

ORDER 15. COMPOUND OF ALUMINUM.

Potas'sæ Alu'mino-Sul'phas seu *Alu'men*.—*Alu'mino-Sul'phate of Pot'ash*
or *Al'um*.

HISTORY.—Although the term alum (*alumen* of the Romans—*στυπτηρία* of the Greeks) occurs in the writings of Herodotus (*Euterpe*, clxxx.), Hippocrates (*De fistulis, De ulceribus, &c.*), Pliny (*Hist. Nat.* xxxv.), Dioscorides (*Lib. v. cap. 123*), and other ancient writers, yet it is not satisfactorily proved that our alum was the substance referred to. On the contrary, the learned Beckmann (*Hist. of Invent.* i. 288) has asserted that the alum of the Greeks and Romans was sulphate of iron, and that the invention of our alum was certainly later than the 12th century. But Geber (*Search of Perfection*, ch. iii., and *Invention of Verity*, ch. iv.), who is supposed to have lived in the 8th century, was acquainted with three kinds of our alum, and describes the method of preparing burnt alum; and it is not, I think, improbable, that even Pliny was acquainted with our alum, but did not distinguish it from sulphate of iron, for he tells us that one kind of alum was white, and was used for dyeing wool of bright colours.—[For further information, consult Parkes's *Chemical Essays*, i. 625, and Thomson's *Hist. of Chem.* i. 125].

NATURAL HISTORY.—It is found native in the neighbourhood of volcanoes, and constitutes the mineral called *native alum*. Native alum occurs in bituminous shale and slate clay, at Hurlett, near Paisley, and near Whitby, in Yorkshire.

PREPARATION.—The method of preparing alum varies somewhat in different places. The mineral from which (in this country) it is procured is called *aluminous slate, aluminous shale, or aluminous schist (schistus aluminaris)*. This substance varies somewhat in its composition in different localities, but always contains sulphuret of iron, alumina, carbon, and sometimes a salt of potash. The most extensive alum manufactory in Great Britain is at Hurlett, near Paisley. Here the aluminous schist lies between the stratum of coal and limestone (Williams, *Nat. Hist. of the Mineral Kingdom*, 2nd. ed. ii. 315). By the action of the air it undergoes decomposition, and falls down on the floor of the mine. The sulphur attracts oxygen, and is converted into sulphuric acid, which combines partly with the iron (oxidized by the air), and partly with the alumina. The solution obtained by lixiviating the decomposed schist is evaporated, and the sulphate of iron allowed to crystallize: to the mother liquor, which contains sulphate of alumina, sulphate of potash is added, by which crystals of alum are procured, which are purified by a second crystallization.

At Whitby, in Yorkshire, the method of making alum is somewhat different. The schist is piled in heaps, and burnt by means of a slow smothered fire. The calcined ore is lixiviated, and a salt of potash added to the solution after it has deposited sulphates of lime and iron, and earthy matters (Winter, in *Nicholson's Journal*, vol. xxv.)

PROPERTIES.—Alum crystallizes usually in regular octahedrons, frequently with truncated edges and angles, and sometimes in cubes. The ordinary alum of the shops consists of large crystalline masses, which do

not present any regular geometrical form; but, by immersion in water during a few days, octahedral and rectangular forms are developed in its surfaces. (Daniel, *Quart. Journ.* i. 24.) Alum has an astringent and sweetish acid taste: its reaction on vegetable colours is that of an acid. Its sp. gr. is 1·7. By exposure to the air it slowly and slightly effloresces. Its translucent or diathermanous power is very slight.

When heated, alum undergoes the watery fusion, swells up, gives out its water of crystallization, and becomes a white spongy mass, called *dried* or *burnt alum* (ALUMEN EXSICCATUM, Ph. L., *alumen ustum*), which has a more astringent taste, and does not so quickly dissolve in water as the crystallized salt. If too much heat be applied a portion of the acid is expelled, and escapes, partly as sulphuric acid, partly in the form of oxygen and sulphurous acid, and the residue consists of alumina and sulphate of potash: the acid liquor obtained by heating alum was formerly termed *spirit of alum*. In the preparation of burnt alum care should be taken not to apply too great a heat in order that the acid may not be driven off. On this account a shallow earthen vessel is preferable to a crucible.

When alum is calcined with charcoal or some carbonaceous substance, as sugar, we obtain a spontaneously inflammable substance called *Homburg's Pyrophorus*, composed of sulphur, potassium, alumina, and charcoal.

Alum dissolves in 18 times its weight of cold and less than its own weight of boiling water.

The alum procured at Tolfa and other parts of Italy, and called *Roman alum* (*alumen Romanum*) is covered with a pale, rose-coloured efflorescence, composed of oxide of iron and an aluminous sulphate of potash. Under the name of *Roche* or *Rock alum* (*alumen rufum*, seu *alumen de Rochi*, so called from Roccha, in Syria, whence a red-coloured alum was formerly brought) we find in English commerce crystalline fragments of alum, not larger than almonds, coloured externally with bole or rose-pink.

CHARACTERISTICS.—That alum is a sulphate is shewn by the tests for the soluble sulphates already mentioned (p. 265). It reddens litmus, and forms sulphate of lead when mixed with pure carbonate of lead: in these properties it agrees with the supersulphates. The nature of its basic constituents is shewn by the following tests:—The ferrocyanides, the oxalates, and hydrosulphuric acid, occasion no precipitate in a solution of alum. Hydrosulphuret of ammonia, the caustic alkalies and their carbonates, and phosphate of soda, throw down white precipitates: that produced by the alkalies is soluble in an excess of alkali, but is insoluble in solutions of the carbonated alkalies: these characters shew the presence of alumina. Potash is recognised by perchloric acid and chloride of platinum (vide p. 274.) Lastly, the crystalline form of the salt assists in recognising it.

COMPOSITION.—The composition of alum is as follows:—

	Eq.			Per Cent.			Thomson.	Berzel.	}	or	Eq.			Per Cent.		
	Eq.	Wt.	Per Cent.	Eq.	Wt.	Per Cent.					Eq.	Wt.	Per Cent.			
Alumina	3	54	11·088	11·09	10·76						Sulphate of Alumina	3	174	35·728		
Potash	1	48	9·856	9·86	9·95						Sulphate of Potash..	1	88	18·069		
Sulphuric Acid	4	160	32·854	32·85	33·74						Water	25	225	46·201		
Water	25	225	46·201	46·20	45·55						Cryst ^d . Alumino- Sulph ^e . Potash ..	1	487	99·998		
Cryst ^d . Potash-Alum	1	487	99·999	100·00	100·00											

In the above table I have assumed, with Thomson, Brande, and Phil-

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lips, alumina to be a protoxide of aluminum, and that its equivalent is 18. Berzelius and Turner regard it as a sesquioxide, and adopt 51.4 as its equivalent. According to the views of the latter chemists the equivalent for alum ($\text{K}\ddot{\text{S}} + \text{Al}\ddot{\text{S}}^3 + 25\text{H}$) is 474.95.

PURITY.—Alum should be colourless, completely soluble in water (by which the absence of uncombined earthy matter is shewn), with a solution of caustic potash or ammonia should form a colourless precipitate of hydrate of alumina soluble in excess of alkali, and should not suffer any change of colour by the addition of tincture of nutgalls or hydrosulphuric acid. The ferro-sulphate of potash, sometimes mixed with alum, cannot be distinguished from the latter, by its form, colour, or taste; but is readily detected by potash, which throws down oxide of iron, and by tincture of nutgalls, which communicates a bluish black colour to it.

PHYSIOLOGICAL EFFECTS. (a.) *On vegetables.*—Alum is probably injurious to plants. (Decandolle, *Physiol. Végét.* 1341).

(b.) *On animals.*—Dogs support large doses of alum with impunity. Orfila (*Ann. d'Hyg. Publiq. et de Méd. Lég.* i. 235) gave seven drachms of crystallized alum in powder to dogs: the animals retained it for from ten to thirty minutes, then vomited, and in an hour or two were apparently well. Two ounces of burnt alum in four ounces of cold water occasioned vomiting only. When the œsophagus was tied to prevent vomiting, death took place in five hours with symptoms of great exhaustion and diminished sensibility. On a post-mortem examination the mucous membrane of the stomach was found inflamed in the whole of its extent. One ounce of finely-powdered burnt alum applied to the subcutaneous cellular tissue of the thigh, caused excessive suppuration and death in fifteen hours. Devergie (*Méd. Légale*, ii. 653) found burnt alum somewhat more active: he says $6\frac{1}{2}$ drachms killed a dog when the œsophagus was tied, and 2 ounces when it was not tied. Moreover, he found burnt alum suspended in cold water, more active than when dissolved in warm water. Veterinarians employ it in doses of from 1 to 6 drachms for large animals. Bourgelat has seen a phthisical condition induced in horses by the use of alum in too great quantities. (Moiroud, *Pharm. Vétér.* 225.)

(c.) *On man.*—The immediate topical effect of a solution of alum is that of an astringent, namely, corrugation of fibres and contraction of small vessels, by virtue of which it checks or temporarily stops exhalation and secretion, and produces paleness of parts by diminishing the diameters of the small blood-vessels. It is by these local effects that alum, when taken internally, causes dryness of the mouth and throat, somewhat increases thirst, checks the secretions of the alimentary canal, and thereby diminishes the frequency and increases the consistency of the stools, as observed by Wibmer (*die Wirkung*, &c. i. 114) in his experiments made on himself, with alum in doses of 3 grains dissolved in 5 drachms of water, and taken several times during the day.

But when alum is applied to a part in larger quantities, and for a longer period, the astringent is soon followed by irritation, the paleness by preternatural redness. And thus taken internally in large doses, alum excites nausea, vomiting, griping, purging, and even an inflammatory condition of the intestinal canal,—effects which may be perhaps induced by small quantities in persons endowed with unusual or morbid sensibi-

lity of the stomach and bowels, as in the case of the lady in whom dangerous gastro-enteritis was apparently induced by a single dose of a solution containing between 10 and 20 grains of burnt alum (*Ann. d Hyg. Publique et de Méd. Lég. i.*) Ordinarily, however, tolerably large doses of alum may be given without any unpleasant effects. Thus Professor Dumeril has given a drachm, properly diluted, in chronic diarrhœas, within twenty-four hours: Professor Marc, two drachms, in passive hemorrhages, within the same period of time: and MM. Kapeler and Gendrin have administered 3 drachms, at one dose, in colica pictonum. (Devergie, *Méd. Lég. ii.* 656.)

After its absorption, alum appears to act as an astringent or astringentonic on the system generally, and to produce more or less general astriction of the tissues and fibres, and a diminution of secretion. Such at least appears to be its effects in some passive hemorrhages and mucous discharges. Barbier (*Traité Élément. de Mat. Méd.* 2d ed. i. 440) says alum "irritates the lungs and often provokes cough," but I am not aware of any other practitioner having confirmed this statement. Kraus (*Heilmittellehre*, 255) observes, that the urine becomes remarkably acid from the use of alum.

USES.—Alum is employed both as an external or topical, and as an internal remedy.

(a.) *As a topical remedy.*—Burnt or calcined alum is employed as a very mild *escharotic* to destroy exuberant spongy granulations, commonly known by the name of proud flesh.

Solutions of alum are sometimes employed to produce contraction or corrugation of the tissues, and thereby to prevent displacements of parts, especially when accompanied with excessive secretion. Thus it is used as a gargle in relaxation of the uvula with evident advantage. In the early stage of prolapsus of the rectum, a solution of alum, applied as a wash, is sometimes of service, especially when the disease occurs in infants. Washes or injections containing alum are of occasional benefit in prolapsus of the uterus.

In hemorrhages, whether proceeding from an exhalation or exudation from the extremities or pores of the minute vessels, or from the rupture of a blood-vessel, a solution, or, in some cases, the powder of alum, may be used with advantage as a *styptic*, to constrict the capillary vessels, and close their bleeding orifices. Thus in epistaxis, when it is considered advisable to arrest the hemorrhage, assistance may be gained by the injection of a solution of alum into the nostrils, or by the introduction of lint moistened with the solution. Where this fails to give relief, finely powdered alum may be employed in the manner of snuff. In hemorrhage from the mouth or throat, gargles containing alum are useful. In hæmatemesis, as well as in intestinal hemorrhage, alum whey may be administered, though of course no reliance can be placed on it, as the hemorrhage usually depends on circumstances which astringents merely cannot be expected to obviate. In uterine hemorrhage a sponge soaked in a solution of alum may be introduced into the vagina with good effect. To check the hemorrhoidal flux when immoderate, washes or enemata containing alum may be employed. To stop the bleeding after leech bites in children, a saturated solution, or the powder of alum, may be applied to the punctures.

In certain inflammations, alum has been used as a *repellent*; that is, it

has been applied to the inflamed part in order to produce contraction of the distended vessels, and thereby to diminish the quantity of blood in the seat of the disease in a manner almost mechanical. Thus, in the first stage of ophthalmia, it is sometimes considered expedient to cut short the disease by the application of a strong astringent solution (as a saturated solution of alum or of acetate of lead). "It is not to be denied," observes Dr. Jacob (*Cyclopædia of Prac. Med.* art. *Ophthalmia*), "that such applications may have the effect of arresting the progress of the disease at once; but if they have not that effect, they are liable to produce an increase of irritation." But, as the details necessary for making the student acquainted with all the circumstances respecting the use of stimulating or astringent applications in the first stage of ophthalmia are too lengthened and numerous to admit of their proper discussion in this work, I must refer for further particulars to the essay of Dr. Jacob before quoted, as well as to the treatises of writers on ophthalmic surgery. I may, however, add, that whatever difference of opinion exists as to the propriety of these applications in the first stage of ophthalmia, all are agreed as to their value after the violence of vascular action has been subdued.

In angina membranacea, called by Bretonneau (*Rech. sur l'Inflam. spéc. du Tissu Muqueux*, 1826) diphtheritis, great importance has been attached to the employment of local applications. Of these hydrochloric acid, calomel, and alum, have, in succession, been highly praised by this writer. In order to promote the expulsion of the false membrane, he recommends the insufflation of finely-powdered alum. This is effected by placing a drachm of it in a tube, and blowing it into the throat. (See also Trousseau and Pidoux, *Traité de Thérap.* ii. 291). Velpeau has subsequently confirmed the statements of Bretonneau, and extended the use of alum to other inflammatory affections of the throat, as those arising in scarlatina, small-pox, &c. In these cases powdered alum may be applied to the affected parts by means of the index finger. Gargles containing this salt will be found useful in most kinds of sore throat, ulcerations of the mouth and gums, aphtha, &c. In inflammation of the vulva, accompanied with membraniform exudation, alum washes are serviceable both in children and adults (Trousseau and Pidoux, *op. cit.*)

Alum has been employed as an *astringent*, to diminish or stop excessive secretion from the mucous surfaces. Thus, a weak solution of this salt is used to repress the discharge in the latter stages of conjunctival inflammation; to check profuse ptyalism, whether from the use of mercury or other causes; and to remove gleet or leucorrhœa. In old-standing diarrhœas it has been administered, in combination with the vegetable astringents (kino, for example), with occasional advantage. It is also applied to check profuse secretion from ulcers.

(b.) *As an internal remedy.*—Alum has been employed, in conjunction with nutmeg, as a remedy for intermittents. Given just before the expected paroxysm, it has in some cases prevented it (Cullen, *Materia Medica*).

In the treatment of *lead colic*, alum has been found more successful than any other agent or class of remedies. It was first used in this disease by a Dutch physician, named Grashuis (*De Colica Pictonum*, Amst. 1752, et *Append.* 1755), and was afterwards administered in fifteen cases by Dr. Percival (*Essays, Med. & Exper.* ii. 194) with great success.

Its efficacy has been fully established by Kapeler, physician to the Hôpital St.-Antoine, in Paris, and Gendrin (quoted by Trousseau and Pidoux, *op. cit.*) and by Dr. Copland (*Dict. of Med.* i. 374), as well as by several other distinguished authorities. It allays vomiting, abates flatulence, mitigates pain, and opens the bowels more certainly than any other medicine, and frequently when other powerful remedies have failed. It should be given in full doses (as from a scruple to two drachms), dissolved in some demulcent liquid (as gum-water) every three or four hours. Opium and (according to Dr. Copland) camphor may be advantageously conjoined. Kapeler also employs oleaginous enemata. The *modus operandi* of alum in lead colic is not very clear. The benefit has been ascribed by some to the chemical action of the sulphuric acid on the lead supposed to be contained in the intestines; and in support of this view must be mentioned the fact, that other sulphates (as those of magnesia, soda, zinc, and copper) as well as free sulphuric acid, have been successfully employed in lead colic. But, on the other hand, the presence of lead in the primæ viæ or evacuations, and, consequently, the formation of sulphate of lead in saturnine colic, have not been demonstrated; though the experiments of Dr. C. G. Mitscherlich (*Müller's Archiv*, No. V. 353, 1836, quoted in *Brit. Ann. of Med.* vol. i. 204, 1837) have shown, that when the acetate of lead is swallowed, the greater part of it forms an insoluble combination with the gastrointestinal mucus, and in this state may remain some time in the alimentary canal. Moreover, alum has been found successful by Kopp (*Denkwürdigkeit*, i. 342, quoted by G. A. Richter, *ausführ. Arzneim.* Suppl. Bd. 515) in other varieties of colic not caused by lead, and unaccompanied by constipation. Dr. Copland is disposed to ascribe the benefit of alum, and other sulphates in lead colic, to their "exciting the action of the partially paralysed muscular coat of the bowels, and thereby enabling them to expel retained matters of a morbid or noxious description,"—an explanation which is inconsistent with the observation of Kopp just quoted.

Alum is administered internally in several other diseases, of which a brief notice only can be given. In passive or asthenic hemorrhages from distant organs; as hæmoptysis, menorrhagia and other uterine hemorrhages, hæmaturia, &c. In colliquative sweating, diabetes, gleet, and leucorrhœa. Kreysig (*Die Krankh. d. Herzens*, Bd. ii. Abt. 2, S. 714, in Richter, *op. cit.*) has advised its use in dilatation of the heart and aortic aneurism. More recently Dzondi (*Aeskulap.* Bd. I, St. 1, 1821, in Richter) has also recommended it in these diseases; and Sundelin (*Heilmittellehre*, ii. 278) has mentioned a case of supposed dilatation of the heart, in which relief was gained by the use of alum. In chronic diarrhœa, alum is occasionally serviceable.

ADMINISTRATION.—The dose of alum is from ten grains to one or two scruples. It may be taken in the form of powder, or made into pills with some tonic extract, or in solution. To prevent nausea, an aromatic (as nutmeg) should be conjoined. A pleasant mode of exhibition is in the form of *alum whey* (*serum aluminosum*, seu *serum lactis aluminatum*), prepared by boiling two drachms of powdered alum with a pint of milk, then straining: the dose is a wine-glassful. The *saccharum aluminatum* of the Prussian Pharmacopœia is composed of equal parts of white sugar and alum: it may be given to children as well as adults. In prescribing

alum, it is to be recollected that the vegetable astringents decompose it; by which the astringent property of the mixture is probably diminished.

For topical uses, alum is used in the form of powder, solution, and poultice. The powder of burnt alum is sprinkled over ulcers, to destroy spongy granulations. Powder of crystallized alum is applied to the mouth and throat as before mentioned. Solutions of alum are made, for topical purposes, of various strengths, according to the object in view.

The *CATAPLASMA ALUMINIS*, Ph. Dub. (*Alum curd of Riverius, Albumen Aluminosum*) is prepared by shaking the whites of two eggs with a drachm of alum. "In cases of chronic and purulent ophthalmia, it is applied to the eye between two folds of old linen. It has been praised as a good application to chilblains which are not broken" (Barker and Montgomery's *Observations on the Dub. Pharm.*)

The *LIQUOR ALUMINIS COMPOSITUS*, Ph. L. (*Aqua aluminosa Ba-teana, or Bates's alum water*) consists of alum, sulphate of zinc—each an ounce; boiling water, three pints: dissolve and strain. It is used as a detergent and astringent wash in old ulcers; when diluted, as a collyrium in mild conjunctival inflammation, as an injection in gleet and leucorrhœa, and as an application to chilblains and slight excoriations.

ANTIDOTE.—In a case of poisoning by alum, let the contents of the stomach be immediately evacuated. Promote vomiting by the use of tepid diluents. The inflammatory symptoms are to be combated by the usual antiphlogistic means. Magnesia has been employed, but is said by Devergie to be altogether useless.

ORDER 16. COMPOUNDS OF ARSENICUM.

Ac'idum Arsenio'sum.—Arse'nious Ac'id.

HISTORY.—Arsenious acid, commonly termed *white arsenic* (*arsenicum album*) or *oxide of arsenic*, is first distinctly mentioned by Geber (*Invent. of Verity*, ch. vii.), who seems to have been also acquainted with metallic arsenic (*Sum of Perfection*, book i. part iv. ch. ii.) Hippocrates (*De Ulceribus*) employed ἀρρηνικόν (*orpiment* or *sesquisulphuret of arsenicum*) and σανδαράκη (*realgar* or *sulphuret of arsenicum*) as topical remedies. Dioscorides (lib. v., cap. xxi.) is the first author who uses the word ἀρσενικόν (*orpiment*).

NATURAL HISTORY.—Arsenious acid occurs only in the mineral kingdom. It is rather a rare mineral, and is found at Andreasberg, in the Hartz; at Joachimsthal, in Bohemia; and at some few other places.

PREPARATION.—It is prepared in Silesia, Bohemia, Saxony, and Cornwall.

At Altenberg it is obtained from arsenical iron (*Mispickel*), a compound of arsenicum, iron, and sulphur. After being reduced to powder the ore is roasted in a muffle furnace (fig. 56), by which the arsenicum is converted into arsenious acid. This is conveyed in the state of vapour, called *flowers of arsenic* or *smeltinghouse-smoke* (*Hüttenrauch*), into the condensing chamber (fig. 57), where it is deposited in a pulverent form, and in this state is called *rough arsenious acid*, or *poison-flour* (*Giftmehl*).

The rough arsenious acid is refined by sublimation. This is effected in cast-iron pots, as shown in fig. 58, p. 376, to which cylindrical iron