabazite occurs most commonly in voids and amygdules in basaltic rocks . Chabazite is found in India, Iceland, the Faroe Islands, the Giants Causeway in Northern Ireland, Bohemia, Italy, Germany, along the Bay of Fundy in Nova Scotia, Oregon, Arizona, and New Jersey.

Category	Tectosilicate
Chemical Formula	$(Ca,K_2,Na_2)_2[Al_2Si_4O_{12}]_2\cdot 12H_2O$.
Color	Colourless, white, yellow, pink, red
Crystal system	triclinic

Mohs scale hardness	4-5
Luster	vitreous
Streak	white
Diaphaneity	transparent, translucent
Specific gravity	2.05 - 2.2

2 - Synthetic chabazite

Many different materials iso structural with the chabazite mineral have been synthesized in laboratories. SSZ-13 is a CHA type zeolite with an Si/Al ratio of 14. This is a composition not found in nature.

13 – Feldspar

Feldspar crystal (18×21×8.5 cm) from Jequitinhonha valley, Minas Gerais **, *Southeastern Brazil.***

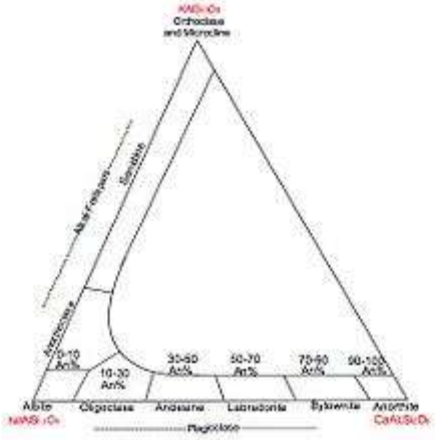
Contents :

1 – Introduction :

Feldspars ($KAlSi_3O_8$ – $NaAlSi_3O_8$ – $CaAl_2Si_2O_8$) are a group of rock - forming tecto silicate minerals which make up as much as 60 % of the Earth's crust.

Feldspars crystallize from magma in both intrusive and extrusive igneous rocks, as veins, and are also present in many types of metamorphic rock . Rock formed almost entirely of calcic plagioclase feldspar (see below) is known as anorthosite . Feldspars are also found in many types of sedimentary rock.

Category	**tecto silicate**
Chemical Formula	$KAlSi_3O_8$ – $NaAlSi_3O_8$ – $CaAl_2Si_2O_8$
Color	pink, white, gray, brown
Crystal system	triclinic or monoclinic
Twinning	tartan, carlsbad, etc
Cleavage	two or three
Fracture	along cleavage planes
Mohs scale hardness	6
Luster	vitreous
Diaphaneity	opaque
Birefringence	first order
Pleochroism	none
Other characteristics	exsolution lamellae common



Compositional phase diagram of the different minerals that constitute the feldspar solid solution.

2 - Etymology :

Feldspar is derived from the German *Feld*, "field", and *Spath*, "a rock that does not contain ore". "Feldspathic" refers to materials that contain feldspar. The alternate spelling, *felspar*, has now largely fallen out of use.

3 - Compositions :

This group of minerals consists of framework tectosilicates. Compositions of major elements in common feldspars can be expressed in terms of three end members :

Potassium-Feldspar (K-spar) endmember $KAlSi_3O_8$

Albite endmember $NaAlSi_3O_8$

Anorthite endmember $CaAl_2Si_2O_8$

Solid solutions between K-feldspar and albite are called alkali feldspar. Solid solutions between albite and anorthite are called *plagioclase,* or more properly *plagioclase feldspar*. Only limited solid solution occurs between K-feldspar and anorthite, and in the two other solid solutions, immiscibility occurs at temperatures common in the crust of the earth. Albite is considered both a plagioclase and alkali feldspar. In addition to albite, barium feldspars are also considered both alkali and plagioclase feldspars. Barium feldspars form as the result of the replacement of potassium feldspar.

3 – 1 - Alkali feldspars :

The alkali feldspars are as follows :

- orthoclase (monoclinic) — $K\ Al\ Si_3\ O_8$
- sanidine (monoclinic) — $(K, Na)Al\ Si_3\ O_8$
- microcline (triclinic) — $KAlSi_3O_8$
- anorthoclase (triclinic) — $(Na, K)\ Al\ Si_3\ O_8$

Sanidine is stable at the highest temperatures, and microcline at the lowest . Perthite is a typical texture in alkali feldspar, due to exsolution of contrasting alkali feldspar compositions during cooling of an intermediate composition. The perthitic textures in the alkali feldspars of many granites can be seen with the naked eye. Micro perthitic textures in crystals are visible using a light microscope, whereas crypto perthitic textures can be seen only with an electron microscope.

3 – 2 - Plagioclase feldspars :

The plagioclase feldspars are triclinic . The plagioclase series follows (with percent anorthite in parentheses) :

- albite (0 to 10) — $NaAlSi_3O_8$
- oligoclase (10 to 30) — $(Na,Ca)(Al,Si)AlSi_2O_8$
- andesine (30 to 50) — $NaAlSi_3O_8$ — $CaAl_2Si_2O_8$
- labradorite (50 to 70) — $(Ca,Na)Al(Al,Si)Si_2O_8$
- bytownite (70 to 90) — $(NaSi,CaAl)AlSi_2O_8$
- anorthite (90 to 100) — $CaAl_2Si_2O_8$

Intermediate compositions of plagioclase feldspar also may exsolve to two feldspars of contrasting composition during cooling, but diffusion is much slower than in alkali feldspar, and the resulting two-feldspar intergrowths typically are too fine-grained to be visible with optical microscopes. The immiscibility gaps in the plagioclase solid solution are complex compared to the gap in the alkali feldspars. The play of colours visible in some feldspar of labradorite composition is due to very fine-grained exsolution lamellae.

3 – 2 - Barium feldspars :

The barium feldspars are monoclinic and comprise the following:

- celsian — $BaAl_2Si_2O_8$
- hyalophane — $(K,Na,Ba)(Al,Si)_4O_8$

Feldspars can form clay minerals through chemical weathering.

Feldspar output in 2005.

4 - Production and uses :

About 20 million tones of feldspar was produced in 2010, mostly by three countries: Italy (4.7 Mt), Turkey (4.5 Mt), and China (2 Mt) .

Feldspar is a common raw material used in glass making , ceramics , and to some extent as a filler and extender in paint, plastics, and rubber. In glass making, alumina from feldspar improves product hardness, durability, and resistance to chemical corrosion. In ceramics, the alkalis in feldspar (calcium oxide, potassium oxide, and sodium oxide) act as a flux, lowering the melting temperature of a mixture. Fluxes melt at an early stage in the firing process, forming a glassy matrix that bonds the other components of the system together. In the US, about 66 % of feldspar is consumed in glass making, including glass containers and glass fiber. Pottery (including electrical insulators, sanitary ware , table ware , and tile) and other uses, such as fillers, accounted for the remainder.

In earth sciences and archaeology, feldspars are used for K-Ar dating, argon-argon dating, thermo luminescence dating and optical dating.

12 – Jarosite

Jarosite crystals from Sierra Peña Blanca ,
Aldama , Chihuahua, Mexico (5.6 x 3.1 x 1.6 cm)

Contents

1 – Introduction :

Jarosite is a basic hydrous sulfate of potassium and iron with a chemical formula of $KFe^{3+}_3(OH)_6(SO_4)_2$. This sulfate mineral is formed in ore deposits by the oxidation of iron sulfides. Jarosite is often produced as a byproduct during the purification and refining of zinc and is also commonly associated with acid mine drainage and acid sulfate soil environments.

Category	Sulfate minerals
Chemical Formula	$K\,Fe^{3+}_3(OH)_6(SO_4)_2$
Crystal symmetry	Trigonal hexagonal scaleno hedral
Unit cell	a = 7.304 Å, c = 17.268 Å; Z = 3
Molar mass	500.8 g

Color	Amber yellow or dark brown
Crystal habit	Crystals are usually pseudocubic or tabular, also as granular crusts, nodules, fibrous masses or concretionary.
Crystal system	Trigonal
Tenacity	Brittle
Mohs scale hardness	2.5 - 3.5
Luster	Sub adamantine to vitreous, resinous on fractures
Streak	light yellow
Diaphaneity	Transparent to translucent
Specific gravity	2.9 to 3.3
Optical properties	Uniaxial (-) , usually anomalously biaxial with very small 2V
Refractive index	n_ω = 1.815 to 1.820; n_ε = 1.713 to 1.715
Pleochroism	E colorless, very pale yellow, or pale greenish yellow, O deep golden yellow or reddish brown
Solubility	Insoluble in water. Soluble in HCl.
Other characteristics	Strongly pyro electric. Non - fluorescent. Barely detectable radioactivity

2 - Physical properties

Jarosite has a trigonal crystal structure and is brittle, with basal cleavage, a hardness of 2.5 - 3.5, and a specific gravity of 3.15-3.26. It is translucent to opaque with a vitreous to dull luster , and is colored dark yellow to yellowish-brown. It can sometimes be confused with limonite or goethite with which it commonly occurs in the gossan (oxidized cap over an ore body). Jarosite is an iron analogue of the potassium aluminium sulfate, alunite .

3 - Solid solution series :

The alunite super group includes the alunite, jarosite , beudantite, crandallite and florencite subgroups. The alunite super group minerals are iso structural with each other and substitution between them occurs, resulting in several solid solution series. The alunite super group has the general formula $AB_3(TO_4)_2(OH)_6$. In the alunite subgroup B is Al, and in the jarosite subgroup B is Fe^{3+}. The beudantite subgroup has the general formula $AB_3(XO_4)(SO_4)(OH)_6$, the crandallite subgroup $AB_3(TO_4)_2(OH)_5.H_2O$ and the florencite subgroup $AB_3(TO_4)_2(OH)_{5 \text{ or } 6}$.

In the jarosite - alunite series Al may substitute for Fe and a complete solid solution series between jarosite and alunite, $KAl_3(SO_4)_2(OH)_6$, probably exists, but intermediate members are rare. The material from Kopec, Czech Republic, has about equal Fe and Al, but the amount of Al in jarosite is usually small.

In the jarosite – natro jarosite series Na substitutes for K to at least Na / K = 1 : 2.4 but the pure sodium end member $NaFe^{3+}{}_3(SO_4)_2(OH)_6$ is not known in nature. Minerals with Na > K are known as natro jarosite. End member formation (jarosite and natro jarosite) is favoured by a low temperature environment, less than 100 °C, and is illustrated by the oscillatory zoning of jarosite and natro jarosite found in samples from the Apex Mine, Arizona, and Gold Hill, Utah. This indicates that there is a wide miscibility gap between the two end members , and it is doubtful whether a complete series exists between jarosite and natro jarosite.

In hydronium jarosite the hydronium ion H_3O^+ can also substitute for K^+, with increased hydronium ion content causing a marked decrease in the lattice parameter *c*, although there is little change in *a* . Hydronium jarosite will only form from alkali-deficient solutions, as alkali - rich jarosite forms preferentially.

Divalent cations may also substitute for the mono valent cation K^+ in the A site . Charge balance may be achieved in three ways.

Firstly by replacing two mono valet cations by one divalent cation, and leaving an A site vacancy, as in plumb o gummite, $Pb^{2+}Al_3(PO_4)_2(OH)_5.H_2O$, which is a member of the crandallite subgroup.

Secondly by incorporating divalent ions in the B sites, as in osarizawaite , $Pb^{2+}Cu^{2+}Al_2(SO_4)_2(OH)_6$, alunite subgroup, and beaverite , $Pb^{2+}Cu^{2+}(Fe^{3+},Al)_2(SO_4)_2(OH)_6$, jarosite subgroup.

Thirdly by replacing divalent anions with trivalent anions, as in beudantite, $PbFe^{3+}{}_3(AsO_4)^{3-}(SO_4)(OH)_6$, beudantite subgroup.

4 - History

Jarosite was first described in 1852 by August Breithaupt in the Barranco del Jaroso in the Sierra Almagrera (near Los Lobos, Cuevas del Almanzora, Almería , Spain) . The name jarosite is also directly derived from Jara, the Spanish name of a yellow flower growing in this sierra. The mineral and the flower have the same color.

In 2004 jarosite was detected on Mars by a Mössbauer spectrometer on the MER-B rover, which has been interpreted as strong evidence that Mars once possessed large amounts of liquid water.

5 - Use in materials science :

Jarosite is also a more generic term denoting an extensive family of compounds of the form $AM_3(OH)_6(SO_4)_2$, where A^+ = Na, K, Rb, NH_4, H_3O, Ag, Tl and M^{3+} = Fe, Cr, V. In condensed matter physics and materials science they are renowned for containing layers with kagome lattice structure, relating to geometrically frustrated magnets.

13 –Kainite

Kainite

Kainite ($MgSO_4 \cdot KCl \cdot 3H_2O$) is a mineral salt that consists of potassium chloride and magnesium sulfate and is used as a fertilizer. This mineral is dull and soft, is colored white through yellow to red and is found in the Stassfurt salt mines in Saxony, Germany. It is a natural salt occurring in irregular granular masses, and is used as a source of potassium and magnesium compounds.

Category	Sulfate minerals
Chemical Formula	$K\ Mg\ [Cl \mid SO_4] \cdot 3H_2O$
Color	Colourless ; yellow , brownish , grayish - green, red , violet , blue
Crystal system	Mono clinic
Fracture	splintery
Mohs scale hardness	2½ - 3
Luster	vitreous
Streak	white
Diaphaneity	transparent
Specific gravity	2.15

14 – Kalinite

Kalinite from the Virgin Valley District, Nevada, USA. Specimen

1 – Introduction :

Kalinite is a fibrous mono clinic type of alum distinct from isometric potassium alum , named in 1868 . Its name comes from Kalium (derived from Arabic: القَلْيَه al-qalyah “plant ashes”) which is the Latin name for potassium, hence its chemical symbol, "K". A proposal to remove recognition of kalinite as a mineral species has been submitted to the International Mineralogical Association , but it is currently (March 2010) on the list of approved minerals . Many older samples, however, have been found to be potassium alum.

Category	Sulfate minerals
Chemical formula	$K Al (SO_4)_2 \cdot 11H_2O$
Crystal symmetry	Mono clinic
Unit cell	a = 19.92 Å, b = 9.27 Å, c = 8.30 Å ; β = 98.79 A°; Z = 4
Molar mass	456.37 g
Color	White to pale blue
Crystal habit	Fibrous
Crystal system	Monoclinic 2/m prismatic

Fracture	Conchoidal
Mohs scale hardness	2 to 2.5
Luster	Vitreous
Streak	White
Diaphaneity	Transparent
Specific gravity	1.75 (observed) 2.0 (calculated)
Optical properties	Biaxial (-)
Refractive index	$n_\alpha = 1.429$ to 1.430, $n_\beta = 1.452$, $n_\gamma = 1.456$ to 1.458
Birefringence	None
Solubility	Soluble in water
Other characteristics	Not fluorescent, barely detectable radioactivity

2 - Environment :

Kalinite is a rare secondary mineral observed in the oxidized zone of mineral deposits, as efflorescence on alum slates, in caves, and as a volcanic sublimate . It is associated with jarosite, $KFe^{3+}{}_3(SO_4)_2(OH)_6$, and cuprian melanterite (pisanite) , $(Fe^{2+},Cu^{2+})SO_4\cdot 7H_2O$, at Quetena , Chile.

15 -Leightonite

1 –Introduction :

Leightonite is a rare sulfate mineral with formula of $K_2Ca_2Cu(SO_4)_4 \bullet 2H_2O$.

Category	Sulfate minerals
Chemical Formula	$K_2Ca_2Cu\ (SO_4)_4 \bullet 2H_2O$
Color	Pale blue, greenish-blue ; pale blue in transmitted light.
Crystal habit	Lathlike crystals , flattened , elongated or equant
Crystal system	Triclinic - pseudo-orthorhombic
Cleavage	None observed
Mohs scale hardness	3
Luster	Vitreous
Diaphaneity	Transparent, translucent
Specific gravity	2.95
Optical properties	Biaxial (-)
Refractive index	$n_\alpha = 1.578$ $n_\beta = 1.587$ $n_\gamma = 1.595$

2 - Crystal class :

Leightonite forms flattened to elongated bladed crystals of variously interpreted crystal structure. It’s crystal system is reported as triclinic morphologically, but also as pseudo – ortho rhombic due to intricate lamellar twinning that mimics orthorhombic symmetry.

Because it is triclinic, the crystal is represented by a system of three unequal vectors with corresponding unequal angles between them.

3 - Optical class :

Leightonite is anisotropic, meaning it has more than one refractive index, in this case three as it is biaxial. The mineral can split polarized light into two rays with different direction and velocity, resulting in the appearance of interference colors when recombined and viewed under polarized light.

4 - Discovery and occurrence :

It was first described in 1938 for an occurrence in the Chuquicamata Mine, Calama, El Loa Province, Antofagasta Region, Chile , and named in honor of Tomas Leighton Donoso (1896 –1967), Professor of Mineralogy at the University of Santiago, Chile.

It occurs in alkali oxidized zones of copper deposits and is associated with natrochalcite, blodite, atacamite, bellingerite, kröhnkite, gypsum and quartz in the discovery location at Chuquicamata, Chile; and with chalcanthite, anhydrite and lammerite at Tsumeb, Namibia.[3] It has also been reported from the Schwaz area of North Tyrol, Austria, and the Visdalen Soapstone Quarry, Lom, Norway .

At the mining site of Chuquicamata, Chile, Leightonite is not found in rich ore; rather it only appears in borderland material within 50 meters of the surface, acting as a cement between rock fragments as it fills in cracks and cross-fiber veins in surfaces as a network of crystals . Although a hydrous sulfate of copper, it is not a major source of the element. Because of its rare nature is valued by mineral collectors.

16 – Lepidolite

Lepidolite, Virgem da Lapa, Minas Gerais, Brazil.

Lepidolite ($KLi_2Al(Al,Si)_3O_{10}(F,OH)_2$ is a lilac-gray or rose-colored phyllosilicate mineral of the mica group that is a secondary source of lithium. It is associated with other lithium-bearing minerals like spodumene in pegmatite bodies. It is one of the major sources of the rare alkali metals rubidium and caesium . In 1861 Robert Bunsen and Gustav Kirchhoff extracted 150 kg of lepidolite and yielded a few grams of rubidium salts for analysis, and therefore discovered the new element rubidium .

It occurs in granite pegmatites, in some high-temperature quartz veins, greisens and granites. Associated minerals include quartz, feldspar, spodumene, amblygonite, tourmaline, columbite, cassiterite, topaz and beryl . Notable occurrences include Brazil; Ural Mountains, Russia; California, United States ; Tanco Mine, Bernic Lake, Manitoba, Canada; and Madagascar.

Category	Silicate mineral
Chemical Formula	$KLi_2Al(Al,Si)_3O_{10}(F,OH)_2$
Crystal symmetry	Monoclinic H-M symbol : Space group : C
Unit cell	a = 5.209 Å b = 9.011 Å c = 10.149 Å; β = 100 :77 °;

	Z = 2
Color	Pink, purple , rose-red , violet-gray , yellowish , white, colorless
Crystal habit	Tabular to prismatic pseudohexagonal crystals, scaly aggregates and massive
Crystal system	Monoclinic
Fracture	Uneven
Mohs scale hardness	2.5 – 3
Luster	Vitreous to pearly
Streak	White
Diaphaneity	Transparent to translucent
Specific gravity	2.8 – 2.9
Optical properties	Biaxial (-)
Refractive index	n_α=1.525 –1.548 , n_β=1.551 –1.58 , n_γ=1.554 –1.586
Pleochroism	X = almost colorless; Y = Z = pink , pale violet

 *Lavender lepidolite"books" from Himalaya Mine,Mesa Grande District, SanDiego County, California, USA.*	 *Yellow lepidolite from Itinga, Minas Gerais, Brazil.*

17 – Leucite

Leucite crystals in a rock from Italy

1 – Introduction :

Leucite is a rock-forming mineral composed of potassium and aluminium tectosilicate $K[AlSi_2O_6]$. Crystals have the form of cubic icositetrahedra but, as first observed by Sir David Brewster in 1821, they are not optically isotropic, and are therefore pseudo-cubic. Goniometric measurements made by Gerhard vom Rath in 1873 led him to refer the crystals to the tetragonal system. Optical investigations have since proved the crystals to be still more complex in character, and to consist of several orthorhombic or monoclinic individuals, which are optically biaxial and repeatedly twinned, giving rise to twin-lamellae and to striations on the faces. When the crystals are raised to a temperature of about 500 °C they become optically isotropic and the twin-lamellae and striations disappear, although they reappear when the crystals are cooled again. This pseudo-cubic character of leucite is very similar to that of the mineral boracite.

The crystals are white or ash-grey in colour, hence the name suggested by A. G. Werner in 1701, from 'λευκος', '(matt) white'. They are transparent and glassy when fresh, albeit with a noticeably subdued 'sub vitreous' lustre due to the low refractive index, but readily alter to become waxy / greasy and then dull and opaque; they are brittle and break with a conchoidal fracture. The Mohs hardness is

5.5, and the specific gravity 2.47. Inclusions of other minerals, arranged in concentric zones, are frequently present in the crystals. On account of the color and form of the crystals the mineral was early known as **white garnet**. French authors in older literature may employ René Just Haüy's name **amphigène**, but 'leucite' is the only name for this mineral species that is recognised as official by the International Mineralogical Association.

Category	Tectosilicates
Chemical Formula	$K[AlSi_2O_6]$
Crystal symmetry	Tetragonal , dipyramidal
Unit cell	a = 13.056 Å , c = 13.751 Å ; Z = 16
Color	White to grey
Crystal habit	Commonly as euhedral, pseudo cubic crystals; rarely granular, massive
Crystal system	Tetragonal
Fracture	Conchoidal
Tenacity	Brittle
Mohs scale hardness	5.5 - 6
Luster	Vitreous
Diaphaneity	Transparent to translucent
Specific gravity	2.45-2.50
Optical properties	Uniaxial (+)
Refractive index	$n_\omega = 1.508$ $n_\varepsilon = 1.509$

2 - Leucite rocks :

Rocks containing leucite are scarce, many countries such as England being entirely without them. However, they are of wide distribution, occurring in every quarter of the globe. Taken collectively, they exhibit a considerable variety of types and are of great interest petro graphically. For the presence of this mineral it is necessary that the silica percentage of the rock should be low, since leucite is incompatible with free quartz and reacts with it to form potassium feldspar. Because it weathers rapidly, leucite is most common in lavas of recent and Tertiary age, which have a fair amount of potassium, or at any rate have potassium equal to or greater than sodium; if sodium is abundant nepheline occurs rather than leucite.

In pre-Tertiary rocks leucite readily decomposes and changes to zeolites , analcite and other secondary minerals. Leucite also is rare in plutonic rocks and dike rocks, but leucite syenite and leucite tinguaite bear witness to the possibility that it may occur in this manner. The rounded shape of its crystals, their white or grey color, and absence of planar cleavage make the presence of leucite easily determinable in many of these rocks by inspection, especially when the crystals are large.

Pseudo leucite from São João Alkaline Massif, RJ, Brazil

"Pseudo leucites " are rounded areas consisting of feldspar, nepheline, analcite , & c., which have the shape, composition and sometimes even the outward crystalline shape of leucite; they are probably pseudo morphs or paramorphs, which have developed from leucite because this mineral is not stable at ordinary temperatures and can be expected under favorable conditions to undergo spontaneous change into an aggregate of other minerals. Leucite is very often accompanied by nepheline, sodalite or nosean ; other minerals which make their appearance with some frequency are melanite , garnet and melilite .

The plutonic leucite - bearing rocks are leucite syenite and missourite. Of these the former consists of orthoclase, nepheline, sodalite , diopside and aegirine , biotite and sphene. Two occurrences are known, one in Arkansas, the other in Sutherland, Scotland. The Scottish rock has been called borolanite. Both examples show large rounded spots in the hand specimens; they are pseudo leucites, and under the microscope prove to consist of orthoclase, nepheline, sodalite and decomposition products. These have a radiate arrangement externally, but are of irregular structure at their centres; it is interesting to note that in both rocks melanite is an important accessory. The missourites are more mafic and consist of leucite, olivine, augite and biotite; the leucite is partly fresh partly altered to analcite, and the rock has a spotted character recalling that of the leucite - syenites. It has been found only in the High wood Mountains of Montana.

The leucite-hearing dike-rocks are members of the tinguaite and monchiquite groups. The leucite tinguaites are usually pale grey or greenish in color and consist principally of nepheline, alkali feldspar and aegirine. The latter forms bright green moss-like patches and growths of indefinite shape, or in other cases scattered acicular prisms, among the feldspars and nephelines of the ground mass. Where leucite occurs, it is always euhedral in small, equant, many-sided crystals in the ground mass, or in larger masses which have the same characters as the pseudo leucites. Biotite occurs in some of these rocks, and melanite also is present. Nepheline decreases in amount as leucite increases since the abundances of the two reflect the Na:K ratio of the rock. Rocks of this group are known from Rio de Janeiro, Arkansas, Kola (in Finland), Montana and a few other places., In Green land there are leucite tinguaites with much arfvedsonite, (hornblende) and eudialyte . Wherever they occur they accompany leucite- and nepheline syenites. Leucite monchiquites are fine-grained dark rocks consisting of olivine, titaniferous augite and iron oxides, with a glassy ground mass in which small rounded crystals of leucite are scattered. They have been described from Czechoslovakia.

By far the greater number of the rocks which contain leucite are lavas of Tertiary or recent geological age. Although these never contain quartz, but feldspar is usually present, though there are certain groups of leucite lavas which are non-feldspathic. Many of them also contain nepheline, sodalite, hauyne and nosean; the much rarer mineral melilite appears also in some examples. The commonest ferromagnesian mineral is augite (sometimes rich in sodium), with olivine in the more basic varieties. Hornblende and biotite occur also, but are less common. Melanite is found in some of the lavas, as in the leucite syenites.

The rocks in which ortho clase (*or sanidine*) is present in considerable amount are leucite - trachytes, leucite-phonolites and leucitophvres. Of these groups the two former, which are not sharply distinguished from one another by most authors, are common in the neighborhood of Rome. They are of trachytic appearance, containing phenocysts of sanidine, leucite, augite and biotite. Sodalite or hauyne may also be present, but nepheline is typically absent. Rocks of this class occur also in the tuffs of the Phlegraean Fields, near Naples. The leucitophyres are rare rocks which have been described from various parts of the volcanic district of the Rhine (Olbrck. Laacher See, etc.) and from Monte Vulture in Italy. They are rich in leucite, but contain also some sanidine and often much nepheline with hauyne or nosean. Their pyroxene is principally aegirine or aegirine-augite; some of them are rich in melanite. Microscopic sections of some of these rocks are of great interest on account of their beauty and the variety of feldspathoid minerals which they contain. In Brazil leucitophyres have been found which belong to the Carboniferous period.

Those leucite rocks which contain abundant essential plagioclase feldspar are known as leucite tephrites and leucite basanites. The former consist mainly of plagioclase, leucite and augite, while the latter contain olivine in addition. The leucite is often present in two sets of crystals, both porphyritic and as an ingredient of the ground mass. It is always idiomorphic with rounded outlines. The feldspar ranges from bytownite to oligoclase, being usually a variety of labradorite; orthoclase is scarce. The augite varies a good deal in chemistry and optical character, being green, brown or violet (suggesting high Na and Ti content), but it is rarely high enough in Na and Fe to qualify as aegirine - augite or aegirine. Among the accessory minerals biotite, brown hornblende , hauyne, iron oxides and apatite are the commonest; melanite and nepheline may also occur. The ground mass of these rocks is only occasionally rich in glass. The leucite-tephrites and leucite - basanites of Vesuvius and Somma are familiar examples of this class of rocks. They are black or ashy-grey in color, often vesicular, and may contain many large grey phenocysts of leucite. Their black augite and yellow green olivine are also easily observed in hand specimens. From Volcan Ello, Sardinia and Roccamonfina similar rocks are obtained; they occur also in Bohemia, in Java, Celebes, Kilimanjaro (Africa) and near Trebizond in Asia Minor.

Leucite lavas from which feldspar is absent are divided into the leucitites and leucite basalts. The latter contain olivine, the former do not. Pyroxene is the usual ferromagnesian mineral, and resembles that of the tephrites and basanites. Sanidine, melanite, hauyne and perovskite are frequent accessory minerals in these rocks, and many of them contain melilite in some quantity, The well-known leucitite of the Capo di Bove, near, Rome, is rich in this mineral, which forms irregular plates, yellow in the hand specimen, enclosing many small rounded crystals of leucite. Bracciano and Roccamonfina are other Italian localities for leucitite, and in Java, Montana, Celebes and New South Wales similar rocks occur, The leucite basalts belong to more basic types and are rich in olivine and augite. They occur in great numbers in the Rhenish volcanic district (Eifel, Laacher See) and in Bohemia, and accompany tephrites or leucitites in Java, Montana, Celebes and Sardinia. The *peperino* of the neighborhood of Rome is a leucitite tuff .

18 - Lopezite

Lopezite

Lopezite is a rare red chromate mineral with chemical formula: $K_2Cr_2O_7$. It crystallizes in the triclinic crystal system.

It occurs as rare vug fillings in nitrate ores in association with tara pacáite (K_2CrO_4), dietzeite and ulexite in the Chilean Atacama and is reported from the Bushveld igneous complex of South Africa.[1][2] Lopezite was first described in 1937 for an occurrence in Iquique Province, Chile and named for Chilean mining engineer Emiliano López Saa (1871-1959).

Most lopezite offered for sale to collectors is artificially produced . Synthetic varieties also exhibit monoclinic crystals.

Category	Sulfate minerals
Chemical formula	$K_2Cr_2O_7$
Strunz classification	07.FD.05

19 – Microcline

Microcline feldspar

Microcline ($KAlSi_3O_8$) is an important igneous rock-forming tectosilicate mineral. It is a potassium - rich alkali feldspar. Microcline typically contains minor amounts of sodium. It is common in granite and pegmatites. Microcline forms during slow cooling of orthoclase; it is more stable at lower temperatures than orthoclase. Sanidine is a polymorph of alkali feldspar stable at yet higher temperature. Microcline may be clear, white, pale-yellow, brick-red, or green; it is generally characterized by cross-hatch twinning that forms as a result of the transformation of monoclinic orthoclase into triclinic microcline.

Crystal System :	Triclinic
Color in PPL :	Colorless
Pleochroism:	N/A
Habit / Shape :	Can be anhedral or euhedral. Grains are commonly elongate with a tabular appearance. May contain lamellae which formed from exsolved albite.
Relief :	Low negative relief
Refractive Index:	nα = 1.514 - 1.529 nβ = 1.518 - 1.533 nγ = 1.521 - 1.539

Birefringence:	Up to first order white (roughly 0.007)
Extinction Habit/Angle:	Inclined extinction to cleavage
Length Slow / Fast:	N / A
Optic Sign:	Biaxial negative
Alteration:	Commonly alters to sericite or clay.
Distinguishing Characteristics:	Gridiron twinning distinguishes microcline from other feldspars. Distinguishable from plagioclase because the lamellae in plagioclase are continuous and do not "pinch and swell."

Microcline may be chemically the same as mono clinic ortho clase , but because it belongs to the triclinic crystal system, the prism angle is slightly less than right angles; hence the name "microcline" from the Greek "small slope." It is a fully ordered triclinic modification of potassium feldspar and is dimorphous with orthoclase. Microcline is identical to orthoclase in many physical properties; it can be distinguished by x-ray or optical examination; viewed under a polarizing microscope, microcline exhibits a minute multiple twinning which forms a grating-like structure that is unmistakable.

Feldspar (Amazonite)

Perthite is either microcline or orthoclase with thin lamellae of exsolved albite.

Amazon stone, or amazonite, is a beautiful green variety of microcline. It is not found anywhere in the Amazon basin, however. Spanish explorers who named it apparently confused it with another green mineral from that region.

The largest documented single crystals of microcline were found in Devils Hole Beryl Mine, Colorado, US and measured ~50x36x14 m. This could be one of the largest crystals of any material found so far .

20 –Minyulite

Minyulite (white) and sincosite (green),
from Ross Hannibal Mine, Lead District, South Dakota, USA

1 – Introduction :

Minyulite is a rare phosphate mineral with a chemical formula of : $KAl_2(OH,F)(PO_4)_2·4(H_2O)$.

It occurs as groups of radiating fine fibrous crystals within rock cracks of phosphatic iron stone . Minyulite belongs to the ortho rhombic crystal system. This indicates that it has three axes of unequal length yet all are perpendicular to each other. It's cell constants are a = 9.35 , b = 9.74 c = 5.52 .

As for its optical properties, Minyulite is an anisotropic mineral which means the velocity of light differs when traveling through it depending on the cut of its cross section which gives it more than one refractive index . The mineral is optically biaxial. Its birefringence value is 0.007. It has three refractive indices which are nα =1.531 nβ =1.534 nγ =1.538 . Refractive indices are a ratio of the speed of light in a median with respect to the speed of light passing through the mineral .

2 : Occurrence :

Colorless minyulite chrystals from Tom's Phosphate quarry, Kapunda, Mount Lofty Ranges, South Australia

It was first described in 1933 for an occurrence in Western Australia and named after the type locality, Minyulo Well in Western Australia.

Minyulite is considered as a secondary phosphate since it is formed by the alteration of a primary phosphate. It occurs in association with dufrenite, apatite, fluellite, wavellite, variscite and leucophosphite.

The mineral can be found in the under laying phosphatized rock zone of ornithogenic soil. Minyulite is not found in abundance, it can be found in the sea shore of the maritime Arctic.

21 – Nepheline

Nepheline, also called **nephelite** (from Greek : "cloud"), is a feld spathoid : a silica-under saturated alumino silicate, $Na_3KAl_4Si_4O_{16}$, that occurs in intrusive and volcanic rocks with low silica, and in their associated pegmatites. It is often found in mica schist and gneiss.

Grayish-white nepheline crystals with dark schorlomite from Bou-Agrao Mt., Tamazeght complex, High Atlas Mts, Morocco

Nepheline crystals are rare and belong to the hexagonal system, usually having the form of a short, six-sided prism terminated by the basal plane. The unsymmetrical etched figures produced artificially on the prism faces indicate, however, that the crystals are hemi morphic and tetartohedral , the only element of symmetry being a polar hexad axis. It is found in compact, granular aggregates, and can be white, yellow, gray, green, or even reddish (in the *eleolite* variety). The hardness is 5.5 - 6, and the specific gravity 2.56 - 2.66. It is often translucent with a greasy luster.

The low index of refraction and the feeble double refraction in nepheline are nearly the same as in quartz; but since in nepheline the sign of the double refraction is negative, while in quartz it is positive, the two minerals are readily distinguished under the microscope. An important determinative character of nepheline is the ease with which it is decomposed by hydrochloric acid, with separation of gelatinous silica (which may be readily stained by coloring matters) and cubes of salt. For this reason, a clear crystal of nepheline becomes cloudy when immersed in acid.

Although sodium and potassium are always present in naturally occurring nepheline in approximately the atomic ratio (3:1), artificially prepared crystals have the composition $NaAlSiO_4$; the corresponding potassium compound, $KAISiO_4$, which is the mineral kaliophilite, has also been prepared artificially. It has therefore been suggested that the ortho silicate formula, $(Na , K) Al Si O_4$, represents the true composition of nepheline.

The mineral is one especially liable to alteration, and in the laboratory various substitution products of nepheline have been prepared. In nature it is frequently altered to zeolites (especially natrolite) , sodalite , kaolin , or compact muscovite. Gieseckite and liebenerite are pseudo morphs.

Two varieties of nepheline are distinguished, differing in their external appearance and in their mode of occurrence, being analogous in these respects to sanidine and common orthoclase respectively. Glassy nepheline has the form of small, colorless, transparent crystals and grains with a vitreous luster. It is characteristic of the later volcanic rocks rich in alkalis, such as phonolite, nepheline-basalt, leucite basalt, etc., and also of certain dike-rocks, such as tinguaite. The best crystals occur with mica, sanidine, garnet, etc., in the crystal-lined cavities of the ejected blocks of Monte Somma, Vesuvius. The other variety, known as elaeolite, occurs as large, rough crystals, or more often as irregular masses, which have a greasy luster and are opaque, or at most translucent, with a reddish, greenish, brownish or grey color. It forms an essential constituent of certain alkaline plutonic rocks of the nepheline syenite series, which are typically developed in southern Norway.

The color and greasy luster of elaeolite (a name given by M. H. Klaproth 1809, from Greek words for oil and stone; German *Fettstein*) are due to the presence of numerous microscopic enclosures of other minerals, possibly augite or hornblende. These enclosures sometimes give rise to a chatoyant effect like that of cats-eye and cymophane; and elaeolite when of a good green or red color and showing a distinct band of light is sometimes cut as a gem-stone with a convex surface.

22 - Niter

1 – Introduction :

Niter (AmE) or **nitre** (BrE) is the mineral form of potassium nitrate, KNO_3, also known as **saltpeter** (AmE) or **saltpetre** (BrE). Historically, the term "niter" – cognate with "natrium", a Latin word for sodium – has been very vaguely defined, and it has been applied to a variety of other minerals and chemical compounds, including sodium nitrate (also "soda niter", "cubic niter", or nitratite) , sodium carbonate and potassium carbonate .

Because of its ready solubility in water, niter is most often found in arid environments. A major source of sodium (not potassium) nitrate mineral is the Atacama desert in Chile. Potassium and other nitrates are of great importance for use in fertilizers, and, historically, gunpowder. Much of the world's demand is now met by synthetically produced nitrates, though the natural mineral is still mined and is still of significant commercial value.

2 – Description :

Niter is a colorless to white mineral crystallizing in the orthorhombic crystal system. It usually is found as massive encrustations and effervescent growths on cavern walls and ceilings where solutions containing alkali potassium and nitrate seep into the openings. It occasionally occurs as prismatic acicular crystal groups, and individual crystals commonly show twinning.

3 – History :

Niter as a term has been known since ancient times, although there is much historical confusion with natron (an impure sodium carbonate/bicarbonate) and not all of the ancient salts known by this name or similar names in the ancient world, contained nitrate. The name is from the Greek *νιτρων nitron* from Ancient Egyptian *netjeri*, related to the Hebrew *néter*, for salt-derived ashes (their interrelationship is not clear).

The Hebrew *néter* may have been used as, or in conjunction with soap, as implied by Jeremiah 2:22, "For though thou wash me with nitre, and take thee much sope…" However, it is not certain which substance (or substances) the Biblical "neter" refers to, with some suggesting sodium carbonate. Indeed, the Neo Latin word for sodium natrium is derived from this same class of desert minerals called *natron* (French) from Spanish *natrón* through Greek *νιτρων* (*nitron*), derived from Ancient Egyptian *netjeri*, referring to the carbonate sodium salts occurring in the deserts of Egypt, not the nitrated sodium salts typically occurring in the deserts of Chile (classically known as "Chilean saltpeter" and variants of this term).

A term (ἀφρόνιτρον) which translates as "foam of niter" was a regular purchase in a fourth - century AD series of financial accounts, and since it was expressed as being "for the baths" was probably used as soap .

Niter was used to refer specifically to nitrated salts known as various types of saltpeter (only nitrated salts were good for making gunpowder) by the time niter and its derivative nitric acid were first used to name the element nitrogen, in 1790.

23 – Orthoclase

1 – Introduction :

Orthoclase (endmember formula $KAlSi_3O_8$) is an important tectosilicate mineral which forms igneous rock. The name is from the Greek for "straight fracture," because its two cleavage planes are at right angles to each other. Alternate names are **alkali feldspar** and **potassium feldspar**. The gem known as moon stone is largely composed of orthoclase.

2 - Formation and subtypes :

Orthoclase is a common constituent of most granites and other felsic igneous rocks and often forms huge crystals and masses in pegmatite.Typically, the pure potassium endmember of orthoclase forms a solid solution with albite, the sodium endmember ($NaAlSi_3O_8$), of plagioclase. While slowly cooling within the earth, sodium-rich albite lamellae form by exsolution, enriching the remaining orthoclase with potassium. The resulting intergrowth of the two feldspars is called perthite.

Adularia with pyrite incrustations.

The higher-temperature polymorph of orthoclase is sanidine. Sanidine is common in rapidly cooled volcanic rocks such as obsidian and felsic pyroclastic rocks, and is notably found in trachytes of the Drachenfels, Germany. The lower-temperature polymorph of orthoclase is microcline. Adularia is found in low temperature hydrothermal deposits, in the Adula Mountains of Switzerland. The largest documented single crystal of othoclase was found in Ural mountains, Russia. It measured ~10×10×0.4 m^3 and weighed ~100 tons.

3 - Uses :

Together with the other potassium feldspars orthoclase is a common raw material for the manufacture of some glasses, some ceramics, such as porcelain, and as a constituent of scouring powder.

Some intergrowths of orthoclase and albite have an attractive pale lustre and are called moonstone when used in jewellery. Most moonstones are translucent and white, although grey and peach-colored varieties also occur. In gemology, their lustre is called adularescence and is typically described as creamy or silvery white with a "billowy" quality. It is the state gem of Florida.

The gemstone commonly called *rainbow moonstone* is more properly a colourless form of labradorite and can be distinguished from "true" moonstone by its greater transparency and play of colour, although their value and durability do not greatly differ.

24 – Pharmacosiderite

Pharmacosiderite is a hydrated basic ferric arsenate, with chemical formula $KFe_4(AsO_4)_3(OH)_4 \cdot (6\text{-}7)H_2O$ and a molecular weight of 873 g / mol. It consists of the elements arsenic, iron, hydrogen, potassium, sodium and oxygen. It has a Mohs hardness of 2 to 3, about that of a finger nail. Its specific gravity is about 2.7 to 2.9, has indistinct cleavage, and is usually transparent or translucent. It has a yellow or white streak and a yellow, green, brown or red color. Its lustre is adamantine, vitreous and resinous, and it has conchoidal, brittle and sectile fracture.

Pharmacosiderite has an isometric crystal system, with yellowish-green, sharply defined cube crystals. Its crystals are doubly refracting, and exhibit a banded structure in polarized light. When placed in ammonium solution, a crystal changes color to a distinguishing red. Upon placing it into dilute hydrochloric acid the original color is restored. This secondary origin mineral is normally formed in the oxidation zones of ore deposits. The alteration of arsenopyrite, tennantite and other primary arsenates can form pharmacosiderite . It can also form from precipitation of hydrothermal solutions, but only rarely. It can be found in abundance in Cornwall, Hungary and the U.S. state of Utah. When it was first discovered, pharmacosiderite was known as cube ore. The present name, given by J. F. L. Hausmann in 1813, is made up of the Greek words for arsenic and iron, the two most significant consisting elements. *Farmakon* means poison, which is related to arsenic, and *sideros* means iron. Pharmacolite and picro pharmacolite , which are different arsenates, are not associated besides via nomenclature. Siderite, a carbonate mineral, only shares the common element iron with pharmacosiderite.

Category	Arsenate minerals
Chemical Formula	$KFe_4(AsO_4)_3(OH)_4\cdot(6\text{-}7)H_2O$
Molar mass	873 g / mol
Color	Greens , browns , Yellows
Crystal habit	Massive to Crystalline
Crystal system	Isometric – Hex tetra hedral
Fracture	Brittle
Mohs scale hardness	2 . 5
Luster	Adamantine
Streak	yellowish green
Diaphaneity	Sub transparent to sub translucent
Density	2.9 g / cm^3
Ultra violet fluorescence	None

25 - Polyhalite

Polyhalite is an evaporite mineral, a hydrated sulfate of potassium, calcium and magnesium with formula: $K_2Ca_2Mg(SO_4)_4 \cdot 2(H_2O)$. Polyhalite crystallizes in the triclinic system although crystals are very rare. The normal habit is massive to fibrous. It is typically colorless, white to gray, although it may be brick red due to iron oxide inclusions. It has a Mohs hardness of 3.5 and a specific gravity of 2.8.

It occurs in sedimentary marine evaporites and is a major potassium ore mineral in the Carlsbad Deposits of New Mexico.

Polyhalite was first described in 1818 for specimens from its type locality in Salzberg, Austria. The name is from the Greek *polys hals* for *many salts*.

It has no connection to the sodium halide mineral halite other than that both are evaporite minerals.

26 - Potash

Contents

1 – Introduction :

Potash is the common name for various mined and manufactured salts that contain potassium in water - soluble form. In some rare cases, potash can be formed with traces of organic materials such as plant remains, and this was the major historical source for it before the industrial era . The name derives from " pot ash " , which refers to plant ashes soaked in water in a pot.

Today, potash is produced worldwide at amounts exceeding 30 million tones per year , mostly for use in fertilizers. Various types of fertilizer-potash thus comprise the single largest global industrial use of the element potassium. Potassium derives its name from potash, from which it was first derived by electrolysis of caustic potash, in 1808.

2 - Terminology :

Potash refers to potassium compounds and potassium-bearing materials, the most common being potassium chloride (KCl). The term "potash" comes from the Old Dutch word *potaschen*. The old method of making potassium carbonate (K_2CO_3) was by leaching of wood ashes and then evaporating the resulting solution in large iron pots, leaving a white residue called "pot ash". Approximately 10% by weight of common wood ash can be recovered as pot ash.[2][3] Later, "potash" became the term widely applied to naturally occurring potassium salts and the commercial product derived from them.[4]

The following table lists a number of potassium compounds which use the word *potash* in their traditional names :

Common name	Chemical name	Formula
Potash fertilizer	c.1942 potassium carbonate; c.1950 any one or more of potassium chloride, potassium sulfate (K_2SO_4), potassium magnesium sulfate ($K_2SO_4 \cdot 2MgSO_4$) , langbeinite ($K_2Mg_2(SO_4)_3$) or potassium nitrate . Does *not* contain potassium oxide, which plants do not take up.	
Caustic potash or potash lye	potassium hydroxide	KOH
Carbonate of potash , salts of tartar , or pearl ash	potassium carbonate	K_2CO_3
Chlorate of potash	potassium chlorate	$KClO_3$
Muriate of potash	potassium chloride	$KCl : NaCl$ (95:5 or higher)
Nitrate of potash or saltpeter	potassium nitrate	KNO_3
Sulfate of potash	potassium sulfate	K_2SO_4
Permanganate of potash	potassium permanganate	$KMnO_4$

3 - History of production :

Potash (especially potassium carbonate) has been used from the dawn of history in bleaching textiles, making glass, and, from about A.D. 500, in making soap. Potash was principally obtained by leaching the ashes of land and sea plants. Beginning in the 14th century potash was mined in Ethiopia. One of the world's largest deposits, 140 to 150 million tons, is located in the Tigray's Dallol area . Potash was one of the most important industrial chemicals in Canada. It was refined from the ashes of broadleaved trees and produced primarily in the forested areas of Europe, Russia, and North America. The first U.S. patent was issued in 1790 to Samuel Hopkins for an improvement "in the making Pot ash and Pearl ash by a new Apparatus and Process " .

As early as 1767, potash from wood ashes was exported from Canada, and exports of potash and pearl ash (potash and lime) reached 43,958 barrels in 1865. There were 519 asheries in operation in 1871. The industry declined in the late 19th century when large-scale production of potash from mineral salts was established in Germany. In 1943, potash was discovered in Saskatchewan, Canada, in the process of drilling for oil. Active exploration began in 1951. In 1958, the Potash Company of America became the first potash producer in Canada with the commissioning of an underground potash mine at Patience Lake; however, due to water seepage in its shaft, production stopped late in 1959 and, following extensive grouting and repairs, resumed in 1965. The underground mine was flooded in 1987 and was reactivated for commercial production as a solution mine in 1989 .

In the late 18th and early 19th centuries, potash production provided settlers in North America a way to obtain badly-needed cash and credit as they cleared wooded land for crops. To make full use of their land, settlers needed to dispose of excess wood. The easiest way to accomplish this was to burn any wood not needed for fuel or construction. Ashes from hard wood trees could then be used to make lye, which could either be used to make soap or boiled down to produce valuable potash. Hardwood could generate ashes at the rate of 60 to 100 bushels per acre (500 to 900 m^3 / km^2) . In 1790, ashes could be sold for $ 3.25 to $ 6.25 per acre ($ 800 to $ 1500 / km^2) in rural New York State – nearly the same rate as hiring a laborer to clear the same area. Potash making became a major industry in British North America. Great Britain was always the most important market. The American potash industry followed the woodsman's ax across the country. After about 1820, New York replaced New England as the most important source; by 1840 the center was in Ohio. Potash production was always a by - product industry, following from the need to clear land for agriculture .

Most of the world reserves of potassium (K) were deposited as sea water in ancient inland oceans evaporated, and the potassium salts crystallized into beds of potash ore. These are the locations where potash is currently being mined today. The deposits are a naturally-occurring mixture of potassium chloride (K Cl) and sodium chloride (Na Cl), better known as common table salt. Over time, as the surface of the earth changed, these deposits were covered by thousands of feet of earth.

Most potash mines today are deep shaft mines as much as 4,400 feet (1,400 m) underground. Others are mined as strip mines, having been laid down in horizontal layers as sedimentary rock. In above-ground processing plants, the K Cl is separated from the mixture to produce a high analysis natural potassium fertilizer. Other naturally occurring potassium salts can be separated by various procedures, resulting in potassium sulfate and potassium-magnesium sulfate.

Today some of the world's largest known potash deposits are spread all over the world from Saskatchewan, Canada, to Brazil, Belarus, Germany, and more notably the Permian Basin. The Permian basin deposit includes the major mines outside of Carlsbad, New Mexico, to the world's purest potash deposit in Lea County New Mexico (not far from the Carlsbad deposits), which is believed to be roughly 80 % pure. Canada is the largest producer, followed by Russia and Belorussia. The most significant reserve of Canada's potash is located in the province of Saskatchewan and controlled by the Potash Corporation of Saskatchewan.

In the beginning of the 20th century, potash deposits were found in the Dallol Depression in Musely and Crescent localities near the Ethiopean - Eritrean border . The estimated reserves are 173 and 12 million tones for the Musely and Crescent, respectively. The latter is particularly suitable for surface mining; it was explored in the 1960s but the works stopped due to the flood in 1967. Attempts to continue mining in the 1990s were halted by the Eritrean – Ethiopian War and have not resumed by 2009.

4 – Consumption :

Production and resources of potash 2010
(in million tones)

Country	Production	Reserves
Canada	9.5	4400
Russia	6.8	3300

Production and resources of potash 2010
(in million tones)

Country	Production	Reserves
Belarus	5.0	750
China	3.0	210
Germany	3.0	150
Israel	2.1	40
Jordan	1.2	40
United States	0.9	130
Chile	0.7	70
Brazil	0.4	300
United Kingdom	0.4	22
Spain	0.4	20
Other countries		50
World total	**33**	**9500**

4 – 1 - Fertilizers :

Potash output in 2005

Potassium is the seventh most abundant element in the Earth's crust, and is the third major plant and crop nutrient after nitrogen and phosphorus. It has been used since antiquity as a soil fertilizer (about 90 % of current use) . Potash is important for agriculture because it improves water retention, yield, nutrient value, taste, colour , texture and disease resistance of food crops. It has wide application to fruit and vegetables, rice, wheat and other grains, sugar, corn, soybeans, palm oil and cotton, all of which benefit from the nutrient's quality enhancing properties .

Demand for food and animal feed has been on the rise since 2000. The U.S. Department of Agriculture's Economic Research Service (ERS) attributes the trend to average annual population increases of 75 million people around the world. Geographically, economic growth in Asia and Latin America greatly contributed to the increased use of potash-based fertilizer. Rising incomes in developing countries also was a factor in the growing potash and fertilizer use. With more money in the household budget, consumers added more meat and dairy products to their diets. This shift in eating patterns required more acres to be planted, more fertilizer to be applied and more animals to be fed – all requiring more potash.

After years of trending upward, fertilizer use slowed in 2008. The worldwide economic downturn is the primary reason for the declining fertilizer use, dropping prices and mounting inventories .

The world's largest consumers of potash are China, the United States, Brazil and India . Brazil imports 90 % of the potash it needs.

Potash imports and exports are often reported in "K_2O equivalent", although fertilizer never contains potassium oxide, per se, because potassium oxide is caustic and hygroscopic.

Potash prices have soared in recent years. What was once a commodity worth about $ 200 a tone is expected to reach $1,500 by 2020; Vancouver prices are US $ 872.50 per tone in 2009, which is a record high . As of November 2011 potash prices have dropped to about $ 470 per metric tone.

4 – 2 - Other uses :

In addition to its use as a fertilizer, potassium chloride is important in industrialized economies, where it is used in aluminium recycling, by the chlor alkali industry to produce potassium hydroxide, in metal electro plating, oil-well drilling fluid, snow and ice melting, steel heat - treating, and water softening. Potassium hydroxide is used for industrial water treatment and is the precursor of potassium carbonate, several forms of potassium phosphate, many other potassic chemicals , and soap manufacturing. Potassium carbonate is used to produce animal feed supplements, cement, fire extinguishers, food products, photographic chemicals, and textiles. It is also used in brewing beer, pharmaceutical preparations, and as a catalyst for synthetic rubber manufacturing. These non fertilizer uses have accounted for about 15 % of annual potash consumption in the United States.

Potash (potassium carbonate) along with hart shorn was also used as a baking aid similar to baking soda in old German baked goods such as lebkuchen (ginger bread) .

27 - Sylvite

Sylvite

Sylvite is potassium chloride (KCl) in natural mineral form. It forms crystals in the isometric system very similar to normal rock salt, halite (NaCl). The two are, in fact, isomorphous.[4] Sylvite is colorless to white with shades of yellow and red due to inclusions. It has a Mohs hardness of 2.5 and a specific gravity of 1.99. It has a refractive index of 1.4903.[5] Sylvite has a salty taste with a distinct bitterness.

Sylvite is one of the last evaporite minerals to precipitate out of solution. As such, it is only found in very dry saline areas. Its principal use is as a potassium fertilizer.

Category	Halide mineral
Chemical Formula	K Cl
Crystal symmetry	Isometric hexoctahedral
Unit cell	a = 6.2931 Å; Z = 4
Molar mass	74.5 g
Color	Colorless to white, pale gray, pale blue; may be yellowish red to red due to hematite inclusions
Crystal habit	As cubes and octahedra ;

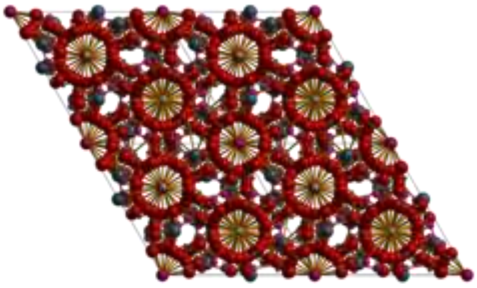
	columnar, in crusts , coarse granular, massive
Crystal system	Isometric
Fracture	Uneven
Tenacity	Brittle to ductile
Mohs scale hardness	2
Luster	Vitreous
Streak	white
Diaphaneity	Transparent to translucent
Specific gravity	1.993
Optical properties	Isotropic
Refractive index	1.4903
Pleochroism	Visible in colored crystals
Ultra violet fluorescence	None
Solubility	Soluble in water
Other characteristics	salty to bitter taste

	
Sylvite From Germany	*Sylvite*

Sylvite is found in many evaporite deposits world wide. Massive bedded deposits occur in New Mexico and western Texas, and in Utah in the US, but the largest world source is in Saskatchewan, Canada. The vast deposits in Saskatchewan, Canada were formed by the evaporation of a Devonian seaway. Sylvite is the official mineral of Saskatchewan.

Sylvite was first described in 1832 at Mt. Vesuvius near Napoli in Italy and named for the Dutch chemist, François Sylvius de le Boe (1614–1672) .

28 –Taranakite



View down the c - axis of tara nakite (four unit cells visible)

1 – Introduction :

Taranakite is a hydrated alkali iron-aluminium phosphate mineral with chemical formula $(K,Na)_3(Al,Fe^{3+})_5(PO_4)_2(HPO_4)_6 \cdot 18H_2O$. It forms from the reaction of clay minerals or aluminous rocks with solutions enriched in phosphate derived from bat or bird guano or, less commonly, from bones or other organic matter.[6] Taranakite is most commonly found in humid, bat inhabited caves near the boundary of guano layers with the cave surface. It is also found in perennially wet coastal locations that have been occupied by bird colonies. The type location, and its namesake, the Sugar Loaf Islands off Taranaki, New Zealand, is an example of a coastal occurrence.

Taranakite forms small white, pale yellow, or gray crystals, which are typically found in pulverulent nodular aggregates, or crusts. Taranakite crystallizes in the hexagonal system, and is noted as having the longest crystallographic axis of any known mineral: the *c*-axis of the taranakite unit cell is 9.505 nanometers long.

2 – Occurrence :

Taranakite was first described in 1866 by James Hector and William Skey . The material had been found by H. Richmond on the Sugar Loaf Islands of Taranaki , New Zealand , as thin yellowish - white amorphous seams in fissures within trachytic rocks. Within the taranakite, dark yellow-brown seams were observed and thought to be wavellite. Modern X- ray analysis later showed this inclusion to be vashegyite $(Al_{11}(PO_4)_9(OH)_6) \cdot 38H_2O)$.

Taranakite itself was initially mistaken for wavellite. Physical differences — its relative softness and ease of fusibility — led Skey, the colonial New Zealand Government analyst, to undertake quantitative chemical analysis which identified the mineral as a double hydrous phosphate of aluminia and potash, with some replacement of aluminium with ferric iron . This identified it as a new mineral species – the first to be discovered in New Zealand.

Hector and Skey identified bird guano as the most likely source of the phosphate required to form taranakite, and speculated on possible advantages of its use in making superphosphate, owing to the absence of carbonate and relatively small amounts of aluminium. Such industrial use was never realized owning to the limited distribution of taranakite.

Taranakite was rediscovered in two cave locations, and given two new names. In 1894, Armand Gautier described a mineral which he called **minervite** from caves at Grotte de Minerve in Hérault, France and argued that it formed from decomposing guano and animal remains reacting with clays. He experimentally justified this by reacting ammonium phosphate with gelatinous aluminium oxide, iron carbonate, and limestone. These reactions yielded a miner vatie - like compound, and iron and calcium phosphates similar to what he observed in the caves . In 1904 Eugenio Casoria found a mineral under a guano layer at Monte Alburno, Italy which he called **palmerite** . These two minerals were later identified through X-ray powder diffraction as taranakite and discredited in favor of taranakite by historical priority.

Further occurrences of taranakite include :

- Misserghin, Algeria (as minervite) (1895)
- Jenolan Caves, Australia (as minervite) (1898)

No guano deposits are present in the caves; phosphatization is believed to occur from river water containing organic matter penetrating the cave.

- Réunion, Indian Ocean (as minervite) (1910)

Within a basalt cave in the Saint-Paul district

- Islas Leones, Patagonia (1933)

Associated with a penguin colony

- Pig Hole Cave, near Blacksburg, Virginia (1954)

A limestone cave. Taranakite occurs as a powder near the contact of bat guano and hair with clay, and within fractures in brecciated clay. This was the first discovery of taranakite in the United States.

- Onino - Iwaya cave, Hiroshima Prefecture, Japan (1975)

As a powder associated with gypsum within clay sediments, no more than three centimeters below the surface in areas of bat guano deposits.

- Mezesse Cave near Yaoundé, Cameroon

Coralloid speleothems of regularly alternating taranakite and opal micro layers in a granitic cave. The regular layering of taranakite was explained as the seasonal effect of leaching of guano and flow of clay from upper parts of the cave during the rainy season.

- Cook's Head Rock and Green Island, Otago, New Zealand (2003)

Occurring with leucophosphite as microcrystalline aggregates in jointed and brecciated basalt. Little Blue Penguins on Green Island and gulls on Cooks Head Rock are believed to be the main guano source.

The coastal occurrences, in New Zealand and Patagonia, occur at high latitudes supporting the necessity of humid conditions for the formation of taranakite. In the tropics, rather than taranakite, the minerals that form from guano-derived phosphatization of igneous rocks are variscite ($AlPO_4 \cdot 2H_2O$), metavariscite ($AlPO_4 \cdot H_2O$), barrandite ($(Al,Fe^{3+})PO_4·2H_2O$), strengite and phosphosiderite ($Fe^{3+}PO_4·2H_2O$).

3 - Presence in soils :

Tarankaite is observed to form in the reaction zone of fertilizers. **Potassium - taranakite** (synonymous with taranakite) or **ammonium - taranakite** (where the alkali cations are replaced by ammonium) may form in acidic soils treated with potassium or ammonium - containing phosphate-fertilizers. The formation of taranakites , which are relatively insoluble, can act to reduce the bioavailability of phosphorus, potassium, and nitrogen if formed. This can both hinder plant growth in initial stages by reducing the available cations, and also aid in the long run by extending the presence of these nutrients.

4 - Structure :

Taranakite crystallizes in the hexagonal crystal system (hexagonal scale nohedral) with the space group R3c. The unit cell dimensions are a = 870.25 pm and c = 9505 pm, enclosing a volume of 6.234 nm^3. The *c*-axis is the longest of any known mineral.

The unit cell of taranakite contains six layers of composition $K_3Al_5(HPO_4)_6(PO_4)_2(H_2O)_{12}$, each 13.78 Å thick and separated by layers of water. The rigid structure of each layer is built around HPO_4^{2-} groups coordinating three crystallo graphically distinct aluminium centers, each of which has coordination number six. Near the middle of each layer, an aluminium ion octa hedrally coordinates six HPO_4^{2-}. Two other oxygens in each hydrogen phosphate group coordinate the other distinct aluminium centers, which in turn are coordinated octahedral to three hydrogen phosphate groups and three water molecules. This structure forms a Al'–P–Al''–P–Al' linkage nearly parallel to the *c*-axis, with the other distinct aluminium atom offset, and nearly vertically below a PO_4^{3-} ion.

Taranakite readily loses water when heated. Thermal gravimetric analysis shows two endothermic water loss events occurring in the ranges 80–140 °C and 140–300 °C corresponding to the sequential loss of five and thirteen water molecules to form francoanellite and a non crystalline material. Heating to 500 °C results in complete dehydration to form $K_3Al_5P_8O_{29}$. In the range 562–595 °C crystalline $AlPO_4$ and $KAlP_2O_7$ form.

29 - Yuksporite

Yuksporite from the Khibiny Massif,
Kola Peninsula, Russia, 4 cm across

Contents

1 – Introduction :

Yuksporite is a rare inosilicate mineral with double width, unbranched chains, and the complicated chemical formula :

$K_4(Ca,Na)_{14}Sr_2Mn(Ti,Nb)_4(O,OH)_4(Si_6O_{17})_2(Si_2O_7)_3(H_2O,OH)_3$

It contains the relatively rare elements strontium Sr, titanium Ti and niobium Nb, as well as the commoner metallic elements potassium K, calcium Ca, sodium Na and manganese Mn. As with all silicates, it contains groups of linked silicon Si and oxygen O atoms, as well as some associated water molecules H_2O.

Yuksporite is a member of the umbite group that has just two known members, umbite, $K_2ZrSi_3O_9.H_2O$, and yuksporite.[3] It was first reported in 1922, from nepheline syenite occurrences in the Kola Peninsula, Russia, and named by Alexander Fersman for the locality, near Mount Yukspor.

Category	Inosilicates
Chemical Formula	$K_4(Ca,Na)_{14}Sr_2Mn(Ti,Nb)_4(O,OH)_4(Si_6O_{17})_2$ $(Si_2O_7)_3(H_2O,OH)_3$
Strunz classification	8/F.35-40 or 9.DG.95
Molar mass	2,547 g
Color	Brownish pink to rose-red to straw-yellow
Crystal habit	Fibrous, scaly or lamellar
Crystal system	Monoclinic
Mohs scale hardness	4.5 to 5
Luster	Vitreous, silky
Streak	Nearly white to white
Diaphaneity	Semitransparent
Specific gravity	3.05
Optical properties	Biaxial
Refractive index	$N_x = 1.644$, $N_z = 1.660$
Pleochroism	X pale rose - yellow, Y , Z rose - yellow
Other characteristics	Barely detectable radioactivity

2 - Unit cell :

Yuksporite was originally thought to be ortho rhombic, space group unknown . In 2004, however, the structure was solved using synchrotron radiation and found to be monoclinic . The monoclinic unit cell has two formula units per cell (Z = 2) and side lengths a = 7.126 Å, b = 24.913 Å and c = 17.075 Å, with the angle β between the a and c axes equal to 101.89°.

3 - Appearance :

The mineral is brownish pink, rose pink or yellowish in color, with a silky to vitreous luster and a nearly white streak. It occurs in semi-transparent fibrous, scaly or lamellar aggregates up to 10 cm across.

4 - Properties :

Yuksporite is a biaxial mineral, but most authors do not specify whether it is (+) or (-); the Handbook of Mineralogy gives it as (+). All agree, however, that the refractive indices are $N_x = 1.644$ and $N_z = 1.660$ (with N_y unspecified), which are larger than those for quartz, but similar to those for tourmaline. Yuksporite shows pleochroism, with X pale rose-yellow, and Y, Z rose-yellow. It has a hardness of 4½ to 5, between fluorite and apatite, and specific gravity 3.05, similar to fluorite. It exhibits barely detectable radioactivity.

5 - Occurrence and associations :

The type locality is the Hackman Valley, Yukspor Mt, Khibiny Massif, Murmanskaja Oblast', Northern Region, Russia , and type material is conserved at the Fersman Mineralogical Museum, Academy of Sciences, Moscow, Russia, catalogue number 25847.[5] The only occurrences reported by Mindat.org are in Russia. At the Khibiny massif it occurs in veins in nepheline syenite associated with titanite, pectolite, astrophyllite, biotite and aegirine.[6] At the Murun massif in the Sakha Republic it is associated with aegirine, kalsilite, potassic feldspar, titanite, lamprophyllite, wadeite and tausonite.[5]

30 –Zippeite

Zippeite from Delta Mine in Utah

1 – Introduction :

Zippeite is a hydrous potassium uranium sulfate mineral with formula : $K_4(UO_2)_6(SO_4)_3(OH)_{10} \cdot 4(H_2O)$. It forms yellow to reddish brown monoclinic - prismatic crystals with perfect cleavage . The typical form is as encrustations and pulverulent earthy masses. It forms as efflorescent encrustations in underground uranium mines. It has a Mohs hardness of 2 and a specific gravity of 3.66. It is strongly fluorescent yellow in UV radiation and is a radioactive mineral.

Category	Sulfates
Chemical Formula	$K_4(UO_2)_6(SO_4)_3(OH)_{10} \cdot 4(H_2O)$
Molar mass	2,307
Color	Yellow, golden yellow, orange red, reddish brown
Crystal habit	Encrustations – forms crust-like aggregates on matrix
Mohs scale hardness	8
Luster	Silky, dull
Streak	Yellow white
Specific gravity	3.66
Other characteristics	Radio active

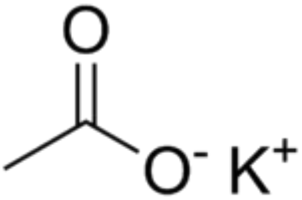
2 - Historical usage :

A mineral which caught the attention of a Bohemian metallurgist, Adolf Patera in the 1850s by its striking colour. This was during the period when the fame of the Jachymov silver mines was dying out. On top of the large, forgotten pit-heaps, powdery minerals began to appear, vividly coloured, originating from the decomposition of the pitchblende. These colourful layers, in which zippeite was in the majority, gave Patera the idea of utilizing the uranium minerals in the manufacture of paints. Mining began in 1859 not only for the products which resulted from uraninite 's decomposition, but for uraninite itself. A variety of yellow paints were manufactured because among all the secondary minerals on the pit-heap there was a prevalence of the yellow powdery coatings.

Zippeite is one of the so-called 'uranium ochres'. It occurs in association with uranopilite, a monoclinic, complex water-soluble alkaline with other secondary uranium minerals in the weathered veins of uranium. It was named after the Prague mineralogist, F. X. M. Zippe (1791-1863). Apart from Jachymov in Bohemia it occurs mainly near Wolsendorf in Bavaria (Germany) and also in Utah (U.S.). Zippeite is no longer used for the manufacture of paints. It is used as a uranium ore, as is pitchblende.

Potassium compounds

1 - Potassium acetate



1 – Introduction :

Potassium acetate (CH_3CO_2K) is the potassium salt of acetic acid.

Other Names : Potassium salt ; E261	
Molecular Formula	CH_3CO_2K
Molar Mass	98 g / mol
Appearance	White deliquescent crystalline powder
Density	1.57 g / cm^3
Melting Point	292 °C
Solubility in water	253 g /100 mL (20 °C) 492 g /100 mL (62 °C)
Solubility	soluble in methanol, ethanol, liquid ammonia insoluble in ether, acetone
Acidity (pK_a)	4.76

2 - Preparation :

It can be prepared by reacting a potassium-containing base such as potassium hydroxide or potassium carbonate with acetic acid:

$$2\ CH_3COOH + K_2CO_3 \rightarrow 2\ CH_3CO_2K + CO_2 + H_2O$$

This sort of reaction is known as an acid-base neutralization reaction. Potassium acetate is the salt that forms along with water as acetic acid and potassium hydroxide are neutralized together.

Conditions / substances to avoid are: moisture, heat, flames, ignition sources, and strong oxidizing agents.

3 – Applications :

Potassium acetate can be used as a deicer instead of chloride salts such as calcium chloride or magnesium chloride. It offers the advantage of being less aggressive on soils and much less corrosive, and for this reason is preferred for airport runways. It is, however, more expensive. Potassium acetate is also the extinguishing agent used in class K fire extinguishers because of its ability to cool and form a crust over burning oils.

In medicine, potassium acetate is used as part of replacement protocols in the treatment of diabetic keto acidosis because of its ability to break down into bicarbonate and help neutralize the acidotic state.

Potassium acetate is used as a food additive as a preservative and acidity regulator. In the European Union, it is labeled by the E number E261 ; it is also approved for usage in the USA[2] and Australia and New Zealand.

In molecular biology, potassium acetate is used to precipitate dodecyl sulfate (DS) and DS - bound proteins, allowing the removal of proteins from DNA. It is also used as a salt for the ethanol precipitation of DNA.

Potassium acetate is used in mixtures applied for tissue preservation, fixation, and mummification. Most museums today use the formaldehyde - based method recommended by Kaiserling in 1897 which contains potassium acetate . For example, Lenin's mummy was soaked in a bath containing potassium acetate .

Potassium acetate was originally used in the preparation of Cadet's fuming liquid, the first organo metallic compound produced. It is used as diuretic and urinary alkalizer , and acts by changing the physical properties of the body fluids and by functioning as an alkali after absorption.

2 - Potassium aluminate

Potassium aluminate is an inorganic compound with the formula $K_2Al_2O_4$. It is used as a dyeing and printing mordant, as a paper sizing , as an accelerant in the setting of concrete .

IUPAC Name : potassium aluminate	
Molecular Formula	$K_2Al_2O_4$
Molar Mass	196 g / mol
Solubility in water	very soluble

3 - Potassium alum

1 – Introduction :

Potassium alum, **potash alum** or **tawas** is the potassium double sulfate of aluminium. Its chemical formula is KAl $(SO_4)_2$ and it is commonly found in its dodeca hydrate form as $KAl(SO_4)_2 \cdot 12(H_2O)$. Alum is the common name for this chemical compound, given the nomenclature of potassium aluminum sulfate dodeca hydrate. It is commonly used in water purification, leather tanning, fireproof textiles, and baking powder . It also has cosmetic uses as a deodorant and as an aftershave treatment.

IUPAC Name : Aluminium potassium sulfate	
Other Names : Potassium alum , Potash alum , Tawas	
Molecular Formula	KAl $(SO_4)_2$
Molar Mass	258 g / mol
Density	1.76 g / cm^3
Melting Point	92 – 93 °C
Boiling Point	200 °C
Solubility in water	14.00 g /100 ml (20 °C) 36.80 g /100 ml (50 °C)

2 - Characteristics :

Potassium alum crystallizes in regular octahedra with flattened corners, and is very soluble in water. The solution reddens litmus and is an astringent. When heated to nearly a red heat it gives a porous, friable mass which is known as "burnt alum." It fuses at 92 °C in its own water of crystallization. "Neutral alum" is obtained by the addition of as much sodium carbonate to a solution of alum as will begin to cause the separation of alumina. Alum finds application as a mordant, in the preparation of lakes for sizing hand-made paper and in the clarifying of turbid liquids.

3 - Mineral form and occurrence :

Potassium alum is a naturally occurring sulfate mineral which typically occurs as encrustations on rocks in areas of weathering and oxidation of sulfide minerals and potassium-bearing minerals. In the past, alum was obtained from alunite , a mineral mined from sulfur-containing volcanic sediments source . Alunite is an associate and likely potassium and aluminium source . It has been reported at Vesuvius, Italy, east of Spring sure, Queens land , Alum Cave, Tennessee, and Alum Gulch, Arizona in the United States and the island of Cebu (Philippines) locally known as tawas. A related mineral is kalunite (rock form) and *kalinite*, a fibrous mineral with formula $KAl(SO_4)_2 \cdot 11(H_2O)$.

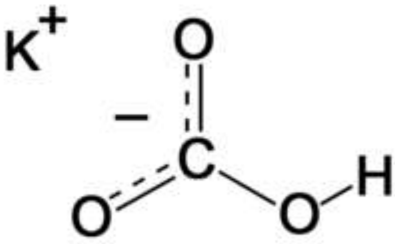
4 - Uses :

Potassium alum is an astringent / styptic and antiseptic. For this reason, it can be used as a natural deodorant by inhibiting the growth of the bacteria responsible for body odor. Use of mineral salts in such a fashion does not prevent perspiration. Its astringent/styptic properties are often employed after shaving and to reduce bleeding in minor cuts and abrasions, nosebleeds, and hemorrhoids. It is frequently used topically and internally in traditional systems of medicine including Ayurveda, where it is called phitkari or saurashtri, and Traditional Chinese Medicine, where it is called *ming fan*. It is also used as a hardener for photographic emulsions (films and papers), usually as part of the fixer, although modern materials are adequately hardened and this practice has fallen out of favor.

5 - Toxicology & safety :

Deodorant crystals containing synthetically made potassium alum are a weak irritant to the skin.

4 - Potassium bi carbonate



1 – Introduction :

Potassium bicarbonate (also known as **potassium hydrogen carbonate** or **potassium acid carbonate**) , is a colorless, odorless, slightly basic, salty substance. According to the US Food and Drug Administration (FDA), potassium bicarbonate is "generally recognized as safe".

Potassium bicarbonate is soluble in water, and is often found added to bottled water to affect taste; however, it is not soluble in alcohol. Decomposition of the substance occurs between 100 °C and 120 °C into K_2CO_3 (potassium carbonate), H_2O (water), and CO_2 (carbon dioxide). In concentrations greater than 0.5 %, $KHCO_3$ can have toxic effects on plants (potassium bicarbonate has widespread use in crops, especially for neutralizing acidic soil, and is also under consideration as an organic fungicide), although there is no evidence of human carcinogenicity, no adverse effects of overexposure, and an undetermined LD_{50}.

Physically, potassium bicarbonate occurs as a crystal or a soft white granular powder. It is manufactured by reacting potassium carbonate with carbon dioxide and water :

$$K_2CO_3 + CO_2 + H_2O \rightarrow 2\ KHCO_3$$

Potassium bicarbonate is very rarely found in its natural form, the mineral called **kalicinite**.

IUPAC Name : potassium hydrogen carbonate	
Other names : potassium acid carbonate	
Molecular Formula	$KHCO_3$
Molar Mass	100 g / mol
Appearance	white crystals
Odor	odorless
Density	2.17 g / cm^3
Melting Point	Decomposes
Solubility in water	33.7 g / 100 mL (20 °C) 60 g / 100 mL (60 °C)
Solubility	practically insoluble in alcohol
Flash Point	Non - Flammable

A fire extinguisher containing potassium bicarbonate.

2 - Uses

The compound is used as a source of carbon dioxide for leavening in baking, extinguishing fire in dry chemical fire extinguishers, acting as a reagent, and a strong buffering agent in medications.

It is used as an additive in wine making and as a base in foods and to regulate pH . It is a common ingredient in club soda, where it is used to soften the effect of effervescence.

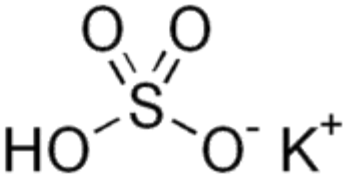
Potassium bicarbonate is used as a fire suppression agent ("BC dry chemical") in some dry chemical fire extinguishers, as the principal component of the Purple - K dry chemical, and in some applications of condensed aerosol fire suppression. It is the only dry chemical fire suppression agent recognized by the National Fire Protection Association for firefighting at airport crash rescue sites. It is about twice as effective in fire suppression as sodium bicarbonate.

Potassium bicarbonate is an effective fungicide against powdery mildew, allowed for use in organic farming.

3 - History :

The word *saleratus*, from Latin *sal æratus* meaning "aerated salt", was widely used in the 19th century for both potassium bicarbonate and sodium bicarbonate. The term has now fallen out of common usage.

5 - Potassium bisulfate



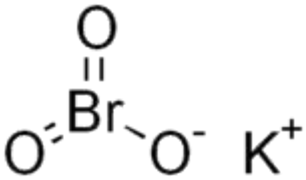
Potassium bisulfate is the potassium salt of bisulfate anion, with the molecular formula $KHSO_4$. This compound is commonly used in the conversion of tartrates to bi tartrates in wine. Potassium bisulfate is also used as a disintegrating agent in analytical chemistry.

A solution of potassium bisulfate behaves as if the two related compounds (K_2SO_4 and H_2SO_4) were side by side uncombined. Adding ethanol to a solution of potassium bisulfate precipitates out sulfate.

Mercallite, the mineralogical form of potassium bisulfate, occurs very rarely. Misenite is the other, more complex, potassium hydrogen sulfate.

IUPAC Name : Potassium hydrogen sulfate	
Other Names : Potassium acid sulfate	
Molecular Formula	$KHSO_4$
Molar Mass	136 g / mol
Density	2.245 g / cm^3
Melting point	197 °C
Boiling point	Dec. > 300 °C
Solubility in water	490 g / L
Hazards	
EU classification	Corrosive (C)
LD_{50}	2340 mg/kg^{-1}

6 - Potassium bromate



1 – Introduction :

Potassium bromate ($KBrO_3$), is a bromate of potassium and takes the form of white crystals or powder.

IUPAC Name : Potassium bromate	
Other Names : Potassium bromated (V) ; Bromic acid , potassium salt	
Molecular Formula	$K\ Br\ O_3$
Molar Mass	167 g / mol
Appearance	white crystalline powder
Density	3.27 g / cm^3
Melting Point	350 °C
Boiling Point	370 °C (decomposes)
Solubility in water	6.91 g /100 mL (20 °C) 13.3 g /100 mL (40 °C)
Solubility	slightly soluble in alcohol insoluble in acetone
Hazards	
EU classification	Toxic (T) Oxidant (O)
Flash Point	Non - flammable
LD_{50}	321 mg/kg

2 - Uses in baking

Potassium bromate is typically used as a flour improver (E number E924) , strengthening the dough and allowing higher rising. It is an oxidizing agent, and under the right conditions, will be completely used up in the baking bread. However, if too much is added, or if the bread is not baked long enough or not at a high enough temperature, then a residual amount will remain, which may be harmful if consumed. Potassium bromate might also be used in the production of malt barley where the U.S. Food and Drug Administration (FDA) has prescribed certain conditions where it may be used safely, which includes labeling standards for the finished malt barley product. It is a very powerful oxidizer (E° = 1.5 volts comparable to potassium permanganate). Bromate is considered a category 2B (possibly carcinogenic to humans) carcinogen by the International Agency for Research on Cancer (IARC) .

3 - Regulation :

Potassium bromate has been banned from use in food products in the EU, Canada, Nigeria, Brazil , Peru and some other countries. It was banned in Sri Lanka in 2001 and China in 2005.

In the United States, it has not been banned. The FDA sanctioned the use of bromate before the Delaney clause of the Food, Drug, and Cosmetic Act — which bans potentially carcinogenic substances — went into effect in 1958 , so it is more difficult for it to now be banned. Instead, since 1991 the FDA has urged bakers to voluntarily stop using it. In California a warning label is required when bromated flour is used.

Japanese baked goods manufacturers stopped using potassium bromate voluntarily in 1980; however, Yamazaki Baking resumed its use in 2005, claiming they had new production methods to reduce the amount of the chemical which remained in the final product.

7 - Potassium bromide

Contents

1 - Introduction :

Potassium bromide (KBr) is a salt, widely used as an anticonvulsant and a sedative in the late 19th and early 20th centuries, with over-the-counter use extending to 1975 in the United States. Its action is due to the bromide ion (sodium bromide is equally effective). Potassium bromide is presently used as a veterinary drug, as an antiepileptic medication for dogs and cats.

Under standard conditions, potassium bromide is a white crystalline powder. It is freely soluble in water. In a dilute aqueous solution, potassium bromide tastes sweet, at higher concentration it tastes bitter, and when most concentrated it tastes salty to humans (these effects are due mainly to potassium ion; sodium bromide merely tastes salty at all concentrations). In high concentration potassium bromide strongly irritates the gastric mucous membrane, leading to nausea and sometimes vomiting (again this effect is typical of all soluble potassium salts).

Molecular Formula	K Br
Molar Mass	119 g / mol
Appearance	white solid
Density	2.75 g / cm^3
Melting Point	734 °C

Boiling Point	1435 °C,
Solubility in water	53.5 g /100 mL (0 °C) 102 g /100 mL (100 °C)
Solubility in glycerol	21.7 g / 100 mL
Solubility in ethanol	4.76 g /100 mL (80 °C)
Crystal structure	Sodium chloride
Coordination geometry	octahedral
EU Index	Not listed

2 - Chemical properties :

Potassium bromide is a typical ionic salt which is fully dissociated and near pH 7 in aqueous solution. It serves as a source of bromide ions - this reaction is important for the manufacture of silver bromide for photographic film :

$$KBr\,(aq) + AgNO_3\,(aq) \rightarrow AgBr\,(s) + KNO_3\,(aq)$$

Aqueous bromide Br^- will also form complexes when reacted with some metal halides such as copper (II) bromide:

$$2\,KBr\,(aq) + CuBr_2\,(aq) \rightarrow K_2[CuBr_4]\,(aq)$$

3 - Preparation

A traditional method for the manufacture of KBr is the reaction of potassium carbonate with a bromide of iron, Fe_3Br_8, made by treating scrap iron under water with excess bromine :

$$4\,K_2CO_3 + Fe_3Br_8 \rightarrow 8\,KBr + Fe_3O_4 + 4\,CO_2$$

4 - Applications

4 – 1 - Medical and veterinary

The anticonvulsant properties of potassium bromide were first noted by Sir Charles Locock at a meeting of the Royal Medical and

Chirurgical Society in 1857. Bromide can be regarded as the first effective medication for epilepsy. At the time, it was commonly thought that epilepsy was caused by masturbation.[1] Locock noted that bromide calmed sexual excitement and thought this was responsible for his success in treating seizures. In the latter half of the 19th century, potassium bromide was used for the calming of seizure and nervous disorders on an enormous scale, with the use by single hospitals being as much as several tons a year (the dose for a given person being a few grams per day) .

There would not be a better drug for epilepsy until Phenobarbital in 1912. It was often said the British Army laced soldiers' tea with bromide to quell sexual arousal, but as doing so would also diminish alertness in battle it is likely to be an urban legend and similar stories were also told about a number of substances.

Bromide compounds, especially sodium bromide, continued to be used in over-the-counter sedatives and headache remedies (such as the original Formulation of Bromo - Seltzer) in the United States until 1975 when bromides were withdrawn as ingredients in all over-the-counter medicinal Formulations, due to the chronic toxicity of bromide . Bromide's exceedingly long half life in the body made it difficult to dose without side effects (see below). Medical use of bromides in the United States was discontinued at this time, as well, as many better and shorter-acting sedatives were known by that time.

Potassium bromide is presently in the veterinary medicine field to treat epilepsy in dogs, either as first-line treatment or in addition to Phenobarbital, when seizures are not adequately controlled with Phenobarbital alone. Use of bromide in cats is limited because it carries a substantial risk of causing lung inflammation (pneumonitis) in this species. The use of bromide as a treatment drug for animals means that veterinary medical diagnostic laboratories are able as a matter of routine to measure serum levels of bromide on order of a veterinarian, whereas human medical diagnostic labs in the United States do not measure bromide as a routine test.

Potassium bromide is not approved by the US Food and Drug Administration (FDA) for use in humans to control seizures. In Germany, it continues to be approved for use as an antiepileptic drug for humans, particularly children and adolescents. These indications include severe forms of generalized tonic- clonic seizures, early-childhood-related Grand - Mal - seizures, and also severe myoclonic seizures during childhood. Adults who have reacted positively to the drug during childhood/adolescence may continue treatment. Potassium bromide tablets are sold under the brand Name *Dibro-Be mono* (Rx-only). The drug has almost complete bioavailability, but the bromide ion has a relatively long half life of 12 days in the blood , making bromide salts difficult to adjust and dose. Bromide is not known to interfere with the absorption or excretion of any other anticonvulsant, though it does have strong interactions with chloride in the body, the normal body uptake and excretion of which strongly *influences bromide's excretion* .

The therapeutic index (ratio of effectiveness to toxicity) is very small for bromide. As with other anti epileptics, some times even therapeutic doses (3 to 5 grams per day, taking 6 to 8 weeks to reach stable levels) may give rise to intoxication. Often indistinguishable from 'expected' side - effects, these include :

Bromism These are central nervous system reactions. They may include :

Depression ,
lethargy , somnolence (from daytime sleepiness to coma)
loss of appetite and cachexia , nausea / emesis with exicosis (loss of body fluid)
loss of reflexes or pathologic reflexes
clonic seizures
tremor
ataxia
loss of neural sensitivity
paresis
cerebral edema with associated headache and papilledema of the eyes
delirium : confusion, abnormal speech, loss of concentration and memory, aggressiveness

psychoses

Acne - form dermatitis and other forms of skin disease may also be seen, as well as mucous hyper secretion in the lungs. Asthma and rhinitis may worsen. Rarely, tongue disorder , aphten , bad breath, and obstipation occur.

4 - 2 - Optics :

Potassium bromide is transparent from the near ultra violet to long wave infrared wavelengths (0.25 - 25 µm) and it has no significant optical absorption lines in its high transmission region. It is used widely as infrared optical windows and components for general spectroscopy because of its wide spectral range. In infrared spectroscopy, samples are analyzed by grinding with powdered potassium bromide and pressing into a disc. Alternatively, the samples may be analyzed as a liquid film (neat, as a solution, or in a mull with Nujol) between two polished potassium bromide discs .

Due to its high solubility and hygroscopic nature it must be kept in a dry environment. The refractive index is about 1.55 at 1.0 µm.

4 – 3 - Photography :

In addition to the manufacture of silver bromide previously mentioned, potassium bromide is used as a restrainer in black and white developer Formulas. It improves the differentiation between exposed and unexposed crystals of silver halide and thus reduces fog.

8 - Potassium carbonate

Contents

1 – Introduction :

Potassium carbonate is a white salt , soluble in water (insoluble in alcohol) , which forms a strongly alkaline solution. It can be made as the product of potassium hydroxide's absorbent reaction with carbon dioxide. It is deliquescent, often appearing a damp or wet solid. Potassium carbonate is used in the production of soap and glass.

Other Names	Potash , pearl ash
Molecular Formula	K_2CO_3
Molar Mass	138 g / mol
Appearance	White , hygroscopic solid
Density	2.29 g / cm^3
Melting Point	891 °C
Boiling Point	Decomposes
Solubility in Water	112 g / 100 mL (20 °C) 156 g / 100 mL (100 °C)
Solubility	insoluble in : alcohol , acetone
Main hazards	Irritant
Flash Point	Non - flammable
LD_{50}	1870 mg / kg

2 - History

Potassium carbonate was first identified in 1742 by Antonio Campanella and is the primary component of potash and the more refined *pearlash* or *salts of tartar*. Historically pearl ash was created by baking potash in a kiln to remove impurities. The fine white powder remaining was the pearl ash . The first patent issued by the U.S. Patent Office was awarded to Samuel Hopkins in 1790 for an improved method of making potash and pearl ash.

In late 18th century North America, before the development of baking powder, pearl ash was used as a leavening agent in "quick breads" .

Other terms for potassium carbonate :

- Carbonate of potash
- Di potassium carbonate
- Di potassium salt
- Pearl ash
- Potash
- Salt of tartar
- Salt of worm wood

3 - Production

Today potassium carbonate is prepared commercially by the electrolysis of potassium chloride. The resulting potassium hydroxide is then carbonated using carbon dioxide to form potassium carbonate, which is often used to produce other potassium compounds.

$$2KOH + CO_2 \rightarrow K_2CO_3 + H_2O$$

4 - Applications

Pearl ash has been used for soap , glass , and china production . and pearl ash added to hard water will soften the water .

In the laboratory, it may be used as a mild drying agent where other drying agents such as calcium chloride and magnesium sulfate may be incompatible. However, it is not suitable for acidic compounds, but can be useful for drying an organic phase if one has a small amount of acidic impurity .

Mixed with water it causes an exothermic reaction .

It is mixed with distilled water to make a safer electrolyte for oxy hydrogen production than potassium hydroxide , the more commonly used electrolyte.

In cuisine, it is used as an ingredient in the production of grass jelly, a food consumed in Chinese and Southeast Asian cuisines.

Potassium carbonate is being used as the electrolyte in many cold fusion experiments.

Potassium carbonate is sometimes used as a buffering agent in the production of mead or wine.

Aqueous potassium carbonate is also used as a fire suppressant in extinguishing deep fat fryers and various other B class related fires.

Potassium carbonate is used in reactions to maintain anhydrous conditions without reacting with the reactants and product formed . It may also be used to pre - dry some ketones, alcohols, and amines prior to distillation .

9 - Potassium chlorate

Contents

1 - Introduction :

Potassium chlorate is a compound containing potassium , chlorine and oxygen, with the molecular Formula K ClO_3 . In pure form, it is a white crystalline substance. It is the most common chlorate in industrial use, and is usually present in well-stocked laboratories. It is used

- as an oxidizing agent,
- to prepare oxygen,
- as a disinfectant,
- in safety matches, and
- in explosives and fireworks.

Other Names	Potassium chlorate (V) , Pot crate
Molecular Formula	$K\,Cl\,O_3$
Molar Mass	122.5 g / mol
Appearance	White crystals or powder
Density	2.34 g / cm^3
Melting Point	356 °C
Boiling Point	400 °C *decomp* .
Solubility in water	7.19 g / 100 ml (20 °C) 57 g / 100 mL (100 °C)
Solubility	insoluble in acetone , liquid ammonia
Refractive index (n_D)	1.40835

Crystal structure	Mono clinic
EU classification	Oxidant (**O**) Harmful (**Xn**) Dangerous for : the environment (**N**)
Flash Point	400 °C
LD_{50}	1870 mg / kg

2 - Uses

Potassium chlorate was one key ingredient in early firearms percussion caps (primers) . It continues in that application , where not supplanted by potassium per chlorate .

Chlorate - based propellants are more efficient than traditional gunpowder and are less susceptible to damage by water. However, they can be extremely unstable in the presence of sulfur or phosphorus and are much more expensive. Chlorate propellants must be used only in equipment designed for them; failure to follow this precaution is a common source of accidents. Potassium chlorate, often in combination with silver fulminate, is used in trick noise-makers known as "crackers", "snappers", "pop - its", or " bang-snaps ", a popular type of novelty firework.

When mixed with a suitable fuel, it may form an explosive material, a so - called Sprengel explosive. The hygroscopic and slightly weaker sodium chlorate is sometimes used as a safer and less expensive substitute for potassium chlorate. In World War I , mixes of potassium chlorate with plasticizers (such as wax) were the most common type of plastic explosive used, often filling grenades and other munitions. When used in explosives as an oxidizer, the explosive is low order meaning it burns rapidly rather than explodes. When mixed with a plasticizer, it may become high order, requiring a blasting cap (generally a commercial #8) to detonate properly. Potassium chlorate is also used in some Formulas of gunpowder, generally replacing the less powerful potassium nitrate.

Potassium chlorate is often used in high school and college laboratories to generate oxygen gas ; it is a far cheaper source than a pressurized or cryogenic oxygen tank. Potassium chlorate will readily decompose if heated in contact with a catalyst, typically manganese (IV) dioxide (MnO_2). Thus, it may be simply placed in a test tube and heated over a burner. If the test tube is equipped with a one-holed stopper and hose, warm oxygen can be drawn off. The reaction is as follows:

$$2KClO_3\,(s) + \text{heat} \rightarrow 3O_2\,(g) + 2KCl\,(s)$$

The safe performance of this reaction requires very pure reagents and careful temperature control. Molten potassium chlorate is an extremely powerful oxidizer and will spontaneously react with many common materials. Explosions have resulted from liquid chlorates spattering into the latex or PVC tubes of oxygen generators, as well as from contact between chlorates and hydrocarbon sealing greases. Impurities in potassium chlorate itself can also cause problems. When working with a new batch of potassium chlorate, it is advisable to take a small sample (~ 1 gram) and heat it strongly on an open glass plate. Contamination may cause this small quantity to explode, indicating that the chlorate should be discarded.

Potassium chlorate is used in chemical oxygen generators (also called chlorate candles or oxygen candles), employed as oxygen - supply systems of e.g. aircraft, space stations , and submarines, and has been responsible for at least one plane crash. A fire on the space station Mir was also traced to this substance. The decomposition of potassium chlorate was also used to provide the oxygen supply for lime lights.

Potassium chlorate is used also as a pesticide. In Finland it was sold under trade Name Fegabit.

3 - Safety

Potassium chlorate should be handled with care. It reacts vigorously, and in some cases spontaneously ignites or explodes, when mixed with many combustible materials. It will burn vigorously in combination with virtually any combustible material, even those which are considered to by only slightly flammable normally (including ordinary dust and lint) . Mixtures of potassium chlorate and a fuel can be ignited by contact with sulfuric acid and this reagent should be kept away from potassium chlorate. Sulfur should be avoided in pyrotechnic compositions containing potassium chlorate, as these mixtures are prone to spontaneous deflagration. Most sulfur contains trace quantities of sulfur-containing acids, and these can cause spontaneous ignition - "Flowers of sulfur" or "sublimed sulfur", despite the overall high purity, contains significant amounts of sulfur acids. Also, mixtures of potassium chlorate with any compound with ignition promoting properties (ex. antimony (III) sulfide) are very dangerous to prepare, as they are extremely shock sensitive.

4 - Production

On an industrial scale, potassium chlorate is produced by the electrolysis of a sodium chloride solution to form sodium chlorate, which is reacted with potassium chloride to precipitate potassium chlorate. The resultant sodium chloride is returned to the mother liquor for electrolysis.

$K ClO_3$ can also be produced on a smaller scale by the thermal disproportion of a hypochlorite to its respective chlorate and chloride by boiling, then adding K Cl. This reaction should be done in a fume hood due to the production of chlorine and chlorine dioxide gas.

10 - Potassium chloride

Contents

1 – Introduction :

The chemical compound **potassium chloride** (K Cl) is a metal halide salt composed of potassium and chlorine. In its pure state it is odorless. It has a white or colorless vitreous crystal, with a crystal structure that cleaves easily in three directions. Potassium chloride crystals are face-centered cubic. Potassium chloride is occasionally known as "muriate of potash," particularly when used as a fertilizer. Potash varies in color from pink or red to white depending on the mining and recovery process used. White potash, sometimes referred to as soluble potash, is usually higher in analysis and is used primarily for making liquid starter fertilizers. KCl is used in medicine, scientific applications, food processing and in judicial execution through lethal injection. It occurs naturally as the mineral sylvite and in combination with sodium chloride as sylvinite.

Other Names	Sylvite , Muriate of potash
Molecular Formula	K Cl
Molar Mass	74.5 g / mol
Appearance	white crystalline solid
Odor	Odorless
Density	1.984 g / cm^3
Melting Point	770 °C

Boiling Point	1420 °C (sublimes)
Solubility in water	28.1 g / 100 ml (0 °C) 34.4 g / 100 ml (20 °C) 56.7 g / 100 ml (100 °C)
Solubility	soluble in ether, glycerol, alkalis slightly soluble in alcohol
Refractive index (n_D)	1.33743
Crystal structure	Face centered cubic
Flash Point	Non - flammable
LD_{50}	2600 mg / kg (oral / rat) , 142 mg / kg (intravenous /rat)

2 - Chemical properties

Potassium chloride can react as a source of chloride ion. As with any other soluble ionic chloride, it will precipitate insoluble chloride salts when added to a solution of an appropriate metal ion :

$$KCl\ (aq) + Ag\ NO_3\ (aq) \rightarrow Ag\ Cl\ (s) + K\ NO_3\ (aq)$$

Although potassium is more electropositive than sodium, KCl can be reduced to the metal by reaction with metallic sodium at 850 °C because the potassium is removed by distillation : $K\ Cl\ (l) + Na\ (l) \rightleftharpoons Na\ Cl\ (l) + K\ (g)$

This method is the main method for producing metallic potassium. Electrolysis (used for sodium) fails because of the high solubility of potassium in molten K Cl .

As with other compounds containing potassium , K Cl in powdered form gives a lilac flame test result .

3 - Production

Potassium chloride occurs naturally as sylvite , and it can be extracted from sylvinite. It is also extracted from salt water and can be manufactured by crystallization from solution, flotation or electrostatic separation from suitable minerals. It is a by-product of the making of nitric acid from potassium nitrate and hydrochloric acid.

4 - Uses

The majority of the potassium chloride produced is used for making fertilizer, since the growth of many plants is limited by their potassium intake. As a chemical feedstock it is used for the manufacture of potassium hydroxide and potassium metal. It is also used in medicine, scientific applications , food processing and as a sodium-free substitute for table salt (sodium chloride) .

Potassium chloride is used as the third of a three -drug combination in lethal injection. Additionally , K Cl is used (albeit rarely) in fetal intra cardiac injections in second - and third-trimester induced abortions .

It is sometimes used in water as a completion fluid in petroleum and natural gas operations, as well as being an alternative to sodium chloride in household water softener units. KCl is useful as a beta radiation source for calibration of radiation monitoring equipment because natural potassium contains 0.0118 % of the isotope ^{40}K . One kilogram of KCl yields 16350 Becquerel s of radiation consisting of 89.28 % beta and 10.72 % gamma with 1.46083 MeV. Potassium chloride makes up 70 % of Ace Hardware's pet and vegetation - friendly "Ice Melt" though inferior in melting quality to calcium chloride (0 °F v. −25 °F) . It is also used in various brands of bottled water, as well as in bulk quantities for fossil fuel drilling purposes .

Potassium chloride was once used as a fire extinguishing agent, used in portable and wheeled fire extinguishers. Known as Super - K dry chemical, it was more effective than sodium bicarbonate - based dry chemicals and was compatible with protein foam. This agent fell out of favor with the introduction of potassium bicarbonate (Purple - K) dry chemical in the late 60s, which was much less corrosive and more effective. Rated for B and C fires.

Along with sodium chloride and lithium chloride, potassium chloride is used as a flux for the gas welding of aluminium.

Potassium chloride is also an optical crystal with a wide transmission range from 210 nm to 20 µm. It was formerly often used in the infrared spectrum range, and still is from time to time. While cheap, KCl crystal is hygroscopic. This limits its application to protected environments or short term uses such as prototyping. Exposed to free air KCl optics will " rot ". Today, much tougher crystals like Zn Se have replaced KCl for IR spectral range applications .

Optical data :

Transmission range : 210 nm to 20 µm
Transitivity = 92% @ 450 nm and rises linearly to 94% 16 µm
Refractive Index = 1.456 @ 10 µm
Reflection Loss = 6.8 % @ 10 µm (two surfaces)
dN/dT (expansion coefficient) = -33.2×10^{-6} / °C
dL/dT (refractive index gradient) = 40×10^{-6} / °C
Coefficient of absorption : 0.001 cm^{-1}
Thermal conductivity = 0.036 W / (cm · K)
Damage threshold (Newman & Novak) : 4 GW / cm^2 or 2 J / cm^2 (0.5 or 1 ns pulse rate) .
Damage threshold (Kovalev & Faizullov) = 4.2 J / cm^2 (1.7 ns pulse rate) .

Potassium chloride has also been used to create heat packs which employ exothermic chemical reactions , but these are no longer being created due to cheaper and more efficient methods such as the oxidation of metals ('Hot Hands' , one time use products) or the crystallization of sodium acetate (multiple use products) .

5 - Biological and medical properties

Potassium is vital in the human body and oral potassium chloride is the common means to replenish it, although it can also be diluted and given intravenously (of course, in concentrations much lower than those used in executions) . It can be used as a salt substitute for food, but due to its weak, bitter, un salty flavor, it is usually mixed with regular salt (sodium chloride), for this purpose to improve the taste (for example, in Morton Lite Salt) . Medically it is used in the treatment of hypokalemia and associated conditions, for digitalis poisoning, and as an electrolyte replenisher . Brand Names include K – Dur , Klor – Con , Micro - K, and Kaon Cl .

Side effects can include gastrointestinal discomfort including nausea and vomiting, diarrhea and bleeding of the digestive tract. Overdoses cause hyperkalemia which can lead to paresthesia , cardiac conduction blocks, fibrillation, arrhythmias, and sclerosis .

Dr . Jack Kevorkian's thanatron machine injected a lethal dose of potassium chloride into the patient, which caused the heart to stop functioning, after a sodium thiopental-induced coma was achieved. A similar device, the German 'Perfusor', also uses potassium chloride as a suicide aid .

6 - Physical properties

Potassium chloride has a crystalline structure like many other salts. Its structure is face - centered cubic. Its lattice constant is roughly 630 pico meters.

In chemistry and physics it is a very commonly used as a standard, for example as a calibration standard solution in measuring electrical conductivity of (ionic) solutions, since carefully prepared KCl solutions have well-reproducible and well-repeatable measurable properties.

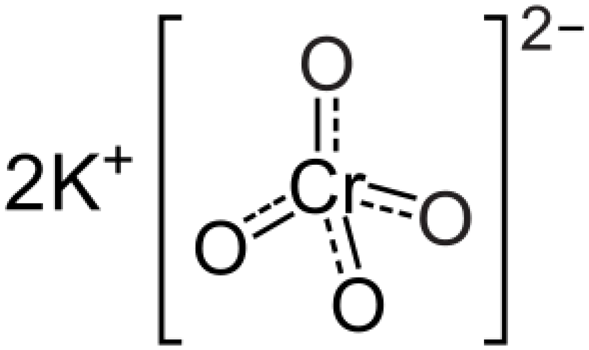
Solubility of KCl in various solvents (g KCl / 100 g of solvent at 25 °C)	
H_2O	36
Liquid ammonia	0.04
Liquid sulfur dioxide	0.041
Methanol	0.53

Formic acid	19.2
Sulfolane	0.004
Acetonitrile	0.0024
Acetone	0.000091
Formamide	6.2
Acetamide	2.45
Dimethyl formamide	0.017 – 0.05

7 - Precautions

Orally , KCl is toxic in excess; the LD_{50} is around 2500 mg / kg (meaning that a lethal dose for 50 % of people weighing 75 kg (165 lb) is about 190 g (6.7 ounces) , or about 38 tea spoons) . Table salt is about as toxic . Intravenously this is reduced to just over 100 mg / kg, but of more concern are its severe effects on the cardiac muscles; high doses can cause cardiac arrest and rapid death, ergo its aforementioned use as the third and final drug delivered in the lethal injection process .

11 - Potassium chromate



1 – Introduction :

Potassium chromate ($K_2Cr\,O_4$) is a yellow chemical indicator used for identifying concentrations of chloride ions in a salt solution with silver nitrate ($AgNO_3$) . It is a class two carcinogen and can cause cancer on inhalation.

IUPAC Name : Potassium chromate

Other Names : Chromic acid , (K_2CrO4) , Di potassium salt

Molecular Formula	$Cr\,K_2\,O_4$
Molar Mass	194 g mol^{-1}
Appearance	Yellow odorless powder
Odor	odorless
Density	2.7320 g / cm^3
Melting Point	968 °C
Boiling Point	1000 °C
Solubility in water	63 g /100 mL (20 °C)

Solubility	insoluble in alcohol
EU classification	Toxic (T) Irritant (Xi) Dangerous for the environment (N)

2 - Physical properties :

Potassium Chromate is a lemon yellow compound that is in the form of a crystalline solid, and it is very stable .

3 - Reactions :

When reacted with lead (II) nitrate , it creates an orange - yellow precipitate, lead (II) chromate. All ions hydrolyze in solution .

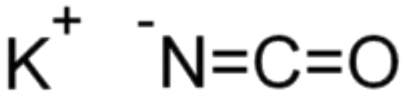
4 - Occurrence :

Tarapacaite is the natural, mineral form of potassium chromate. It occurs very rarely and until now is known from only few localities on Atacama desert .

5 - Safety :

Potassium chromate is very toxic and may be fatal if swallowed. It may also act as a carcinogen , and can create reproductive defects if inhaled or swallowed. It also is a strong oxidizing agent if in the presence of H^+ to produce the dichromate ion. It may react rapidly, or violently. It is also possible that it may react explosively with other reducing agents and flammable objects.

12 - Potassium cyanate



$K^+ \quad ^-N=C=O$

1 – Introduction :

Potassium cyanate is an inorganic compound with the Formula KOCN (some times denoted KCNO). It is a colourless solid. It is used to prepare many other compounds including useful herbicide. Worldwide production of the potassium and sodium salts was 20,000 tons in 2006.

Molecular Formula	KOCN
Molar Mass	81 g / mol
Appearance	white powder
Density	2.056 g / cm^3
Melting Point	315 °C
Boiling Point	~ 700°C, decomp.
Solubility in water	75 g/100 ml
LD_{50}	Oral: 841 mg/kg^{-1}

2 - Structure and bonding :

Cyanate is iso electronic with carbon dioxide azide, being linear. The C-N distance is 121 nm, about 60 nm longer than for cyanide.[3] It is iso structural with potassium azide.

3 - Uses :

For most applications, the potassium and sodium salts can be used interchangeably. Potassium cyanate is often preferred to the sodium salt, which is less soluble in water and less readily available in pure form.

Potassium cyanate is used as a basic raw material for various organic syntheses, for example, urea derivatives , semicarbazides , carbamates and iso cyanates . For example, it is used to prepare the drug hydroxy urea . It is also used for the heat treatment of metals (e.g., Ferritic nitro carburizing) .

4 - Preparation and reactions :

KOCN is prepared by urea with potassium carbonate at 400 °C :

$$2\ OC(NH_2)_2 + K_2CO_3 \rightarrow 2\ KOCN + (NH_4)_2CO_3$$

The reaction produces a liquid. Intermediates and impurities include biuret , cyanuric acid , and potassium allophanate ($KO_2CNHC(O)NH_2$), as well as un reacted starting urea, but these species are un stable at 400 °C.

Protonation gives a 97 :3 mixture (at room temperature) of two tautomers , HNCO and NCOH. The more abundant tautomer trimerizes to give cyanuric acid.

13 - Potassium cyanide

Contents

1 – Introduction :

Potassium cyanide is an inorganic compound with the Formula KCN . This colorless crystalline compound, similar in appearance to sugar, is highly soluble in water. The vast majority of KCN is used in gold mining followed by use in organic synthesis, and electroplating. Smaller applications include jewelry for chemical gilding and buffing

KCN is highly toxic. Due to hydrolysis, the moist solid emits small amounts of hydrogen cyanide, which smells like bitter almonds. However, not everyone can smell this odor: the ability to do so is a genetic trait . It is used by entomologists as a killing agent in collecting jars, as most insects succumb within seconds, minimizing damage of even highly fragile specimens.

Molecular Formula	K CN
Molar Mass	65 g / mol
Appearance	White crystalline solid deliquescent
Density	1.52 g / cm^3
Melting Point	634.5 °C
Boiling Point	1625 ºC
Solubility in water	71.6 g / 100 ml (25 °C) 100 g / 100 mL (100 °C)
Solubility in methanol	4.9 g / 100 mL (20 °C)
Solubility in glycerol	Soluble

Flash Point	Non - flammable
EU classification	Very toxic (**T+**) Dangerous for the environment (**N**)
LD_{50}	5 – 10 mg / kg (oral in rats , mice , rabbits)

2 - Production

KCN is produced by treating hydrogen cyanide with potassium hydroxide .

$$H\,CN + K\,OH \rightarrow K\,CN + H_2O$$

Approximately 50,000 tons are produced yearly .

Or by treating formamide with potassium hydroxide .

$$H\,CONH_2 + K\,OH \rightarrow K\,CN + 2H_2O$$

3 - Structure

In aqueous solution , KCN is dissociated into hydrated K^+ ions and CN^-. As a solid, the salt crystallizes such that the cations and anions organize like Na^+ and Cl^- in Na Cl. The cations and anions six - coordinate . Each K^+ is linked to two pi-bonds of the CN^- as well as two links each to C and N each. Since CN^- is diatomic, the symmetry of the solid is lower than that in Na Cl. The cyanide anions form sheets. The CN^- ions rapidly rotate in the solid at ambient temperature such that the time averaged shape of the CN^- ions is spherical.[4]

4 - Applications

In gold mining, KCN and Na CN form water - soluble salts from gold metal in the presence of air :

$$4\,Au + 8\,K\,CN + O_2 + 2\,H_2O \rightarrow 4\,K\,[Au\,(CN)_2] + 4\,KOH$$

Very few alternative methods exist for this extraction process .

KCN and the related Na CN are widely used in organic synthesis for the preparation of nitriles and carboxylic acids; illustrative in the von Richter reaction.

5 - Toxicity

KCN can be detoxified most efficiently with hydrogen peroxide :

$$KCN + H_2O_2 \rightarrow KOCN + H_2O$$

Cyanide is a potent inhibitor of cellular respiration, acting on mitochondrial cyto chrome c oxidize and hence blocking oxidative phosphorylation . This prevents the body from oxidizing food to produce useful energy. Lactic acidosis then occurs as a consequence of anaerobic metabolism. Initially, acute cyanide poisoning causes a red or ruddy complexion in the victim because the tissues are not able to use the oxygen in the blood. The effects of potassium and sodium cyanide are identical. The person may die within two hours if not treated medically. During this period, convulsions may occur. Death occurs mainly by cardiac arrest.

A number of prominent persons were killed or committed suicide using potassium cyanide, including members of the Black Hand Gang (un successfully) and members of the Nazi Party, such as Hermann Goering and Heinrich Himmler, WWII era British agents (using purpose-made suicide pills) and various religious cults such as in Jonestown. Potassium cyanide (and other forms of cyanide) is a popular method of murder in fiction, especially in the books written by Agatha Christie.

14 - Potassium Dichromate

Contents

1 – Introduction :

Potassium dichromate, $K_2Cr_2O_7$, is a common inorganic chemical reagent, most commonly used as an oxidizing agent in various laboratory and industrial applications. As with all hexavalent chromium compounds, it is potentially harmful to health and must be handled and disposed of appropriately. It is a crystalline ionic solid with a very bright, red-orange color. It is also known as **potassium bi chromate** ; **bi chromate of potash**; **di potassium dichromate**; **di chromic acid , di potassium salt**; **chromic acid, di potassium salt**; and **lopezite**.

IUPAC Name : Potassium dichromate (VI)	
Other Names : Potassium bichromate	
Molecular Formula	$K_2Cr_2O_7$
Molar Mass	294 g/mol
Appearance	Red - orange crystalline solid
Odor	odorless
Density	2.676 g / cm^3, solid
Melting Point	398°C
Boiling Point	500°C *decomp.*
Solubility in water	4.9 g / 100 mL (0°C) 102 g / 100 mL (100 °C)
Solubility	insoluble in alcohol
EU classification	Oxidant (O) Highly toxic (T+) Harmful (Xn) Corrosive (C) Dangerous for the environment (N)
Flash Point	Non - flammable

2 - Chemistry :

Potassium dichromate is an oxidant (oxidizing agent). The reduction half - equation can be seen :

$$Cr_2O_7^{2-}(aq) + 14H^+ + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O \ (E = +1.23 \text{ V})$$

In organic chemistry, potassium dichromate is a mild oxidizer compared with potassium permanganate. It is used to oxidize alcohols. It converts primary alcohols into aldehydes, or into carboxylic acids if heated under reflux. In contrast, with permanganate, carboxylic acids are the sole products. Secondary alcohols are converted into ketones — no further oxidation is possible. For example, menthone may be prepared by oxidation of menthol with acidified dichromate . Tertiary alcohols are not oxidized by potassium dichromate.

In an aqueous solution the color change exhibited can be used to test whether an aldehyde or ketone is present. When an aldehyde is present the chromium ions will be reduced from the +6 to the +3 oxidation state, changing color from orange to green. This is because the aldehyde can be further oxidized to the corresponding carboxylic acid. A ketone will show no such change because it cannot be oxidized further, and so the solution will remain orange.

3 - Uses :

3 – 1 - Cleaning :

Like other chromium (VI) compounds (chromium trioxide , sodium dichromate) , potassium dichromate may be used to prepare "chromic acid", which can be used for cleaning glassware and etching materials.

3 – 2 - Construction :

It is used as an ingredient in cement in which it retards the setting of the mixture and improves its density and texture. This usage commonly causes contact dermatitis in construction workers.

3 – 3 - Ethanol determination :

The concentration of ethanol in a sample can be determined by back titration with acidified potassium dichromate. Reacting the sample with an excess of potassium dichromate, all ethanol is oxidized to acetic acid:

$$C_2H_5OH + [O] \rightarrow CH_3COOH$$

The excess dichromate is determined by titration against sodium thio sulfate . Subtracting the amount of excess dichromate from the initial amount, gives the amount of ethanol present.

Accuracy can be improved by calibrating the dichromate solution against a blank.

One major application for this reaction is in old police breathalyzer tests. When alcohol vapor makes contact with the yellow dichromate-coated crystals, the color changes from yellow to green. The degree of the color change is directly related to the level of alcohol in the suspect's breath.

3 – 4 - Leather

It is used to tan leather which is used for footwear.[4]

3 – 5 - Photography

Potassium dichromate has important uses in photography and in photographic screen printing, where it is used as an oxidizing agent together with a strong mineral acid.

Gum bi chromate printing was one of the very first stable photographic printing processes, dating back to about 1850. A solution of gum arabic and potassium dichromate, once applied to paper and dried, will harden when exposed to ultraviolet light.

Chromium intensification or *Photo chromos* uses potassium dichromate together with equal parts of concentrated hydrochloric acid diluted down to approximately 10 % v/v to treat weak and thin negatives of black and white photograph roll. This solution reconverts the elemental silver particles in the film to silver chloride. After thorough washing and exposure to actinic light, the film can be redeveloped to its end - Point yielding a stronger negative which is able to produce a more satisfactory print.

A potassium dichromate solution in sulfuric acid can be used to produce a reversal negative (i.e., a positive transparency from a negative film). This is effected by developing a black and white film but allowing the development to proceed more or less to the end Point. The development is then stopped by copious washing and the film then treated in the acid dichromate solution. This converts the silver metal to silver sulfate, a compound that is insensitive to light. After thorough washing and exposure to actinic light, the film is developed again allowing the previously unexposed silver halide to be reduced to silver metal.

The results obtained can be unpredictable, but sometimes excellent results are obtained producing images that would otherwise be unobtainable. This process can be coupled with solarisation so that the end product resembles a negative and is suitable for printing in the normal way.

Cr^{VI} compounds have the property of tanning animal proteins when exposed to strong light. This quality is used in photographic screen-printing.

In screen-printing a fine screen of bolting silk or similar material is stretched taut onto a frame similar to the way canvas is prepared before painting. A colloid sensitized with a dichromate is applied evenly to the taut screen. Once the dichromate mixture is dry, a full-size photographic negative is attached securely onto the surface of the screen, and the whole assembly exposed to strong light - typically about half an hour in bright sunlight - hardening the exposed colloid. When the negative is removed, the unexposed mixture on the screen can be washed off with warm water, leaving the hardened mixture intact, acting as a precise mask of the desired pattern, which can then be printed with the usual screen - printing process.

3 – 6 - Silver test :

When dissolved in an approximately 35 % nitric acid solution it is called Schwerter's solution and is used to test for the presence of various metals, notably for determination of silver purity. Pure silver will turn the solution bright red, sterling silver will turn it dark red, low grade coin silver (0.800 fine) will turn brown (largely due to the presence of copper which turns the solution brown) and even green for 0.500 silver.

3 – 7 - Sulfur dioxide test

Potassium dichromate paper can be used to test for sulfur dioxide , as it turns distinctively from orange to green. This is typical of all redox reactions where hexavalent chromium is reduced to the less harmful trivalent chromium. Therefore, it is not a conclusive test for sulfur dioxide .

3 – 8 - Wood treatment :

Potassium dichromate is used to finish certain types of wood. It brings out the color and grain to a very deep, rich appearance. This is particularly effective on mahogany.

4 - Natural occurrence :

lopezite

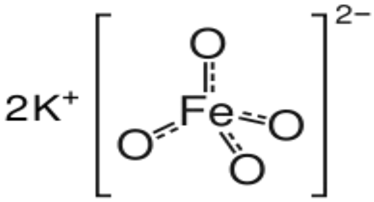
Potassium dichromate occurs naturally as the rare mineral lopezite. It has only been reported as vug fillings in the nitrate deposits of the Atacama desert of Chile and in the Bush veld igneous complex of South Africa.

5 - Safety

Potassium dichromate is one of the most common causes of chromium dermatitis ; chromium is highly likely to induce sensitization leading to dermatitis, especially of the hand and fore-arms, which is chronic and difficult to treat. Toxicological studies have further illustrated its highly toxic nature. With rabbits and rodents, concentrations as low as 14 mg/kg have shown a 50% fatality rate amongst test groups . Aquatic organisms are especially vulnerable if exposed, and hence responsible disposal according local environmental regulations is advised.

As with other Cr ^{VI} compounds, potassium dichromate is carcinogenic and should be handled with gloves and appropriate health and safety protection. The compound is also corrosive and exposure may produce severe eye damage or blindness . Human exposure further encompasses impaired fertility, heritable genetic damage and harm to unborn children.

15 - Potassium ferrate



1 – Introduction :

Potassium ferrate is the chemical compound with the Formula K_2FeO_4. This purple salt is paramagnetic, and is a rare example of an iron(VI) compound. In most of its compounds, iron has the oxidation state +2 or +3 (Fe^{2+} or Fe^{3+}). Reflecting its high oxidation state, FeO_4^{2-} is a powerful oxidizing agent.

K_2FeO_4 has attracted interest for applications in "green chemistry" because the by-products of its use, iron oxides, are environmentally innocuous. In contrast, some related oxidants such as chromate are considered environmentally hazardous. However, the main difficulty with the use of K_2FeO_4 is that it is often too reactive, as indicated by the fact that it decomposes in contact with water.

$$4\ K_2FeO_4 + 4\ H_2O \rightarrow 3\ O_2 + 2\ Fe_2O_3 + 8\ KOH$$

IUPAC Name : Potassium ferrate (VI)	
Other Names ; Potassium ferrate , Di potassium ferrate	
Molecular Formula	$K_2\ Fe\ O_4$
Molar Mass	198 g / mol
Appearance	Dark purple solid
Density	2.829 g / cm^3, solid
Melting Point	> 198 °C (decomposition temp)
Solubility in water	soluble in 1M KOH
Solubility in other solvents	reacts with most solvents
Crystal structure	K_2SO_4 motif

Main hazards	oxidizer

2 - Synthesis and structure :

Georg Ernst Stahl (1660 – 1734) first discovered that the residue formed by igniting a mixture of potassium nitrate (salt petre) and iron powder dissolved in water to give a purple solution. Edmond Frémy (1814 – 1894) later discovered that fusion of potassium hydroxide and iron(III) oxide in air produced a compound that was soluble in water. The composition corresponded to that of potassium manganate . In the laboratory, K_2FeO_4 is prepared by oxidizing an alkaline solution of an iron (III) salt with concentrated chlorine bleach.

The salt is iso structural with K_2MnO_4, K_2SO_4, and K_2CrO_4. The solid consists of K^+ and the tetrahedral FeO_4^{2-} anion, with Fe-O distances of 1.66 Å . The poorly soluble barium salt , Ba Fe O_4, is also known.

3 - Properties and applications

As a dry solid, K_2FeO_4 is stable. It decomposes with evolution of O_2 in neutral water, and especially rapidly in acidic water. At high pH, aqueous solutions are stable. The deep purple solutions are similar in appearance to potassium permanganate ($KMnO_4$). It is stronger oxidizing agent than the latter.

Because the side products of its redox reactions are rust-like iron oxides, K_2FeO_4 has been described as a "green oxidant." It has been employed in waste-water treatment as an oxidant for organic contaminants and as a biocide. Conveniently, the resulting reaction product is iron (III) oxy hydroxide , an excellent flocculent.

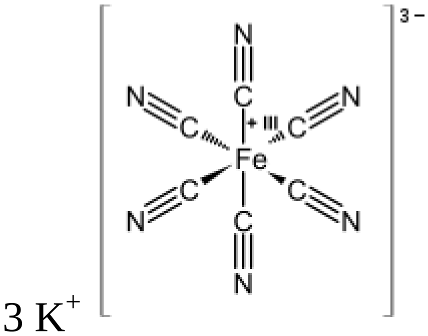
In organic synthesis, K_2FeO_4 oxidizes primary alcohols.

K_2FeO_4 has also attracted attention as a potential cathode material in a "super iron battery."

16 - Potassium ferri cyanide

1 - Introduction :

Potassium ferri cyanide is the chemical compound with the Formula $K_3[Fe(CN)_6]$. This bright red salt contains the octahedrally coordinated $[Fe(CN)_6]^{3-}$ ion . It is soluble in water and its solution shows some green-yellow fluorescence.



IUPAC Name : Potassium hexa cyano ferrate (III)	
Other Names : Red prussiate , Prussian red , Potassium ferri cyanide	
Molecular Formula	$C_6 N_6 Fe K_3$
Molar Mass	329 g / mol
Appearance	deep red crystals
Density	1.89 g / cm^3 , solid

Melting Point	300 °C
Boiling Point	*decomp.*
Solubility in water	330 g / L ("cold water") 464 g / L (20°C) 775 g / L ("hot water")
Solubility	slightly soluble in alcohol , soluble in acid , soluble in water
Crystal structure	monoclinic
Flash Point	Non - flammable

2 – Preparation :

Potassium ferri cyanide is manufactured by passing chlorine through a solution of potassium ferro cyanide. Potassium ferricyanide separates from the solution:

$$2\ K_4[Fe(CN)_6] + Cl_2 \rightarrow 2\ K_3[Fe(CN)_6] + 2\ KCl$$

3 - Applications

In 19th century, it was used for reading palimpsests and old manuscripts.

The compound has widespread use in blueprint drawing and in photography (Cyanotype process). Iron and copper toning involve the use of potassium ferri cyanide. Potassium ferri cyanide is used as an oxidizing agent to remove silver from negatives and positives, a process called dot etching. In color photography, potassium ferri cyanide is used to reduce the size of color dots without reducing their number, as a kind of manual color correction. The compound is also used to harden iron and steel, in electroplating, dyeing wool, as a laboratory reagent, and as a mild oxidizing agent in organic chemistry. It is also used in black-and-white photography with sodium thio sulfate (hypo) to reduce the density of a negative or gelatin silver print where the mixture is known as Farmer's reducer;

this can help offset problems from over exposure of the negative, or brighten the highlights in the print.

Potassium ferri cyanide is also one of two compounds present in ferroxyl indicator solution (along with phenol phthalein) which turns blue (Prussian blue) in the presence of Fe^{2+} ions, and which can therefore be used to detect metal oxidation that will lead to rust. It is possible to calculate the number of moles of Fe^{2+} ions by using a colorimeter, because of the very intense color of Prussian blue $Fe_4[Fe(CN)_6]_3$.

Potassium ferri cyanide is often used in physiology experiments as a means of increasing a solution's redox potential (E°' ~ 436 mV at pH 7). Sodium dithionite is usually used as a reducing chemical in such experiments (E°' ~ −420 mV at pH 7) .

Potassium ferricyanide is used in many ampere metric biosensors as an electron transfer agent replacing an enzyme's natural electron transfer agent such as oxygen as with the enzyme glucose oxidase . It is used as this ingredient in many commercially available blood glucose meters for use by diabetics.

Potassium ferri cyanide is the main component of Murakami's etchant for cemented carbides.

4 - Prussian blue

Prussian blue, the deep blue pigment in blue printing, is generated by the reaction of $K_3[Fe(CN)_6]$ with ferrous (Fe^{2+}) ions.

In histology, potassium ferri cyanide is used to detect ferrous iron in biological tissue, as the stain Perls' Prussian blue. In this reaction, potassium ferri cyanide reacts with ferrous iron in acidic solution to produce an insoluble blue pigment, and both the stain and the pigment are commonly referred to as Turnbull's blue. To detect ferric (Fe^{3+}) iron, potassium *ferro cyanide* is used instead; the stain and pigment produced are commonly known as Prussian blue.[6] It has been found that the compound formed in the Turnbull's blue reaction and the compound formed in the Prussian blue reaction are the same unique compound, Prussian blue .

5 – Safety :

Potassium ferri cyanide has very low toxicity, its main hazard being that it is a mild irritant to the eyes and skin. However, under very strongly acidic conditions, highly toxic hydrogen cyanide gas is evolved, according to the equation :

$$6\ H^{+} + [Fe(CN)_6]^{3-} \rightarrow 6\ HCN + Fe^{3+}$$ [9]

The reaction with hydrochloric acid is as follows:

$$6\ H\,Cl + K_3[Fe(CN)_6] \rightarrow 6\ HCN + FeCl_3 + 3\ KCl$$

17 - Potassium ferro cyanide

Contents :

1 - Introduction :

Potassium ferro cyanide is the inorganic compound with Formula $K_4[Fe(CN)_6]•3H_2O$. It is the potassium salt of the coordination complex $[Fe(CN)_6]^{4-}$. This salt forms lemon-yellow monoclinic crystals.

IUPAC Name : Potassium hexa cyanide ferrate (II)

Other Names :
yellow prussiate of potash , tetra potassium ferro cyanide ; potassium prussiate tri hydrate ; tetra potassium hexa cyanide ferrate (4 -) , tri hydrate potassium hexa cyanide ferrate (II)

Molecular Formula	$C_6 N_6 Fe K_4$
Molar Mass	368 g / mol (anhydrous) 422 g / mol (tri hydrate)
Appearance	Light yellow, crystalline granules.
Density	1.85 g/cm^3 (tri hydrate)
Melting Point	69 - 71°C
Boiling Point	400°C (decomp)
Solubility in water	*Tri hydrate* 28.9 g/100 mL (20 °C)
Solubility	insoluble in ethanol , ether
Flash Point	Non - flammable

2 - Synthesis :

Potassium ferro cyanide is produced industrially from hydrogen cyanide, ferrous chloride, calcium hydroxide, the combination of which affords $Ca_2[Fe(CN)_6]\cdot 11H_2O$. This solution is then treated with potassium salts to precipitate the mixed calcium-potassium salt $CaK_2[Fe(CN)_6]$, which in turn is treated with potassium carbonate to give the tetra potassium salt.

3 - Chemical reactions :

The most famous reaction involves treatment with ferric salts to give Prussian blue. With the approximate composition $KFe_2(CN)_6$, this insoluble but deeply coloured material is the blue of blueprinting.

Upon treatment with chlorine gas, it converts to potassium ferri cyanide :

$$2\ K_4[Fe(CN)_6] + Cl_2 \rightarrow 2\ K_3[Fe(CN)_6] + 2\ KCl$$

This reaction can be used to remove potassium ferro cyanide from a solution . When the two are combined, the product is Prussian blue. Potassium ferro cyanide, potassium ferri cyanide , and Prussian blue account for over 97 % of cyanides in the environment.

4 – Applications :

Potassium ferro cyanide finds many niche applications in industry. It and the related sodium salt are widely used as anti-caking agents for both road salt and table salt. The potassium and sodium ferro cyanides area also used in the purification of tin and the separation of copper from molybdenum ores. Potassium ferrocyanide is used in the production of wine and citric acid .

In the laboratory, potassium ferro cyanide is used to determine the concentration of potassium permanganate, a compound often used in titrations based on redox reactions. Potassium ferro cyanide is used in a mixture with potassium ferri cyanide and phosphate buffered solution (PBS) to provide a buffer for X- Gal, which is used to cleave Beta - galactosidase , giving a bright blue visualization where an antibody (or other molecule), conjugated to Beta-gal, has bonded to its target.

4 – 1 - Trivia :

Potassium ferro cyanide can be used as a fertilizer for plants. It is often used as a gardening technique. In an experiment to test this aim, plants were either deprived of nitrogen or given a nitrogen-rich environment while all were exposed to potassium ferro cyanide and potassium ferri cyanide. The plants were unable to sustain themselves solely on the cyanides, but the uptake of the cyanides did increase in the absence of nitrogen. Furthermore, the plants appeared to have different methods for the uptake of the two cyanides.

4 – 2 - Toxicity :

Potassium ferro cyanide itself is nontoxic, although upon contact with strong acid it can release of toxic hydrogen cyanide gas. The lethal dose (LD50) in rats is low, at 6400 mg / kg.

18 - Potassium fluoride

1 – Introduction :

Potassium fluoride is the chemical compound with the Formula KF. After hydrogen fluoride, KF is the primary source of the fluoride ion for applications in manufacturing and in chemistry. It is an alkali metal halide and occurs naturally as the rare mineral carobbiite. Aqueous solutions of KF will etch glass due to the formation of soluble fluorosilicates, although HF is more effective.

IUPAC Name : Potassium fluoride	
Molecular Formula	KF
Molar Mass	58 g / mol
Appearance	colourless crystals
Density	2.48 g / cm^3
Melting Point	858 °C
Boiling Point	1505 °C
Solubility in water	92 g/100 mL (18 °C)
Solubility	soluble in HF insoluble in alcohol
EU classification	Toxic (T)
Flash Point	Non - flammable
LD_{50}	245 mg /kg (oral, guinea pig)

2 - Preparation

Potassium fluoride is prepared by dissolving potassium carbonate in excess hydrofluoric acid. Evaporation of the solution forms crystals of potassium bi fluoride . The bi fluoride on heating yields potassium fluoride :

$$K_2CO_3 + 4HF \rightarrow 2KHF_2 + CO_2\uparrow + H_2O$$

$KHF_2 \rightarrow KF + HF\uparrow$

The salt must not be prepared in glass or porcelain vessels as HF and the aqueous solution of KF corrode glass and porcelain. Heat resistant plastic or platinum containers may be used.

3 - Applications in organic chemistry :

In organic chemistry, KF is the preferred source of fluoride for the conversion of chloro carbons into fluoro carbons. Such reactions usually employ polar solvents such as dimethyl formamide , ethylene glycol, and dimethyl sulfoxide.

4 - Safety considerations

Like other sources of the fluoride ion, F^{-}, KF is poisonous, although lethal doses approach gram levels for humans. It is harmful by inhalation and ingestion. It is highly corrosive, and skin contact may cause severe burns.

19 - Potassium hydro sulfide

Potassium hydrosulfide is the inorganic compound with the Formula KHS. This colourless salt consists of the cation K^+ and the bi sulfide anion $[SH]^-$. It is the product of the half-neutralization of hydrogen sulfide with potassium hydroxide. The compound is used in the synthesis of some organo sulfur compounds. It is prepared by neutralizing aqueous KOH with H_2S. Aqueous solutions of potassium sulfide consist of a mixture of potassium hydrosulfide and potassium hydroxide.

The structure of the potassium hydrosulfide resembles that for potassium chloride. Their structure is however complicated by the non-spherical symmetry of the SH^- anions, but these tumble rapidly in the solid high temperatures.

IUPAC Name : Potassium hydro sulfide	
Other Names : Potassium bi sulfide , Potassium sulfhydrate , potassium hydrogen sulfide	
Molecular Formula	HKS
Molar Mass	72 g / mol
Appearance	white solid
Density	1.68 – 1.70 g / cm^3
Melting Point	455 ºC
Solubility in water	good
EU Index	Not listed
Main hazards	Flammable solid , stench , releases hydrogen sulfide

20 - Potassium hydroxide

Contents

1 : Introduction :

Potassium hydroxide is an inorganic compound with the Formula KOH. Along with sodium hydroxide, this colour less solid is a prototypical "strong base". It has many industrial and niche applications. Most applications exploit its reactivity toward acids and its corrosive nature. In 2005, an estimated 700,000 to 800,000 tons were produced. Approximately 100 times more NaOH than KOH is produced annually . KOH is noteworthy as the precursor to most soft and liquid soaps as well as numerous potassium-containing chemicals.

Other Names : Caustic potash , Potash lye , Potassia , Potassium hydrate	
Molecular Formula	KOH
Molar Mass	56 g / mol

Appearance	White solid , deliquescent
Density	2 g / cm^3
Melting Point	420 °C
Boiling Point	1327 °C
Solubility in water	110 g /100 mL (25 °C) 178 g /100 mL (100 °C)
Solubility	soluble in alcohol , glycerol insoluble in ether , liquid ammonia
Acidity (pK_a)	13.5 (0.1 M)
Refractive index (n_D)	1.409
Crystal structure	Mono clinic
Coordination geometry	rhombohedral
EU classification	Corrosive (**C**) Harmful (**Xn**)
Flash Point	Non - flammable
LD_{50}	273 mg / kg

2 - Properties and structure

Potassium hydroxide is usually sold as translucent pellets , which will become tacky in air because KOH is hygroscopic . Consequently , KOH characteristically contains varying amounts of water (as well as carbonates) . Its dissolution in water is strongly exothermic , meaning the process gives off significant heat. Concentrated aqueous solutions are sometimes called potassium lyes .

2 – 1 : - Structure

At higher temperatures, solid KOH crystallizes in the Na Cl motif. The OH group is either rapidly or randomly disordered so that the OH^- group is effectively a spherical anion of radius 1.53 Å (between Cl^- and F^- in size) . At room temperature the OH^- groups are ordered and the environment about the K^+ centers is distorted with K^+--- OH^- distances ranging from 2.69 to 3.15 Å , depending on the orientation of the OH group . KOH forms a series of crystalline hydrates , Namely the monohydrate KOH · H_2O , the di hydrate KOH · $2H_2O$, and the tetra hydrate KOH · $4H_2O$.

2 - 2 : Solubility and desiccating properties

Approximately 121 g of KOH will dissolve in 100 mL of water at room temperature (compared with 100 g of Na OH in the same volume) . Lower alcohols such as methanol, ethanol , and propanols are also excellent solvents . The solubility in ethanol is about 40 g KOH / 100 mL .

Because of its high affinity for water, KOH serves as a desiccant in the laboratory. It is often used to dry basic solvents, especially amines and pyridines: distillation of these basic liquids from a slurry of KOH yields the anhydrous reagent .

2 – 3 : - Thermal stability

Like Na OH , KOH exhibits high thermal stability. The gaseous species is dimeric . Even at high temperatures, dehydration does not occur. Because of its high stability and relatively low melting Point, it is often melt - cast as pellets or rods, forms that have low surface area and convenient handling properties .

3 - Reactions

3 – 1 : As a base

KOH is highly basic, forming strongly alkali solutions in water and other polar solvents. These solutions are capable of deprotonating many acids, even weak ones. In analytical chemistry , titrations using solutions of KOH are used to assay acids .

3 – 2 : As a nucleophile in organic chemistry

KOH, like Na OH , serves as a source of OH^- , a highly nucleophilic anion that attacks polar bonds in both inorganic and organic materials. In perhaps its most well - known reaction, aqueous KOH saponifies esters :

$$KOH + RCO_2R' \rightarrow RCO_2K + R'OH$$

When R is a long chain, the product is called a potassium soap. This reaction is manifested by the ‘’greasy” feel that KOH gives when touched – fats on the skin are rapidly converted to soap and glycerol.

Molten KOH is used to displace halides and other leaving groups. The reaction is especially useful for aromatic reagents to give the corresponding phenols .

3 -3 : Reactions with inorganic compounds :

Complementary to its reactivity toward acids, KOH attacks anhydrides, defined in the broadest sense. Thus, SiO_2 and CO_2 are attacked by KOH to give the silicates and bicarbonate, respectively:

$$KOH + CO_2 \rightarrow KHCO_3$$

4 - Manufacture :

Historically KOH was made by boiling a solution of potassium carbonate (potash) with calcium hydroxide (slaked lime) , leading to a metathesis reaction which caused calcium carbonate to precipitate leaving potassium hydroxide in solution :

$$Ca(OH)_2 + K_2CO_3 \rightarrow CaCO_3 + 2\,KOH$$

Filtering off the precipitated calcium carbonate and boiling down the solution gives potassium hydroxide (" calcinated or caustic potash") . This method used potash extracted from wood ashes using slaked lime. It was the most important method of producing potassium hydroxide until the late 19th century, when it was largely replaced by the modern method of electrolysis of potassium chloride solutions, analogous to the method of manufacturing sodium hydroxide :

$$2\,KCl + 2\,H_2O \rightarrow 2\,KOH + Cl_2 + H_2$$

Hydrogen gas forms as a by - product on the cathode ; concurrently, an anodic oxidation of the chloride ion takes place , forming chlorine gas as a byproduct. Separation of the anodic and cathodic spaces in the electrolysis cell is essential for this process .

5 - Uses

KOH and Na OH can be used inter changeably for a number of applications , although in industry , Na OH is preferred because of its lower cost .

5 – 1 - Precursor to other potassium compounds :

Many radium salts are prepared by neutralization reactions involving KOH. The potassium salts of carbonate, cyanide, permanganate, phosphate, and various silicates are prepared by treating either the oxides or the acids with KOH . The high solubility of potassium phosphate is desirable in fertilizers .

5 – 2 : Manufacture of bio diesel :

Although more expensive than using sodium hydroxide, KOH works well in the manufacture of biodiesel by saponification of the fats in vegetable oil . Glycerin from potassium hydroxide-processed biodiesel is useful as an inexpensive food supplement for livestock, once the toxic methanol is removed .

5 – 3 : Manufacture of soft soaps

The saponification of fats with KOH is used to prepare the corresponding " potassium soaps ", which are softer than the more common sodium hydroxide - derived soaps. Because of their softness and greater solubility , potassium soaps require less water to liquefy, and can thus contain more cleaning agent than liquefied sodium soaps

5 – 4 : As an electrolyte :

Aqueous potassium hydroxide is employed as the electrolyte in alkaline batteries based on nickel - cadmium and manganese dioxide-zinc. Potassium hydroxide is preferred over sodium hydroxide because its solutions are more conductive .

5 - 5 - Niche applications :

K OH attracts numerous specialized applications, which virtually all rely on its basic or degradative properties . K OH is widely used in the laboratory for the same purposes. In chemical synthesis, the selection of K OH vs. Na OH is guided by the solubility for the resulting salt. Its corrosive properties make it useful as an ingredient in cleaning and disinfection of resistant surfaces and materials . It is often the main active ingredient in chemical "cuticle removers." KOH is also widely used as a way to remove hair from animal hides, leaving the hides in a solution of K OH and water for a few hours .

21 - Potassium Iodate

1 – Introduction :

Potassium iodate (KIO_3) is a chemical compound. It is ionic, made up of K^+ ions and IO_3^- ions in a 1:1 ratio.

IUPAC Name : Potassium iodate	
Other Names : Iodic acid potassium salt	
Molecular Formula	KIO_3
Molar Mass	214 g / mol
Appearance	white crystalline powder
Density	3.89 g/cm^3
Melting Point	560 °C decomp.
Solubility in water	4.74 g / 100 mL (0 °C) 32.3 g / 100 mL (100 °C)
Solubility	soluble in KI solution insoluble in alcohol , & liquid ammonia
Hazards	
EU Index	Oxidant [O]
Flash Point	Non - flammable

2 - Chemical properties :

Potassium iodate is an oxidizing agent and as such it can cause fires if in contact with combustible materials or reducing agents. It can be prepared by reacting a potassium - containing base such as potassium hydroxide with iodic acid , for example:

$$HIO_3 + KOH \rightarrow KIO_3 + H_2O$$

It can also be prepared by adding iodine to a hot, concentrated solution of potassium hydroxide.

$$3\ I_2 + 6\ KOH \rightarrow KIO_3 + 5\ KI + 3\ H_2O$$

Or by fusing potassium iodide with potassium chlorate, bromate or per chlorate, the melt is extracted with water and potassium iodate is isolated from the solution by crystallization :

$$KI + KClO3 \rightarrow KIO3 + KCl$$

Conditions / substances to avoid include: heat , shock , friction, combustible materials, reducing materials, aluminium, organic compounds, carbon, hydrogen peroxide and sulfides.

3 - Applications

Potassium iodate is sometimes used for iodination of table salt. Because iodide can be oxidized by molecular oxygen to iodine under wet conditions, US companies add thio sulfates or other anti oxidants to the potassium iodide. In other countries, potassium iodate is used as source for iodine. It is also an ingredient in baby Formula milk.

Like potassium bromate, potassium iodate is occasionally used as a maturing agent in baking.

3 – 1 - Radiation protection :

Potassium iodate may be used to protect against accumulation of radioactive iodine in the thyroid by saturating the body with a stable source of iodine prior to exposure . Approved by the World Health Organization for radiation protection, potassium iodate (KIO_3) is an alternative to potassium iodide (KI), which has poor shelf life in hot and humid climates . The UK, Ireland, Singapore, United Arab Emirates, and US states Idaho and Utah are known to stock potassium iodate in tablet form . It is not approved by the U.S. Food and Drug Administration (FDA) for use as a thyroid blocker, and the FDA has taken action against US websites that promote this use.

22 - Potassium Iodide

Contents

1 – Introduction :

Potassium iodide is an inorganic compound with the chemical Formula KI. This white salt is the most commercially significant iodide compound, with approximately 37,000 tons produced in 1985. It is less hygroscopic (absorbs water less readily) than sodium iodide, making it easier to work with. Aged and impure samples are yellow because of aerial oxidation of the iodide to elemental iodine.

$$4\ KI + 2\ CO_2 + O_2 \rightarrow 2\ K_2CO_3 + 2\ I_2$$

Potassium iodide is medicinally supplied in 130 mg tablets for emergency purposes. Potassium iodide may also be administered as a "saturated solution of potassium iodide" (**SSKI**) which in the U.S.P. generic Formulation contains 1000 mg of KI per mL of solution. This represents 333 mg KI and about 250 mg iodide (I^-) in a typical adult dose of 5 drops, assumed to be ⅓ mL . Because SSKI is a viscous liquid, it is normally assumed to contain 15 drops/milliliter, not 20 drops/milliliter as is often assumed for water. Thus, each drop of U.S.P. SSKI is assumed to contain about 50 mg iodine as iodide, I^-. Thus, two (2) drops of U.S.P. SSKI solution is equivalent to one 130 mg KI tablet (100 mg iodide).

SSKI can also be prepared by truly saturating water with KI. This preparation can be made without a measuring scale. Since the solubility of KI in water at room temperature is about 1.40 to 1.48 grams per mL pure water, and the resulting solution has a density of about 1.72 g / mL , this process also results in a final concentration) of KI of about 1000 mg KI per mL of saturated KI solution, and also contains essentially the same concentration of iodide per drop as does the U.S.P. Formulation.

Neither SSKI or KI tablets are used as nutritional supplements, since the nutritional requirement for iodine is only 150 micrograms or 0.15 mg of iodide per day. Thus, a drop of SSKI provides 50/0.15 = 333 times the daily iodine requirement, and a standard KI tablet provides twice this much.

Kelp is a natural KI source. The iodide content can range from 89 µg/g to 8165 µg / g in Asian varieties, making prepared foods content difficult to estimate . Eating 3-5 grams of most dried, unrinsed seaweeds will provide the 100-150 micrograms iodide recommended daily allowance for nutritional purposes.

IUPAC Name : Potassium iodide	
Molecular Formula	KI
Molar Mass	166 g / mol
Appearance	white crystalline solid
Density	3.123 g / cm^3

Melting Point	681 °C
Boiling Point	1330 °C
Solubility in water	128 g / 100 mL (0 °C) 140 g / 100 mL (20 °C) 176 g / 100 mL (60°C) 206 g / 100 mL (100°C)
Solubility	2 g /100 mL (ethanol) 1.31 g /100 mL (acetone) slightly soluble in ether , ammonia

2 - Structure , production , properties :

Potassium iodide is ionic, K^+I^-. It crystallizes in the sodium chloride structure. It is produced industrially by treating KOH with iodine.

2 – 1 - Inorganic chemistry :

Since the iodide ion is a mild reducing agent, I^- is easily oxidized to I_2 by powerful oxidising agents such as chlorine:

$$2\ KI\ (aq) + Cl_2\ (aq) \rightarrow 2\ KCl + I_2\ (aq)$$

This reaction is employed in the isolation of iodine from natural sources. Air will oxidize iodide, as evidenced by the observation of a purple extract when aged samples of KI are rinsed with dichloromethane. As formed under acidic conditions, hydro iodic acid (HI) is a stronger reducing agent.

Like other iodide salts, KI forms I_3^- when combined with elemental iodine.

$$KI(aq) + I_2(s) \rightarrow KI_3(aq)$$

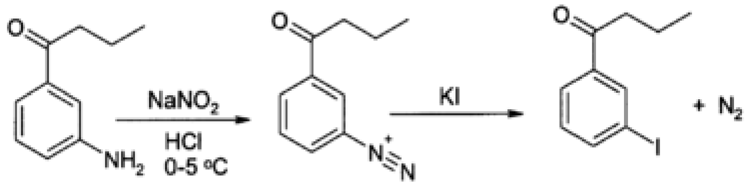
Unlike I_2, I_3^- salts can be highly water-soluble. Through this reaction iodine is used in redox titrations. Aqueous KI_3, "Lugol's solution," are used as disinfectants and as etchants for gold surfaces.

Potassium iodide is the precursor to silver(I) iodide, which is used for high speed photographic film :

$$KI(aq) + AgNO_3(aq) \rightarrow AgI(s) + KNO_3(aq)$$

2 – 2 - Organic chemistry :

KI serves as a source of iodide in organic synthesis. A useful application is in the preparation of aryl iodides from arenediazonium salts . For example:



KI, acting as a source of iodide, may also act as a nucleophilic catalyst for the alkylation of alkyl chlorides, bromides, or mesylates.

3 - Applications :

3 – 1 - Industry

KI is a precursor to silver iodide (Ag I) an important chemical in photography. KI is a component in some disinfectants and hair treatment chemicals. KI is also used as a fluorescence quenching agent in biomedical research, an application that takes advantage of collisional quenching of fluorescent substances by the iodide ion. However, for several fluorophores addition of KI in µM-mM concentrations results in increase of fluorescence intensity, and Iodide acts as fluorescence enhancer. Potassium iodide is a component in the electrolyte of dye sensitized solar cells (DSSC) along with iodine.

3 – 2 - Nutrition

The major uses of KI include use as a nutritional supplement in animal feeds and also the human diet. For the latter, it is the most common additive used to "iodize" table salt (a public health measure to prevent iodine deficiency in populations which get little seafood) . The oxidation of iodide causes slow loss of iodine content from iodized salts that are exposed to excess air. The alkali metal iodide salt, over time and exposure to excess oxygen and carbon dioxide, slowly oxidizes to metal carbonate and elemental iodine, which then evaporates. Potassium iodate is used to add iodine to some salts so that the iodine is not lost by oxidation.

For reasons noted above, therapeutic drops of SSKI, or 130 mg tablets of KI as used for nuclear fission accidents, are not used as nutritional supplements, since an SSKI drop or nuclear-emergency tablet provides 300 to 700 times more iodine than the daily adult nutritional requirement. Dedicated nutritional iodide tablets containing 0.15 mg (150 micro gram or mcg) of iodide, from KI or from various other sources (such as kelp extract) are marketed as supplements, but they are not to be confused with the much higher pharmaceutical dose preparations.

3 – 3 - Pharmaceutical applications

Potassium iodide can be conveniently prepared as a saturated solution, abbreviated SSKI. This method of delivering potassium iodide does not require a method to weigh out the potassium iodide so it can be used in an emergency situation. KI crystals are simply added to water until no more KI will dissolve and instead sits at the bottom of the container. With pure water, the concentration of KI in the solution depends only on the temperature. Potassium iodide is highly soluble in water so SSKI is a concentrated source of KI. At 20 degrees Celsius the solubility of KI is 140-148 grams per 100 grams of water.[15] Because the volumes of KI and water are approximately additive, the resulting SSKI solution will contain about 1.40 gram (1400 mg) KI per milliliter (mL) of solution. This is 100 % weight/volume (note units of Mass concentration) of KI (one gram KI per mL solution), which is possible because SSKI is significantly more dense than pu re water—about 1.72 g / mL . Because KI is about 76.4 % iodide by weight, SSKI contains about 764 mg iodide per mL . This concentration) of iodide allows the calculation of the iodide dose per drop, if one knows the number of drops per milliliter.

For SSKI, a solution more viscous than water, there are assumed to be 15 drops per mL; the iodide dose is therefore approximately 51 mg per drop, assuming 15 drops / mL . It is conventionally rounded to 50 mg per drop .

The term SSKI is also used, especially by pharmacists, to refer to a U.S.P. pre-prepared solution Formula, made by adding exactly KI to water to prepare a solution containing of 1000 mg KI per mL solution (100% wt/volume KI solution), to closely approximate the concentration of SSKI made by saturation. This is essentially interchangeable with SSKI made by saturation, and also contains about 50 mg iodide per drop.

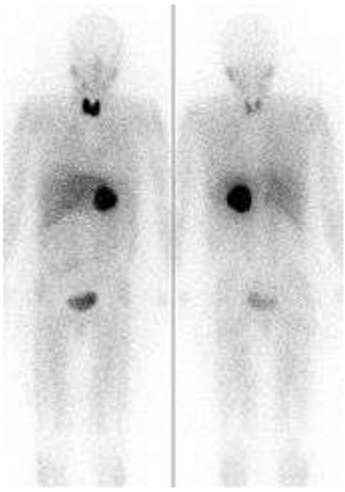
- Saturated solutions of potassium iodide can be an emergency treatment for hyperthyroidism (so - called thyroid storm) as high amounts of iodide temporarily suppress secretion of thyroxine from the thyroid gland . The dose typically begins with a loading dose, then 1 / 3 mL SSKI (5 drops or 250 mg iodine as iodide), three times per day.

- Iodide solutions made from a few drops of SSKI added to drinks have also been used as expectorants to increase the water content of respiratory secretions and encourage effective coughing .

- SSKI has been proposed as a topical treatment for sporotrichosis , but no trials have been conducted to determine the efficacy or side effects of such treatment.
- Potassium iodide has been used for symptomatic treatment of erythema nodosum patients for persistent lesions whose cause remains unknown. It has been used in cases of erythema nodosum associated with Crohn's disease.

3 – 4 - Thyroid protection during medical treatment :

Thyroid iodine uptake blockade with potassium iodide is used in nuclear medicine scintigraphy and therapy with some radio iodinated compounds that are not targeted to the thyroid, such as iobenguane (MIBG), which is used to image or treat neural tissue tumors, or iodinated fibrinogen, which is used in fibrinogen scans to investigate clotting. These compounds contain iodine, but not in the iodide form. However, since they may be ultimately metabolized or break down to radioactive iodide, it is common to administer non-radioactive potassium iodide to ensure that iodide from these radiopharmaceuticals is not sequestered by the normal affinity of the thryoid for iodide.



Pheochromocytoma seen as dark sphere in center of the body. Image is by MIBG scintigraphy with radiation from radioiodine in the MIBG. However, note unwanted uptake of radioiodine from the pharmaceutical by the thyroid gland in the neck, in both images (front and back) of the same patient. Radioactivity is also seen in the bladder.

U.S. Food and Drug Administration-approved dosing of potassium iodide for this purpose with iobenguane , is as follows (per 24 hours): infants less than 1 month old, 16 mg; children 1 month to 3 years , 32 mg ; children 3 years to 18 years, 65 mg; adults 130 mg. However, some sources recommend alternative dosing regimens.

Not all sources are in agreement on the necessary *duration* of thyroid blockade, although agreement appears to have been reached about the *necessity* of blockade for both scintigraphic and therapeutic applications of iobenguane . Commercially available iobenguane is labeled with iodine - 123, and product labeling recommends administration of potassium iodide 1 hour prior to administration of the radiopharmaceutical for all age groups , while the European Associated of Nuclear Medicine recommends (for iobenguane labeled with either isotope) that potassium iodide administration begin one day prior to radiopharmaceutical administration, and continue until the day following the injection, with the exception of new-borns, who do not require potassium iodide doses following radiopharmaceutical injection.

Product labeling for diagnostic iodine - 131 iobenguane recommends potassium iodide administration one day before injection and continuing 5 to 7 days following administration, in keeping with the much longer half-life of this isotope and its greater danger to the thyroid . Iodine-131 iobenguane used for therapeutic purposes requires a different pre-medication duration, beginning 24 – 48 hours prior to iobenguane injection and continuing 10 – 15 days following injection .

3 – 5 - Thyroid protection due to nuclear accidents and emergencies :

In 1982, the U.S. Food and Drug Administration approved potassium iodide to protect thyroid glands from radioactive iodine involving accidents or fission emergencies. In an accidental event or attack on a nuclear power plant, or in nuclear bomb fallout, volatile fission product radio nuclides may be released. Of these products, ^{131}I is one of the most common and is particularly dangerous to the thyroid gland because it may lead to thyroid cancer. By saturating the body with a source of stable iodide prior to exposure, inhaled or ingested ^{131}I tends to be excreted, which prevents radioiodine uptake by the thyroid. The protective effect of KI lasts approximately 24 hours. For optimal prophylaxis, KI must be dosed daily until a risk of significant exposure to radioiodine by either inhalation or ingestion no longer exists.

Emergency 130 **milligrams** potassium iodide doses provide 100 mg iodide (the other 30 mg is the potassium in the compound) , which is roughly 700 times larger than the normal nutritional need (see recommended dietary allowance) for iodine, which is 150 **micrograms** (0.15 mg) of iodine (as iodide) per day for an adult.

Potassium iodide cannot protect against any other causes of radiation poisoning, nor can it provide any degree of protection against dirty bombs that produce radionuclides other than radioisotopes of iodine. See fission products and the external links for more details concerning radio nuclides.

The potassium iodide in iodized salt is insufficient for this use . A likely lethal dose of salt (more than a **kilogram**) would be needed to equal the potassium iodide in one tablet .

The World Health Organization does not recommend KI prophylaxis for adults over 40 years, unless inhaled radiation dose levels are expected to threaten thyroid function; because, the KI side effects increases with age and may exceed the KI protective effects "...unless doses to the thyroid from inhalation rise to levels threatening thyroid function, that is of the order of about 5 Gy. Such radiation doses will not occur far away from an accident site " .

The U.S. Department of Health and Human Services restated these two years later as "The downward KI (potassium iodide) dose adjustment by age group, based on body size considerations, adheres to the principle of minimum effective dose. The recommended standard (daily) dose of KI for all school - age children is the same (65 mg). However, adolescents approaching adult size (i.e., >70 kg [154 lbs]) should receive the full adult dose (130 mg) for maximal block of thyroid radioiodine uptake. Neonates ideally should receive the lowest dose (16 mg) of KI " .

SSKI (i.e., the solution of KI rather than tablets) may be used in radioiodine-contamination emergencies (i.e., nuclear accidents) to "block" the thyroid's uptake of radioiodine, at a dose of two drops of SSKI per day for an adult. This is not the same as blocking the thyroid's release of thyroid hormone, for which the adult dose is different (and is actually higher by a factor of 7 or 8), and for which KI anti-radiation pills (not a common medical treatment form of KI) are not usually available in pharmacies, or normally used in hospitals, or by physicians. Although the two forms of potassium iodide are completely interchangeable, normally in practice the SSKI solution, which is the historical medical form of high dose iodine, is generally used for all medical purposes save for radioiodine prophylaxis. For protection of the thyroid against radioiodine (iodine-131) contamination, the convenient standard 130 mg KI pill is used if available. As noted, the equivalent two drops of SSKI may be used for this purpose, if the pills are not available.

3 – 5 – 1 - Historical use and analysis :

Following the Chernobyl nuclear reactor disaster in April, 1986, a saturated solution of potassium iodide (SSKI) was administered to 10.5 million children and 7 million adults in Poland[29] as a prophylactic measure against accumulation of radioactive iodine - 131 in the thyroid gland. People in the areas immediately surrounding Chernobyl itself , however, were not given the supplement .

Potassium iodide’s (KI) value as a radiation protective (thyroid blocking) agent was demonstrated at the time of the Chernobyl nuclear accident when Soviet authorities distributed it in a 30 km zone around the plant. The purpose was to protect residents from radioactive iodine, a highly carcinogenic material found in nuclear reactors which had been released by the damaged reactor. Only a limited amount of KI was available, but those who received it were protected. Later, the US Nuclear Regulatory Commission (NRC) reported, “thousands of measurements of I-131 (radioactive iodine) activity...suggest that the observed levels were lower than would have been expected had this prophylactic measure not been taken. The use of KI...was credited with permissible iodine content in 97% of the evacuees tested ” .

Poland, 300 miles from Chernobyl, also distributed KI to protect its population. Approximately 18 million doses were distributed, with follow-up studies showing no known thyroid cancer among KI recipients . With the passage of time, people living in irradiated areas where KI was not available have developed thyroid cancer at epidemic levels, which is why the US Food and Drug Administration (FDA) reported “The data clearly demonstrate the risks of thyroid radiation...KI can be used [to] provide safe and effective protection against thyroid cancer caused by irradiation.

Chernobyl also demonstrated that the need to protect the thyroid from radiation was greater than expected. Within ten years of the accident, it became clear that thyroid damage caused by released radioactive iodine was virtually the only adverse health effect that could be measured. As reported by the NRC, studies after the accident showed that "As of 1996, except for thyroid cancer, there has been no confirmed increase in the rates of other cancers, including leukemia, among the...public, that have been attributed to releases from the accident ".

But equally important to the question of KI is the fact that radiation releases are not "local" events. Researchers at the World Health Organization accurately located and counted the cancer victims from Chernobyl and were startled to find that "the increase in incidence [of thyroid cancer] has been documented up to 500 km from the accident site...significant doses from radioactive iodine can occur hundreds of kilometers from the site, beyond emergency planning zones." . Consequently, far more people than anticipated were affected by the radiation, which caused the United Nations to report in 2002 that "The number of people with thyroid cancer... has exceeded expectations . Over 11,000 cases have already been reported ".

These findings were consistent with studies of the effects of previous radiation releases. In 1945, millions of Japanese were exposed to radiation from nuclear weapons, and the effects can still be measured. Today, nearly half (44.8 %) the survivors of Nagasaki studied have identifiable thyroid disease, with the American Medical Association reporting "it is remarkable that a biological effect from a single brief environmental exposure nearly 60 years in the past is still present and can be detected " .This, as well as the development of thyroid cancer among residents in the North Pacific from radioactive fallout following the United States' nuclear weapons testing in the 1950s (on islands nearly 200 miles downwind of the tests) were instrumental in the decision by the FDA in 1978 to issue a request for the availability of KI for thyroid protection in the event of a release from a commercial nuclear power plant or weapons - related nuclear incident. Noting that KI's effectiveness was "virtually complete" and finding that iodine in the form of potassium iodide (KI) was substantially superior to other forms including iodate (KIO_3) in terms of safety, effectiveness, lack of side effects, and speed of onset, the FDA invited manufacturers to submit applications to produce and market KI.

Today, three companies (Anbex, Inc., Fleming Co, and Recip of Sweden) have met the strict FDA requirements for manufacturing and testing of KI, and they offer products (IOSAT, ThyroShield, and Thyro-Safe, respectively) which are available for purchase. The Swedish manufacturing facility for Thyrosafe , a potassium iodide tablet for thyroid protection from radiation manufactured by Recipharm AB, was mentioned on the secret US 2008 Critical Foreign Dependencies Initiative leaked by Wiki leaks in 2010.

It was reported on March 16, 2011, that potassium iodide tablets were given prophylactic ally to U.S. Naval air crew members flying within 70 nautical miles of the Fukushima Daiichi Nuclear plant damaged in the Massive Japanese earthquake (8.9/9.0 magnitude) and ensuing tsunami on March 11, 2011. The measures were seen as precautions, and the Pentagon said no U.S. forces have shown signs of radiation poisoning. By March 20, the US Navy instructed personnel coming within 100 miles of the reactor to take the pills.

4 - Adverse reactions

There have been some reports of potassium iodide treatment causing swelling of the parotid gland (one of the three glands which secrete saliva), due to its stimulatory effects on saliva production.

A saturated solution of KI (SSKI) is typically given orally in adult doses of about 250 mg iodide several times a day (5 drops of SSKI assumed to be ⅓ ml) for thyroid blockade (to prevent the thyroid from excreting thyroid hormone) and occasionally this dose is also used when iodide is used as an expectorant. The anti-radioiodine doses used for I - 131 uptake blockade are lower, and range downward from 100 mg a day for an adult, to less than this for children . All of these doses should be compared with the far lower dose of iodine needed in normal nutrition, which is only 150 μg per day (150 **micrograms**, not milligrams).

At maximal doses, and sometimes at much lower doses, side effects of iodide used for medical reasons, in doses of 1000 times the normal nutrional need, may include: acne, loss of appetite, or upset stomach (especially during the first several days, as the body adjusts to the medication). More severe side effects which require notification of a physician are: fever, weakness, unusual tiredness, swelling in the neck or throat, mouth sores, skin rash, nausea, vomiting, stomach pains, irregular heartbeat, numbness or tingling of the hands or feet, or a metallic taste in the mouth.

5 - Precautions

Potassium iodide is a mild irritant and should be handled with gloves. Chronic overexposure can have adverse effects on the thyroid. Potassium iodide is a possible teratogen .

23 - Potassium Manganate

1 – Introduction :

Potassium manganate is the inorganic compound with the Formula K_2MnO_4. This green - colored salt is an intermediate in the industrial synthesis of potassium permanganate ($KMnO_4$), a common chemical. Occasionally, potassium manganate and potassium *per*manganate are confused, but they are different compounds with distinctly different properties.

IUPAC Name : Potassium Manganate (VI)	
Molecular Formula	$K_2 Mn O_4$
Molar Mass	197 g / mol
Appearance	dark green crystals
Density	2.78 g / cm^3 , solid
Melting Point	190 °C
Solubility in water	decomposes
Acidity (pK_a)	7.1
Crystal structure	Iso morphous with K_2SO_4
Coordination geometry	Tetrahedral anion
Main hazards	oxidizer

2 - Structure :

K_2MnO_4 is a salt, consisting of K^+ cations and MnO_4^{2-} anions. X-ray crystallography shows that the anion is tetrahedral, with Mn - O distances of 1.66 Å, ca. 0.03 Å longer than the Mn-O distances in $KMnO_4$. It is iso structural with potassium sulfate.

3 - Synthesis

The industrial route entails treatment of MnO_2 with air:

$$2\ MnO_2 + 4\ KOH + O_2 \rightarrow 2\ K_2MnO_4 + 2\ H_2O$$

The transformation gives a green - colored melt. In fact, one can test an unknown substance for the presence of manganese by heating the sample in strong KOH in air. The production of a green coloration indicates the presence of Mn. This green color results from an intense absorption at 610 nm.

In laboratory, K_2MnO_4 can be synthesized by heating a solution of $KMnO_4$ in concentrated KOH solution followed by cooling to give green crystals :

$$4\ KMnO_4 + 4\ KOH \rightarrow 4\ K_2MnO_4 + O_2 + 2\ H_2O$$

This reaction illustrates the relatively rare role of hydroxide as a reducing agent. Solutions of K_2MnO_4 are generated by allowing a solution of $KMnO_4$ in 5 - 10 M KOH to stir for a day at room temperature followed by removal of MnO_2, which is insoluble. The concentration of K_2MnO_4 in such solutions can be checked by measuring their absorbance at 610 nm.

The one-electron reduction of permanganate to manganate can also be effected using iodide as the reducing agent:

$$2\ KMnO_4 + 2\ KI \rightarrow 2\ K_2MnO_4 + I_2$$

The conversion is signaled by the color change from purple, characteristic of permanganate, to the green color of manganate. This reaction also illustrates the fact that manganate(VII) can serve as an electron acceptor in addition to its usual role as an oxygen-transfer reagent. Barium manganate, $BaMnO_4$, is generated by the reduction of $KMnO_4$ with iodide in the presence of barium chloride. Just like $BaSO_4$, $BaMnO_4$ exhibits low solubility in virtually all solvents.

An easy method for preparing potassium manganate in the laboratory involves heating crystals or powder of pure potassium permanganate. Potassium permanganate will decompose into potassium manganate, manganese dioxide and oxygen gas:

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

This reaction is a laboratory method to prepare oxygen.

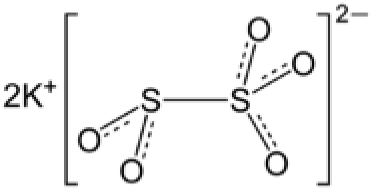
4 - Reactions

At lower pH, the manganate ion will disproportionate to permanganate ion and manganese dioxide:

$$3\ K_2MnO_4 + 2\ H_2O \rightarrow 2\ KMnO_4 + MnO_2 + 4\ KOH$$

The colorful nature of this reaction has led the manganate/manganate (VII) pair to be referred to as a "chemical chameleon." This disproportionate reaction, which becomes rapid when $[OH^-] < 1M$, follows bimolecular kinetics.

24 - Potassium meta bi sulfite



1 – Introduction :

Potassium meta bi sulfite, $K_2S_2O_5$, is a white crystalline powder with a pungent sulfur odour . The main use for the chemical is as an antioxidant or chemical sterilant. It is a di sulfite and is chemically very similar to sodium meta bi sulfite, with which it is sometimes used interchangeably. Potassium meta bi sulfite is generally preferred out of the two as it does not contribute sodium to the diet.

Potassium meta bi sulfite has a monoclinic crystal structure which decomposes at 190°C, yielding potassium oxide and sulfur dioxide :

$$K_2S_2O_5(s) \rightarrow K_2O(s) + 2SO_2(g)$$

Other Names : Potassium pyro sulfite , Di potassium di sulfite	
Molecular Formula	$K_2\ O_5\ S_2$
Molar Mass	222 g mol−1
Appearance	White crystalline powder
Odor	pungent (Sulfur dioxide)
Density	2.34 g / cm3 (solid)
Melting Point	190 °C decomp.
Solubility in water	450 g / l (20 °C)
Solubility	Insoluble in ethanol

EU Index	Not listed
Main hazards	Irritant, asthma risk
Other cations	Sodium meta bi sulfite

2 - Uses :

It is used as a food additive, also known as E224 . It is restricted in use and may cause severe allergic reactions in sensitive persons .

Potassium is an inhibitor of the poly phenol oxidase enzyme.

2 - 1 – Wine :

Potassium meta bi sulfite is a common wine or must additive, in which it forms sulfur dioxide gas (SO_2). This both prevents most wild micro organisms from growing, and it acts as a potent anti oxidant, protecting both the color and delicate flavors of wine.

The typical dosage is 1 / 4 tsp potassium meta bi sulfite per six-gallon bucket of must (yielding roughly 75 ppm of SO_2) prior to fermentation; then 1/2 tsp per six - gallon bucket (150 ppm of SO_2) at bottling. Most commercial wineries do not add more than 30ppm at bottling.

Winemaking equipment is sanitized by spraying with a 1 % SO_2 (2 tsp potassium meta bi sulfite per L) solution.

2 - 2 – Beer :

Potassium meta bi sulfite is some times used in the brewing industry to inhibit the growth of wild yeasts , bacteria, and fungi. This is called 'stabilizing'. It is also used to neutralize chloramine that has been added to tap water at the source as a disinfectant. It is used both by home brewers and commercial brewers alike. It is not used as much for brewing beer, because the wort is almost always boiled, which kills most microorganisms anyway. It can also be added to strike water (the water used to mash the barley) in order to remove chloramines which can cause phenolic off flavors in beer.

3 - Other uses :

- Potassium meta bi sulfite is used in the textile industry for dyeing and cotton printing.

- Potassium meta bi sulfite is sometimes used to precipitate gold from solution in aqua regia (as an alternative to sodium sulfite) .

- It is a component of certain photographic developers and solutions used in photographic fixing.

25 - Potassium Nitrate

Contents

1 – Introduction :

Potassium nitrate is a chemical compound with the chemical Formula K NO_3 . A naturally occurring mineral source of nitrogen , KNO_3 constitutes a critical oxidizing component of black powder / gun powder . In the past it was also used for several kinds of burning fuses , including slow matches .

Potassium nitrate readily precipitates from mixtures of salts , and decomposing urine was the main commercial source of the nitrate ion, through various means, from the Late Middle Ages and Early Modern era through the 19 th century .

Its common Names include **salt petre** (**salt peter** in American English) , from Medieval Latin *sal petræ* : " stone salt " or possibly " Salt of Petra " , **nitrate of potash** , and **nitre** (American **niter**) . For specific information about the naturally occurring mineral.

The Name **Chile salt petre** (American " Chile salt peter ") is applied to sodium nitrate , a similar nitrogen compound that is also used in explosives and fertilizers . The major problem of using the cheaper sodium nitrate in gun powder is its tendency to go damp .

Other Names : Salt petre , Nitrate of potash , Vesta powder	
Molecular Formula	KNO_3
Molar Mass	101 g / mol

Appearance	white solid
Odor	odorless
Density	2.109 g / cm^3 (16 °C)
Melting Point	334 °C
Boiling Point	400 °C decomp .
Solubility in water	13.3 g / 100 mL (0 °C) 36 g / 100 mL (25 °C) 247 g / 100 mL (100 °C)
Solubility	slightly soluble in ethanol soluble in glycerol , ammonia
Crystal structure	Orthorhombic , Aragonite
Main hazards	Oxidant
Flash Point	Non - flammable
LD_{50}	3750 mg / kg
Thermodynamic data	Phase behavior Solid , liquid , gas

2 - Description

Potassium nitrate is the oxidizing component of black powder. Before the large - scale industrial fixation of nitrogen through the Haber process, major sources of potassium nitrate were the deposits crystallizing from cave walls and the draining of decomposing organic material . Dung - heaps were a particularly common source: ammonia from the decomposition of urea and other nitrogenous materials would undergo bacterial oxidation to produce nitrates. These often contained calcium nitrate, which could be converted to potassium nitrate by the addition of potash from wood ashes. It was and is also used as a component in some fertilizers. When used by itself as a fertilizer, it has an NPK rating of 13 - 0 - 38 (indicating 13.9 %, 0 %, and 38.7 % of nitrogen , phosphorus , and potassium , by Mass , respectively) .

Potassium nitrate was once thought to induce impotence, and is still falsely rumored to be in institutional food (such as military fare) as an an aphrodisiac ; these uses would be ineffective, since potassium nitrate has no such properties.[2] However, potassium nitrate successfully combats high blood pressure and was once used as a hypo tensive . Other nitrates and nitrites such as glyceryl tri nitrate (GTN) , amyl nitrite and iso sorbide derivatives are still used to relieve angina .

3 - History of production

Historically, niter - beds were prepared by mixing manure with either mortar or wood ashes, common earth and organic materials such as straw to give porosity to a compost pile typically 1.5 meters high by 2 meters wide by 5 meters long.[3] The heap was usually under a cover from the rain, kept moist with urine, turned often to accelerate the decomposition and leached with water after approximately one year. The liquid containing various nitrates was then converted with wood ashes to potassium nitrate , crystallized and refined for use in gun powder .

Urine has also been used in the manufacture of salt petre for gun powder . In this process , stale urine placed in a container of straw hay is allowed to sour for many months, after which water is used to wash the resulting chemical salts from the straw. The process is completed by filtering the liquid through wood ashes and air-drying in the sun.[3] Saltpetre crystals can then be collected and added to sulfur and charcoal to create black powder . Potassium nitrate could also be harvested from accumulations of bat guano in caves. This was the traditional method used in Laos for the manufacture of gunpowder for Bang Fai rockets .

The earliest known complete purification process for potassium nitrate is described in 1270 by the Arab chemist and engineer Hasan al - Rammah of Syria in his book *al-Furusiyya wa al - Manasib al - Harbiyya* (' The Book of Military Horseman ship and Ingenious War Devices ') , where he first described the use of potassium carbonate (

in the form of wood ashes) to remove calcium and magnesium salts from the potassium nitrate .

During the 19 th century and until around World War I , potassium nitrate was produced on an industrial scale , first by the Birkeland – Eyde process in 1905 , and then later from ammonia produced by the much more efficient Haber process. The latter process came online during World War I, and supplied Germany with nitrates critical for the warfare that it otherwise had no access to because the deposits of natural nitrate in Chile were in British hands. It is assumed that this prolonged World War I . Today practically all nitrates are produced from the oxidation of ammonia made by the Haber process.

4 - Uses

Potassium nitrate is also used as a fertilizer , in amateur rocket propellants , and in several fireworks such as smoke bombs .

In the process of food preservation , potassium nitrate has been a common ingredient of salted meat since the Middle Ages, but its use has been mostly discontinued due to inconsistent results compared to more modern nitrate and nitrite compounds. Even so, salt petre is still used in some food applications, such as charcuterie and the brine used to make corned beef . Sodium nitrate (and nitrite) have mostly supplanted potassium nitrate's culinary usage , as they are more reliable in preventing bacterial infection than salt petre. All three give cured salami and corned beef their characteristic pink hue .

In the European Union , the compound is referred to as E252 . It is commonly used in pre - rolled cigarettes to maintain an even burn of the tobacco .

As a fertilizer , it is used as a source of nitrogen and potassium, two of the macro nutrients for plants . Potassium nitrate is also the main component (usually about 98 %) of tree stump remover , as it accelerates the natural decomposition of the stump .

Potassium nitrate is also commonly used in the heat treatment of metals as a solvent in the post – wash . The oxidizing, water solubility and low cost make it an ideal short -term rust inhibitor .

It has also been used in the manufacture of ice cream and can be found in some tooth pastes for sensitive teeth . Recently, the use of potassium nitrate in tooth pastes for treating sensitive teeth has increased dramatically, despite the fact that it has not been conclusively shown to reduce dentine hypersensitivity .

Potassium nitrate is also one of the three components of black powder, along with powdered charcoal (substantially carbon) and sulfur, where it acts as an oxidizer. When subjected to the flame test it produces a lilac flame due to the presence of potassium .

5 - Urban legend

A popular myth for generations, particularly among primarily male populations (armed services , schools , summer camps , prisons) holds that saltpeter , institutionally added to food , decreases sex drive and inhibits erection . There is no scientific evidence to support that the substance causes such an effect. Ironically, alcohol — commonly sought out and/or abused by these same populations — *can* cause erectile dysfunction and ejaculatory incompetence, sterility, lowered testosterone levels and even gynecomastia .

26 - Potassium Nitrite

Potassium nitrite (distinct from potassium nitrate) is a salt with chemical Formula KNO_2 .

It is a strong oxidizer and may accelerate the combustion of other materials. Like other nitrite salts such as sodium nitrite, potassium nitrite is toxic if swallowed, and laboratory tests suggest that it may be mutagenic or teratogenic . Gloves and safety glasses are usually used when handling potassium nitrite.

Potassium nitrite is used in the manufacturing of heat transfer salts. As food additive E249, potassium nitrite is a preservative similar to sodium nitrite and is approved for usage in the EU, USA and Australia and New Zealand (where it is listed under its INS number 249) .

Molecular Formula	$K NO_2$
Molar Mass	85 g / mol
Appearance	white or slight yellow solid deliquescent
Density	1.915 g / cm^3
Melting Point	440.02 °C (decomp)
Solubility in water	281 g/100 mL (0 °C) 413 g/100 mL (100 °C)
Solubility	soluble in alcohol, ammonia
EU classification	Oxidant (**O**) Harmful (**Xn**) Dangerous for the environment (**N**)
Flash Point	Non-flammable
LD_{50}	235 mg / kg

27 - Potassium Oxide

! – Introduction :

Potassium Oxide is an ionic compound of potassium and oxygen. This pale yellow solid, the simplest oxide of potassium, is a rarely encountered, highly reactive compound. Some materials of commerce, such as fertilizers and cements, are assayed assuming the percent composition that would be equivalent to K_2O.

IUPAC Name : Potassium Oxide	
Other Names : Potassium Monoxide	
Molecular Formula	$K_2 O$
Molar Mass	94 g / mol
Appearance	pale yellow solid
Density	2.35 g / cm^3
Melting Point	>350 °C decomp.
Solubility in water	Reacts forming KOH
Crystal structure	Anti fluorite (cubic) ,
EU Index	Not listed
Main hazards	Corrosive , reacts violently with water
Flash Point	Non - flammable
Related compounds	Potassium hydroxide

2 - Production :

Potassium oxide is produced from the reaction of oxygen and potassium; this reaction affords potassium peroxide, K_2O_2. Treatment of the peroxide with potassium produces the oxide

$$K_2O_2 + 2\,K \rightarrow 2\,K_2O$$

Alternatively and more conveniently , K_2O is synthesized by heating potassium nitrate with metallic potassium:

$$2\ KNO_3 + 10\ K \rightarrow 6\ K_2O + N_2$$

Potassium hydroxide cannot be further dehydrated to the oxide.

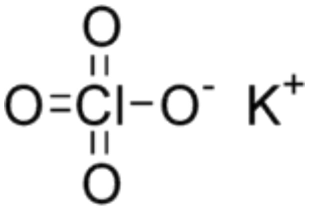
3 - Properties and reactions

K_2O crystallizes in the anti fluorite structure. In this motif the positions of the anions and cations are reversed relative to their positions in $Ca\ F_2$, with potassium ions coordinated to 4 oxide ions and oxide ions coordinated to 8 potassium . K_2O is a basic oxide and reacts with water violently to produce the caustic potassium hydroxide. It is deliquescent and will absorb water from the atmosphere, initiating this vigorous reaction.

4 - Fertilizers :

The chemical Formula K_2O is used in the N - P - K (nitrogen-phosphorus-potassium) numbers on the labels of fertilizers. Although K_2O is the correct Formula for potassium oxide, potassium oxide is not used as a fertilizer in these products. Normally, potassium chloride, potassium sulfate, or potassium carbonate is used as a fertilizer source for potassium. The percentage of K_2O given on the label only represents the amount of potassium in the fertilizer if it was in the form of potassium oxide. Potassium oxide is about 83% potassium by weight, but potassium chloride, for instance, is only 52% potassium by weight. Potassium chloride provides less potassium than an equal amount of potassium oxide. Thus, if a fertilizer is 30 % potassium chloride by weight, its standard potassium rating, based on potassium oxide, would be only 19 %.

28 - Potassium per chlorate



1 – Intro0duction :

Potassium per chlorate is the inorganic salt with the chemical Formula $KClO_4$. Like other per chlorates, this salt is a strong oxidizer and potentially reacts with many organic substances. This usually obtained as a colorless, crystalline solid is a common oxidizer used in fireworks, ammunition percussion caps, explosive primers, and is used variously in propellants, flash compositions, stars, and sparklers. It has been used as a solid rocket propellant , although in that application it has mostly been replaced by the higher performance ammonium per chlorate. $KClO_4$ has the lowest solubility of the alkali metal per chlorates (1.5 g in 100 mL of water at 25 °C).

Other Names : Potassium chlorate (VII) , Per chloric acid potassium salt , peroidin	
Molecular Formula	$K\,Cl\,O_4$
Molar Mass	138.5 g / mol
Appearance	Colorless / white crystalline powder
Density	2.5239 g/cm^3
Melting Point	525 °C
Boiling Point	600 °C (decomp.)
Solubility in water	1.5 g / 100 mL (25 °C)[1] 21.8 g / 100 mL (100 °C)
Solubility	Negligible in alcohol Insoluble in ether
Crystal structure	rhombohedral

EU classification	Oxidant (O) Harmful (Xn)

2 - Production :

$KClO_4$ is prepared industrially by treating an aqueous solution of sodium per chlorate with KCl. This single precipitation reaction exploits the low solubility of $KClO_4$, which is about 100 times less than the solubility of Na Cl O_4 (209.6 g /100 mL at 25 °C) .

3 - Oxidizing properties :

$KClO_4$ is an oxidizer in the sense that it exothermically transfers oxygen to combustible materials, greatly increasing their rate of combustion relative to that in air. Thus, with glucose it gives carbon dioxide : $3\ KClO_4 + C_6H_{12}O_6 \rightarrow 6\ H_2O + 6\ CO_2 + 3\ KCl$

The conversion of solid glucose into hot gaseous CO_2 is the basis of the explosive force of this and other such mixtures. Even with cane sugar, $KClO_4$ yields a low explosive, provided the necessary confinement. Other wise such mixtures simply deflagrate with an intense purple flame characteristic of potassium. Flash compositions used in firecrackers usually consist of fine aluminium powder mixed with potassium per chlorate.

As an oxidizer, potassium per chlorate can be used safely in the presence of sulfur, whereas potassium chlorate cannot. The greater reactivity of chlorate is typical – per chlorates are kinetically poorer oxidants. Chlorate produces chloric acid, which is highly unstable and can lead to premature ignition of the composition. Correspondingly, per chloric acid is quite stable.

4 - In medicine :

Potassium per chlorate can be used as an anti thyroid agent used to treat hyperthyroidism, usually in combination with one other medication. This application exploits the similar ionic radii and hydrophilicity of per chlorate and iodide.

29 - Potassium permanganate

Contents

1 – Introduction :

Potassium permanganate is an inorganic chemical compound with the Formula $KMnO_4$. It is a salt consisting of K^+ and MnO_4^- ions. Formerly known as **permanganate of potash** or **Condy's crystals**, it is a strong oxidizing agent. It dissolves in water to give intensely purple solutions, the evaporation of which leaves prismatic purplish-black glistening crystals. In 2000, worldwide production was estimated at 30,000 tones . In this compound, manganese is in the +7 oxidation state.

IUPAC Name : Potassium manganate (VII)	
Other Names : Potassium permanganate Chameleon mineral Condy's crystals Permanganate of potash	
Molecular Formula	$K Mn O_4$
Molar Mass	158 g / mol
Appearance	Purplish – bronze - gray needles magenta – rose in solution
Odor	odorless
Density	2.703 g / cm^3
Melting Point	240 °C (decomp.)
Solubility in water	6.38 g / 100 mL (20 °C) 25 g / 100 mL (65 °C)
Solubility	decomposes in alcohol and organic solvents
Crystal structure	Orthorhombic
EU classification	Oxidant (O) Harmful (Xn) Dangerous for the environment (N) Non - Flammable

2 - Structure and preparation :

Potassium permanganate is produced industrially from manganese dioxide, which also occurs as the mineral pyrolusite . The MnO_2 is fused with potassium hydroxide and heated in air or with a source of oxygen, like potassium nitrate or chlorate . This process gives potassium manganate , which upon electrolytic oxidation in alkaline media, or by boiling the manganate solution in the presence of carbon dioxide until all the green color is discharged, gives potassium permanganate .

$$2\ MnO_2 + 4\ KOH + O_2 \rightarrow 2\ K_2MnO_4 + 2\ H_2O$$
$$2\ MnO_4^{2-} + Cl_2 \rightarrow 2\ MnO_4^{-} + 2\ Cl^{-}$$

Or : $3\ K_2MnO_4 + 2\ CO_2 \rightarrow 2\ KMnO_4 + 2\ K_2CO_3 + MnO_2$

In which the potassium permanganate is separated by filtering the insoluble manganese dioxide, evaporating the solution to 1 / 3 and re crystallizing it.

Permanganate salts can also be generated by treating a solution of Mn^{2+} ions with strong oxidants such as lead dioxide (PbO_2), or sodium bismuthate ($NaBiO_3$) . Tests for the presence of manganese exploit the vivid violet colour of permanganate produced by these reagents.

$KMnO_4$ forms ortho rhombic crystals with constants : a = 910.5 pm, b = 572.0 pm, c = 742.5 pm. The overall motif is similar to that for barium sulfate, with which it forms solid solutions.[4] In the solid (as in solution), each MnO_4^- centers are tetrahedral. The Mn-O distances are 1.62 Å .

3 - Reactions :

A solution of $KMnO_4$ in water, in a volumetric flask

3 – 1 – Analytical :

Potassium permanganate can be used to quantitatively determine the total oxidisable organic material in an aqueous sample. The value determined is known as the *permanganate value*. In analytical chemistry, a standardized aqueous solution of $KMnO_4$ is sometimes used as an oxidizing titrant for redox titrations (per manganometry) . In a related way, it is used as a reagent to determine the Kappa number of wood pulp. For the standardization of $KMnO_4$ solutions, reduction by oxalic acid is often used.

Aqueous, acidic solutions of $KMnO_4$ are used to collect gaseous mercury in flue gas during stationary source emissions testing.

3 – 2 – Organic chemistry

Dilute solutions of $KMnO_4$ convert alkenes into diols (glycols). This behavior is also used as a qualitative test for the presence of double or triple bonds in a molecule, since the reaction decolorizes the permanganate solution. It is sometimes referred to as Baeyer's reagent. However, bromine serves better in measuring un saturation (double or triple bonds) quantitatively, since $KMnO_4$, being a very strong oxidizing agent, can react with a variety of groups.

Under acidic conditions, the alkene double bond is cleaved to give the appropriate carboxylic acid :

$$CH_3(CH_2)_{17}CH{=}CH_2 + 2\ KMnO_4 + 3\ H_2SO_4 \rightarrow$$
$$CH_3\,(CH_2)_{17}\ COOH + CO_2 + 4\ H_2O + K_2SO_4 + 2\ MnSO_4$$

Potassium permanganate oxidizes aldehydes to carboxylic acids, such as the conversion of *n* - heptanal to heptanoic acid :

$$5\ C_6H_{13}CHO + 2\ KMnO_4 + 3\ H_2SO_4 \rightarrow$$
$$5\ C_6H_{13}COOH + 3\ H_2O + K_2SO_4 + 2\ MnSO_4$$

Even an alkyl group (with a benzylic hydrogen) on an aromatic ring is oxidized, e.g. toluene to benzoic acid.

$$5\ C_6H_5CH_3 + 6\ KMnO_4 + 9\ H_2SO_4 \rightarrow$$
$$5\ C_6H_5COOH + 14\ H_2O + 2\ K_2SO_4 + 6\ MnSO_4$$

Glycols and polyols are highly reactive toward $KMnO_4$. For example, addition of potassium permanganate to an aqueous solution of sugar and sodium hydroxide produces the "chemical chameleon" reaction, which involves dramatic colour changes associated with the various oxidation states of manganese. A related vigorous reaction is exploited as a fire starter in survival kits. For example, a mixture of potassium permanganate and glycerol or pulverized glucose ignites readily . Its sterilizing properties are another reason for inclusion of $KMnO_4$ in a survival kit.

3 – 2 - 1 – " Purple benzene " :

Purple benzene refers to solutions prepared by treating a two phase mixture of aqueous potassium permanganate and benzene with a quat salt. The quat cation forms a salt of permanganate that is soluble in benzene, giving this organic solvent a purple color. The reaction illustrate the ability of quat salts to confer lipophilicity to hydrophilic anions. The same effect can be obtained by complexing the potassium to 18 – crown - 6.

3 – 3 – Reaction with acids

Concentrated sulfuric acid reacts with $KMnO_4$ to give Mn_2O_7 which can be explosive . Similarly concentrated hydrochloric acid gives chlorine. The Mn - containing products from redox reactions depend on the pH . Acidic solutions of permanganate are reduced to the faintly pink manganese(II) ion (Mn^{2+}) and water. In neutral solution, permanganate is only reduced by $3e^-$ to give MnO_2 , wherein Mn is in a +4 oxidation state. This is the material that stains one's skin when handling $KMnO_4$. $KMnO_4$ spontaneously reduces in an alkaline solution to green $K_2\ MnO_4$, wherein manganese is in the +6 oxidation state.

A curious reaction occurs upon addition of concentrated sulfuric acid to potassium permanganate. Although no reaction may be apparent, the vapor over the mixture will ignite paper impregnated with alcohol. Potassium permanganate and sulfuric acid react to produce some ozone, which has a high oxidizing power and rapidly oxidizes the alcohol, causing it to combust. As the reaction also produces explosive Mn_2O_7, this should only be attempted with great care.

3 – 4 – Photodecomposition :

Potassium permanganate decomposes when exposed to light :

$$2\ K\ Mn\ O_4 \rightarrow K_2\ Mn\ O_4 + MnO_2\ (s) + O_2$$

3 – 5 – Handling

As an oxidizer that generates the dark brown product MnO_2, potassium permanganate rapidly stains virtually any organic material such as skin, paper, and clothing. This staining effect is used to "develop" TLC plates. The redox reaction is used for artistic purposes as an agent to prepare paper for fast bleaching. Lemon juice is enough to quickly remove colour from the paper and applied with a paint brush this can create interesting aesthetics . Even glassware containing solutions of $KMnO_4$ can become brown. MnO_2 can be removed by scrubbing with dilute acids (a lemon rubbed into the skin works especially well) or with sodium thio sulfate .

4 – Uses :

Almost all applications of potassium permanganate exploit its oxidizing properties. As a strong oxidant that does not generate toxic byproducts, $KMnO_4$ has many niche uses.

Potassium permanganate is one of the principal chemicals used in the film and television industries to "age" props and set dressings. Its oxidizing effects create "hundred year old" or "ancient" looks on hessian cloth , ropes , timber and glass . It was used on props and sets in films such as "Troy", "300" and "Indiana Jones".

4 – 1 – Disinfectant and water treatment :

As an oxidant, potassium permanganate can act as an antiseptic. For example, dilute solutions are used to treat canker sores (ulcers), disinfectant for the hands and treatment for mild pompholyx , dermatitis , and fungal infections of the hands or feet. Potassium permanganate is used extensively in the water treatment industry. It is used as a regeneration chemical to remove iron and hydrogen sulfide (rotten egg smell) from well water via a "Manganese Greensand" Filter. "Pot-Perm" is also obtainable at pool supply stores, is used additionally to treat waste water. Historically it was used to disinfect drinking water . It currently finds application in the control of nuisance organisms such as Zebra mussels in fresh water collection and treatment systems.

4 – 2 – Bio medical uses

Related to the use of $KMnO_4$ for water treatment, this salt is often employed as a specialized disinfectant for treating human and animal ailments. In histology, it is used to bleach melanin which obscures tissue detail. Potassium permanganate can also be used to differentiate amyloid AA from other types of amyloid pathologically deposited in body tissues. Incubation of fixed tissue with potassium permanganate will prevent amyloid AA from staining with congo red whereas other types of amyloid are unaffected . Permanganate washes were once used to treat gonorrhea and are still used to treat candidiasis . It can be used to inactivate the poison strychnine.

4 – 3 – Organic synthesis

Aside from its use in water treatment, the other major application of $KMnO_4$ is as a reagent for the synthesis of organic compounds . Significant amounts are required for the synthesis of ascorbic acid, chloramphenicol , saccharin , iso nicotinic acid, and pyrazinoic acid .

4 – 4 – Fruit preservation :

Addition of potassium permanganate substrata to banana shipments adsorbs the ethylene and doubles the fruit ripening period .

4 – 5 – Survival kits :

Potassium permanganate is typically included in survival kits : as a fire starter , water sterilizer and for creating distress signals on snow .

5 - History

In 1659, Johann Rudolf Glauber fused a mixture of the mineral pyrolusite and potassium carbonate to obtain a material that, when dissolved in water, gave a green solution (potassium manganate) which slowly shifted to violet and then finally red. This report represents the first description of the production of potassium permanganate . Just under two hundred years later London chemist Henry Bollmann Condy had an interest in disinfectants , and marketed several products including *ozonised water*. He found that fusing pyrolusite with NaOH and dissolving it in water produced a solution with disinfectant properties. He patented this solution, and marketed it as *Condy's Fluid*. Although effective, the solution was not very stable. This was overcome by using KOH rather than Na OH. This was more stable, and had the advantage of easy conversion to the equally effective potassium permanganate crystals. This crystalline material was known as *Condy's crystals* or *Condy's powder*. Potassium permanganate was comparatively easy to manufacture so Condy was subsequently forced to spend considerable time in litigation in order to stop competitors from marketing products similar to *Condy's Fluid* or *Condy's Crystals*.

Early photographers used it as a component of flash powder. It is now replaced with other oxidizers, due to the instability of permanganate mixtures. Aqueous solutions of $KMnO_4$ have been used together with T - Stoff (i.e. 80 % hydrogen peroxide) as propellant for the rocket plane Messerschmitt Me 163. In this application, it was known as Z- Stoff. This combination of propellants is sometimes still used in torpedoes.

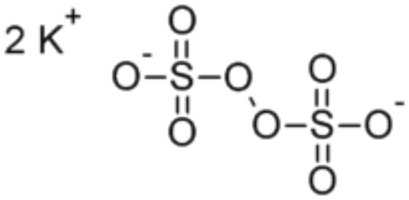
6 - Safety

Solid $KMnO_4$ is a strong oxidizer and thus should be kept separated from oxidizable substances. Reaction with concentrated sulfuric acid produces the highly explosive manganese (VII) oxide (Mn_2O_7). When solid $KMnO_4$ is mixed with pure glycerol or other simple alcohols it will result in a violent combustion reaction.

$$3\ C_3H_5(OH)_3 + 14\ KMnO_4 \rightarrow 14\ MnO_2 + 14\ KOH + 9\ CO_2 + 5\ H_2O$$

Potassium permanganate may leave behind a brownish stain which can be removed by using sodium bi sulfite or oxalic acid.

30 - Potassium Per Sulfate



1 – Introduction :

Potassium per sulfate (also **potassium per oxy di sulfate** or KPS) is an inorganic chemical compound with the Formula ($K_2S_2O_8$)

Other Names : potassium per oxy di sulfate , Anthion , potassium per di sulfate	
Molecular Formula	$K_2 S_2 O_8$
Molar Mass	270 g / mol
Appearance	white powder
Density	2.477 g / cm^3
Melting Point	<100 °C decomp .
Solubility in water	1.75 g / 100 mL (0 °C) 5.29 g / 100 mL (20 °C)
EU classification	Oxidant (O) Harmful (Xn) Irritant (Xi)

2 - Uses

It is a food additive and it is used in organic chemistry as an oxidizing agent for instance in the Elbs per sulfate oxidation, and in hair dye substances as whitening agent with hydrogen peroxide. It takes also an important role as initiator for emulsion polymerization.

3 – Preparation :

Potassium per sulfate can be prepared by electrolysis of a mixture between potassium sulfate and hydrogen sulfate at a high current density.

$$2\ KHSO_4 \rightarrow K_2S_2O_8 + H_2$$

It can also be prepared by adding potassium bisulfate ($KHSO_4$) to an electrolyzed solution of ammonium bisulfate (NH_4HSO_4).

Another reaction of its formation is the following (although the practical use of it outside of clandestine chemistry is doubtable).

$$I_2 + 2KHSO_4 \rightarrow K_2S_2O_6(O_2) + 2HI$$

4 - Precautions :

Conditions / substances to avoid are : heat , flames , ignition sources, powdered metals , phosphorus , hydrides , organic matter, halogens, acids and alkalis .

31 - Potassium Phosphate

Introduction :

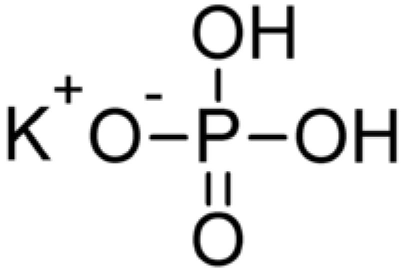
Potassium phosphate is a generic term for the salts of potassium and phosphate ions including :

I) Mono potassium phosphate (KH_2PO_4)

II) Di potassium phosphate (K_2HPO_4)

III) Tri potassium phosphate (K_3PO_4)

I) – Mono Potassium Phosphate



1 – Introduction :

Mono potassium phosphate (also **potassium di hydrogen phosphate**, **KDP**, or **monobasic potassium phosphate**, **MKP**) -- KH_2PO_4 -- is a soluble salt which is used as a fertilizer, a food additive and a fungicide. It is a source of phosphorus and potassium. It is also a buffering agent. When used in fertilizer mixtures with urea and ammonium phosphates, it minimizes escape of ammonia by keeping the pH at a relatively low level.

Fertilizer grade MKP contains the equivalent of 52 % P_2O_5 and 34 % K_2O, and is labeled 0-52-34. MKP is often used as a nutrient source in the greenhouse trade and in hydroponics.

It is one of the components of Gatorade (used as both an emulsifier and pH buffer) and is used as an additive in cigarettes .

At 400°C it decomposes, by loss of water, to potassium meta phosphate (KPO_3)

IUPAC Name : Potassium di hydrogen phosphate	
Other Names : Potassium phosphate monobasic , Phosphoric acid mono potassium salt	
Molecular Formula	$K\,H_2\,PO_4$
Molar Mass	136 g / mol
Appearance	White powder deliquescent

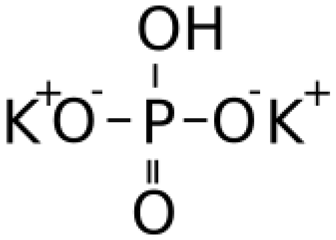
Density	2.338 g / cm^3
Melting Point	252.6 °C
Boiling Point	400 °C , dec
Solubility in water	22 g /100 mL (25°C)
Solubility	insoluble in alcohol
Crystal structure	Tetragonal
Flash Point	Non - flammable

2 - Non linear optics use :

As a crystal, it is noted for its non - linear optical properties. Used in optical modulators and for non - linear optics such as SHG (second-harmonic generation).

Also to be noted is **KD*P**, Potassium dideuterium phosphate, with slightly different properties. Highly deuterated KDP is used in nonlinear frequency conversion of laser light instead of protonated (regular) KDP due to the fact that the replacement of protons with deuterons in the crystal shifts the third overtone of the strong OH molecular stretch to longer wavelengths, moving it mostly out of the range of the fundamental line at ~1,064 nm of neodymium - based lasers. Regular KDP has absorbances at this wave length of around 4.7- 6.3 % / cm of thickness while highly deuterated KDP has absorbances of typically less than 8 % / cm.

II) - Di Potassium Phosphate



1 – Introduction :

Di potassium phosphate (K_2HPO_4) - also phosphoric acid, di potassium salt ; di potassium hydrogen ortho phosphate ; potassium phosphate dibasic - is a highly water - soluble salt which is often used as a fertilizer , food additive and buffering agent. It is a common source of phosphorus and potassium.

The pH of a di potassium phosphate solution is almost neutral. It is formed by the stoichiometric neutralization of phosphoric acid with potassium hydroxide :

$$H_3PO_4 + 2\ KOH \rightarrow K_2HPO_4 + 2\ H_2O$$

It reacts with phosphoric acid to generate monopotassium phosphate :

$$K_2HPO_4 + H_3PO_4 \rightarrow 2\ KH_2PO_4$$

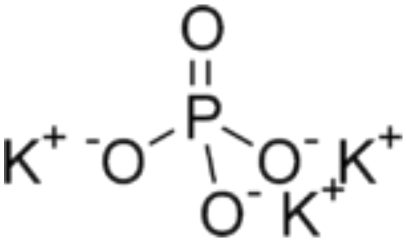
IUPAC Name : Potassium hydrogen phosphate	
Other Names : Potassium mono hydrogen phosphate Phosphoric acid di potassium salt Potassium phosphate dibasic	
Molecular Formula	$K_2\ H\ PO_4$
Molar Mass	174 g / mol
Appearance	white powder deliquescent

Odor	odorless
Density	2.44 g / cm^3
Melting Point	> 465 °C decomp.
Solubility in water	149.25 g /100 mL (20 °C)
Solubility	Slightly soluble in alcohol
Flash Point	Non - flammable

2 - Safety :

As a food additive , Di potassium phosphate is on the FDA's Generally recognized as safe, or GRAS, list of substances . It is used in non - dairy creamers to prevent coagulation .

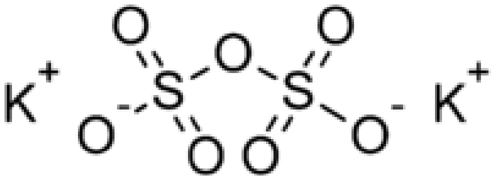
III) - Tri Potassium Phosphate



Tri potassium phosphate is a water - soluble ionic salt which has the chemical Formula K_3PO_4. It is used as a food additive for its properties as an emulsifier , foaming agent and whipping agent . In combination with fatty acids , it is a potential anti microbial agent in poultry processing . As a fertilizer , its proportions of N, P_2O_5 , and K_2O are 0-33-67, making it one of the few fertilizer compounds in which the nutrient percentages have a total of 100 % .

IUPAC Name : Tri potassium phosphate	
Molecular Formula	$K_3 PO_4$
Molar Mass	212 g / mol
Appearance	white powder deliquescent
Density	2.564 g / cm^3
Melting Point	1380 °C
Solubility in water	90 g / 100 mL (20 °C)
Solubility	Insoluble in alcohol
Flash Point	Non - flammable

32 - Potassium Pyro Sulfate



Potassium pyro sulfate (potassium di sulfate) is a chemical compound, $K_2S_2O_7$. It contains the pyro sulfate anion $S_2O_7^{2-}$ which has a dichromate like structure and can be visualized as two corner sharing SO_4 tetra hedra , with a bridging oxygen atom . A semi - structural Formula for pyro sulfate ion is O_3 SO SO_3^{2-}. In this compound sulfur has an oxidation state of +6 .

Potassium pyro sulfate is used in analytical chemistry; samples are fused with potassium pyro sulfate, (or a mixture of potassium pyro sulfate and potassium fluoride , KF) to ensure complete dissolution prior to a quantitative analysis .

It is also used as a catalyst in conjunction with vanadium (V) oxide , for example .

IUPAC Name : Di potassium (sulfonato oxy) sulfonate	
Other Names : Potassium pyro sulphate ; potassium di sulfate	
Molecular Formula	K_2 O_7 S_2
Molar Mass	254 g mol^{-1}
Density	2.28 g / cm^3
Melting Point	325 °C
Solubility in water	soluble

33 - Potassium Silicate

Contents

1 – Introduction ;

Potassium silicate is a water - soluble and glass - forming silicate salt of general Formula $K_2 Si O_3$ with many common uses for at least a century.

Preferred IUPAC Name : Potassium meta silicate	
Other Names : Liquid glass , Water glass	
Molecular Formula	$K_2 O_3 Si$
Molar Mass	154 g mol^{-1}
Exact Mass	154 g mol^{-1}
Appearance	White crystals
EU classification	Corrosive (C), Irritant (Xi)

2 - Uses :

2 – 1 - Wood work protection against fire :

Impregnation of wood with a potassium silicate solution is an easy and low cost way for rendering the wood work of houses secure against catching fire. The wood work is first saturated with a diluted and nearly neutral solution of potash silicate. After drying, one or two coats of a more concentrated solution are usually applied.

2 – 2 - Horticulture :

In horticulture, potassium silicate is used as a soluble source of potassium and makes also the growing medium more alkaline.

2 – 3 - Industrial uses :

Some metal cleaning Formulations use potassium silicate, which also serves as a corrosion inhibitor . It also finds various uses in the fabrication of welding rods or even of cosmetics.

34 - Potassium Sulfate

Contents

1 - Introduction :

Potassium sulfate (K_2SO_4) (in British English **potassium sulphate** , also called **sulphate of potash** , **arcanite**, or archaically known as **potash of sulfur**) is a white crystalline salt which is soluble in water. The chemical is commonly used in fertilizers , providing both potassium and sulfur .

Other Names	Potassium sulphate
Molecular Formula	$K_2\ SO_4$
Molar Mass	174 g / mol
Appearance	White crystalline solid
Density	2.66 g /cm^3
Melting Point	1069 ° C
Boiling Point	1689 °C
Solubility in water	11.1 g / 100 ml (20 °C) 12 g / 100 mL (25 °C) 24 g /100 mL (100 °C)
Solubility	slightly soluble in glycerol insoluble in acetone, alcohol , CS_2
Crystal structure	ortho rhombic

Main hazards	Irritant
LD_{50}	6600 mg / kg

2 - History

Potassium sulfate (K_2SO_4) has been known since early in the 14th century, and it was studied by Glauber , Boyle and Tachenius . In the 17th century it was Named *arcanuni* or *sal duplicatum*, as it was a combination of an acid salt with an alkaline salt. It was also know as *vitriolic tartar*.

3 - Natural resources

The mineral form of potassium sulfate, Namely arcanite, is relatively rare. Natural resources of potassium sulfate are minerals abundant in the Stassfurt salt. These are co crystallizations of potassium sulfate and sulfates of magnesium calcium and sodium . The minerals are

- Kainite , $MgSO_4 \cdot KCl \cdot H_2O$
- Schönite , $K_2SO_4 \cdot MgSO_4 \cdot 6\ H_2O$
- Leonite , $K_2SO_4 \cdot MgSO_4 \cdot 4\ H_2O$
- Langbeinite , $K_2SO_4 \cdot 2MgSO_4$
- Glaserite , $K_3Na(SO_4)_2$
- Polyhalite , $K_2SO_4 \cdot MgSO_4 \cdot 2\ CaSO_4 \cdot 2\ H_2O$

From some of the minerals like kainite, the potassium sulfate can be separated , because the corresponding salt is less soluble in water.

With potassium chloride kieserite $MgSO_4 \bullet 2\ H_2O$ can be transformed and then the potassium sulfate can be dissolved in water.

4 - Manufacture

- Potassium sulfate can be synthesized by the decomposition of potassium chloride with sodium sulfate .

- The Hargreaves method is basically the same process with different starting materials. Sulfur dioxide, oxygen and water (the starting materials for sulfuric acid) are reacted with potassium chloride. Hydrochloric acid evaporates off .

- Potassium Sulfate is produced by mixing the following :

Potassium Chloride and Sulfuric Acid (with molar ratio) .

$2K\ Cl + H_2\ SO_4 \rightarrow 2H\ Cl + K_2\ SO_4$

5 - Properties

The anhydrous crystals form a double six-sided pyramid, but are in fact classified as rhombic . They are transparent, very hard and have a bitter, salty taste . The salt is soluble in water, but insoluble in solutions of potassium hydroxide (sp. gr. 1.35), or in absolute ethanol . It melts at 1078 °C .

6 - Uses

The principal use of potassium sulfate is as a fertilizer. The crude salt is also used occasionally in the manufacture of glass .

7 - Potassium hydrogen sulfate

Potassium hydrogen sulfate or bisulfate , $K\ HSO_4$, is readily produced by mixing $K_2\ SO_4$ with an equivalent no . of moles of sulfuric acid . It forms rhombic pyramids, which melt at 197 °C. It dissolves in three parts of water at 0 °C . The solution behaves much as if its two congeners, $K_2\ SO_4$ and $H_2\ SO_4$, were present side by side of each other uncombined ; an excess of ethanol the precipitates normal sulfate (with little bisulfate) with excess acid remaining .

The behavior of the fused dry salt is similar when heated to several hundred degrees; it acts on silicates , titanates , etc., the same way as sulfuric acid that is heated beyond its natural boiling Point does. Hence it is frequently used in analytical chemistry as a disintegrating agent. For information about other salts that contain

35 - Potassium Sulfide

1 – Introduction :

Potassium sulfide is the inorganic compound with the Formula K_2S. The colorless solid is rarely encountered, because it reacts readily with water, a reaction that affords potassium bi sulfide (KSH) and potassium hydroxide (KOH).

2 - Structure :

It adopts "anti fluorite structure," which means that the small K^+ ions occupy the tetrahedral (F^-) sites in fluorite, and the larger S^{2-} centers occupy the eight - coordinate sites. Li_2S, Na_2S, and Rb_2S crystallize similarly.

3 - Synthesis and reactions

It can be produced by heating K_2SO_4 with carbon (coke) :

$$K_2SO_4 + 4\ C \rightarrow K_2S + 4\ CO$$

In the laboratory, a number of methods exist , K_2S arises from the reaction of potassium and sulfur. In the laboratory, this synthesis is usually conducted by combining a solution of potassium in anhydrous ammonia with elemental sulfur. Another method of making K_2S in laboratory involves the reaction of potassium permanganate and elemental sulfur:

$$2\ KMnO_4 + S \rightarrow K_2S + 2\ MnO_2 + 2\ O_2$$

Sulfide is highly basic, consequently K_2S completely and irreversibly hydrolyzes in water according to the following equation:

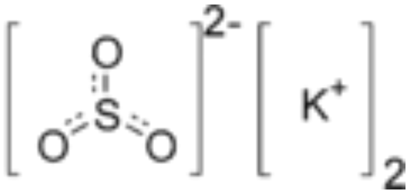
$$K_2S + H_2O \rightarrow KOH + KSH$$

For many purposes, this reaction is inconsequential since the mixture of SH^- and OH^- behaves as a source of S^{2-}. Other alkali metal sulfides behave similarly.

4 - Use in fire works :

Potassium sulfides are formed when black powder is burned and are important intermediates in many pyrotechnic effects, such as senko hanabi and some glitter Formulations .

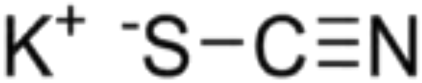
36 - Potassium Sulfite



Potassium sulfite (K_2SO_3) is a chemical compound which is the salt of potassium cation and sulfite anion. As a food additive it is used as a preservative under the E number E225 . It is approved for use in Australia and New Zealand and is not approved in the EU.

IUPAC Name : Potassium sulfite	
Other Names : E225	
Molecular Formula	$K_2 SO_3$
Molar Mass	158 g / mol
Appearance	white solid
Solubility in water	soluble
Flash Point	Non - flammable

37 - Potassium thio cyanate



1 – Introduction :

Potassium thio cyanate is the chemical compound with the molecular Formula KSCN. It is an important salt of the thio cyanate anion, one of the pseudo halides. The compound has a low melting Point relative to most other inorganic salts.

Other Names : Potassium sulfo cyanate Potassium iso thio cyanate Potassium thio cyanide	
Molecular Formula	K S CN
Molar Mass	97 g mol^{-1}
Appearance	Colorless deliquescent crystals
Odor	Odorless
Density	1.886 g / cm^3
Melting Point	173.2 °C
Boiling Point	500 °C (decomp)
Solubility in water	177 g / 100 mL (0 °C) 217 g / 100 mL (20 °C)
Solubility in acetone	21.0 g / 100 mL
EU classification	Harmful (Xn)
LD_{50}	854 mg / kg

2 - Use in chemical synthesis :

Aqueous KSCN reacts almost quantitatively with $Pb(NO_3)_2$ to give $Pb(SCN)_2$, which has been used to convert acyl chlorides to thio cyanates .

KSCN converts ethylene carbonate to ethylene sulfide. For this purpose, the KSCN is first melted under vacuum to remove water. In a related reaction, KSCN converts cyclo hexene oxide to the corresponding epi sulfide.

$$C_6H_{10}O + KSCN \rightarrow C_6H_{10}S + KOCN$$

KSCN is also the starting product for the synthesis of carbonyl sulfide.

3 - Other uses :

Dilute aqueous KSCN is occasionally used for moderately realistic blood effects in film and theater. It can be painted onto a surface or kept as a colorless solution. When in contact with ferric chloride solution (or other solutions containing Fe^{3+}), the product of the reaction is a solution with a blood red colour, due to the formation of the thio cyanato iron complex ion. Thus this chemical is often used to create the effect of 'stigmata'. Because both solutions are colorless, they can be placed separately on each hand. When the hands are brought into contact, the solutions react and the effect looks remarkably like stigmata .

Similarly, this reaction is used as a test for Fe^{3+} in the laboratory.