

## CLASSICS OF SCIENCE:

## Isolation of Potassium

Chemistry

THE DECOMPOSITION OF THE FIXED ALKALIES AND ALKALINE EARTHS, by Humphry Davy. Published by the Alembic Club, Edinburgh, 1807-1808. *On the Methods Used for the Decomposition of the Fixed Alkalies*

The researches I had made on the decomposition of acids, and of alkaline and earthy neutral compounds, proved that the powers of electrical decomposition were proportional to the strength of the opposite electricities in the circuit, and to the conducting power and degree of concentration of the materials employed.

In the first attempts that I made on the decomposition of the fixed alkalies, I acted upon aqueous solutions of potash and soda, saturated at common temperatures, by the highest electrical power I could command, and which was produced by a combination of VOLTAIC batteries belonging to the Royal Institution, containing 24 plates of copper and zinc of 12 inches square, 100 plates of 6 inches, and 150 of 4 inches square, charged with solutions of alum and nitrous acid; but in these cases, though there was a high intensity of action, the water of the solutions alone was affected, and hydrogen and oxygen disengaged with the production of much heat and violent effervescence.

The presence of water appearing thus to prevent any decomposition, I used potash in igneous fusion. By means of a stream of oxygen gas from a gasometer applied to the flame of a spirit lamp, which was thrown on a platina spoon containing potash, this alkali was kept for some minutes in a strong red heat, and in a state of perfect fluidity. The spoon was preserved in communication with the positive side of the battery of the power of 100 of 6 inches, highly charged; and the connection from the negative side was made by a platina wire.

By this arrangement some brilliant phenomena were produced. The potash appeared a conductor in a high degree, and as long as the communication was preserved, a most intense light was exhibited at the negative wire, and a column of flame, which seemed to be owing to the development of combustible matter, arose from the point of contact.

When the order was changed, so



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that the platina spoon was made negative, a vivid and constant light appeared at the opposite point: there was no effect of inflammation round it; but aeriform globules, which inflamed in the atmosphere, rose through the potash.

The platina, as might have been expected, was considerably acted upon; and in the cases when it had been negative, in the highest degree.

The alkali was apparently dry in this experiment; and it seemed probable that the inflammable matter arose from its decomposition. The residual potash was unaltered; it contained indeed a number of dark grey metallic particles, but these proved to be derived from the platina.

I tried several experiments on the electrization of potash rendered fluid by heat, with the hopes of being able to collect the combustible matter, but without success; and I only attained my object by employing electricity as the common agent for fusion and decomposition.

Though potash, perfectly dried by ignition, is a non-conductor, yet it is rendered a conductor by a very slight addition of moisture, which does not perceptibly destroy its aggregation; and in this state it readily fuses and decomposes by strong electrical powers.

A small piece of pure potash, which had been exposed for a few seconds to the atmosphere, so as to give conducting power to the surface, was placed upon an insulated disc of

platina, connected with the negative side of the battery of the power of 250 of 6 and 4, in a state of intense activity; and a platina wire, communicating with the positive side, was brought in contact with the upper surface of the alkali. The whole apparatus was in the open atmosphere.

Under these circumstances a vivid action was soon observed to take place. The potash began to fuse at both its points of electrization. There was a violent effervescence at the upper surface; at the lower, or negative surface, there was no liberation of elastic fluid; but small globules having a high metallic lustre, and being precisely similar in visible characters to quicksilver, appeared, some of which burnt with explosion and bright flame, as soon as they were formed, and others remained, and were merely tarnished, and finally covered by a white film which formed on their surfaces.

These globules, numerous experiments soon shewed to be the substance I was in search of, and a peculiar inflammable principle the basis of potash. I found that the platina was in no way connected with the result, except as the medium for exhibiting the electrical powers of decomposition; and a substance of the same kind was produced when pieces of copper, silver, gold, plumbago, or even charcoal were employed for completing the circuit.

The phenomenon was independent of the presence of air; I found that it took place when the alkali was in the vacuum of an exhausted receiver.

The substance was likewise produced from potash fused by means of a lamp, in glass tubes confined by mercury, and furnished with hermetically inserted platina wires by which the electrical action was transmitted. But this operation could not be carried on for any considerable time; the glass was rapidly dissolved by the action of the alkali, and this substance soon penetrated through the body of the tube.

Soda, when acted upon in the same manner as potash, exhibited an analogous result; but the decomposition demanded greater intensity of action in the batteries, or the alkali was required to be in much thinner and smaller pieces. With the battery of 100 of 6 inches in full activity I obtained good re- (Turn to next page)

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sults from pieces of potash weighing from 40 to 70 grains, and of a thickness which made the distance of the electrified metallic surfaces nearly a quarter of an inch; but with a similar power it was impossible to produce the effects of decomposition on pieces of soda of more than 15 or 20 grains in weight, and that only when the distance between the wires was about 1-8 or 1-10 of an inch.

The substance produced from potash remained fluid at the temperature of the atmosphere at the time of its production; that from soda, which was fluid in the degree of heat of the alkali during its formation, became solid on cooling, and appeared having the lustre of silver.

When the power of 250 was used, with a very high charge for the decomposition of soda, the globules often burnt at the moment of their formation, and sometimes violently exploded and separated into smaller globules, which flew with great velocity through the air in a state of vivid combustion, producing a beautiful effect of continued jets of fire.

### *Theory of the Decomposition of the Fixed Alkalies; Their Composition and Production*

As in all decompositions of compound substances which I had previously examined, at the same time that combustible bases were developed at the negative surface in the electrical circuit, oxygene was produced, and evolved or carried into combination at the positive surface, it was reasonable to conclude that this substance was generated in a similar manner by the electrical action upon the alkalies; and a number of experiments made above mercury, with the apparatus for excluding external air, proved that this was the case.

When solid potash, or soda in its conducting state, was included in glass tubes furnished with electrified platina wires, the new substances were generated at the negative surfaces; the gas given out at the other surface proved by the most delicate examination to be pure oxyene; and unless an excess of water was present, no gas was evolved from the negative surface.

In the synthetical experiments, a perfect coincidence likewise will be found.

I mentioned that the metallic lustre of the substance from potash immediately became destroyed in the atmosphere, and that a white crust

formed upon it. This crust I soon found to be pure potash, which immediately deliquesced, and new quantities were formed, which in their turn attracted moisture from the atmosphere till the whole globule disappeared, and assumed the form of a saturated solution of potash.\*

When globules were placed in appropriate tubes containing common air or oxygene gas confined by mercury, an absorption of oxygene took place; a crust of alkali instantly formed upon the globule; but from the want of moisture for its solution, the process stopped, the interior being defended from the action of the gas.

With the substance from soda, the appearances and effects were analogous.

When the substances were strongly heated, confined in given portions of oxygene, a rapid combustion with a brilliant white flame was produced, and the metallic globules were found converted into a white and solid mass, which in the case of the substance from potash was found to be potash, and in the case of that from soda,

Oxygene gas was absorbed in this operation, and nothing emitted which affected the purity of the residual air.

The alkalies produced were apparently dry, or at least contained no more moisture than might well be conceived to exist in the oxygene gas absorbed; and their weights considerably exceeded those of the combustible matters consumed.

### *On the Properties and Nature of the Basis of Potash*

After I had detected the bases of the fixed alkalies, I had considerable difficulty to preserve and confine them so as to examine their properties, and submit them to experiments; for, like the *alkahests* imagined by the alchemists, they acted more or less upon almost every body to which they were exposed.

The fluid substance amongst all those I have tried, on which I find they have least effect, is recently distilled naphtha.—In this material, when excluded from the air, they remain for many days without considerably

\*Water likewise is decomposed in the process. We shall hereafter see that the bases of the fixed alkalies act upon this substance with greater energy than any other known bodies. The minute theory of the oxydation of the bases of the alkalies in the free air, is this:—oxygene gas is first attracted by them, and alkali formed. This alkali speedily absorbs water. This water is again decomposed. Hence, during the conversion of a globule into alkaline solution, there is a constant rapid disengagement of small quantities of gas.

changing, and their physical properties may be easily examined in the atmosphere when they are covered by a thin film of it.

The basis of potash at 60° FAHRENHEIT, the temperature in which I first examined it, appeared, as I have already mentioned, in small globules possessing the metallic lustre, opacity, and general appearance of mercury; so that when a globule of mercury was placed near a globule of the peculiar substance, it was not possible to detect a difference by the eye.

At 60° FAHRENHEIT it is however only imperfectly fluid, for it does not readily run into a globule when its shape is altered; at 70° it becomes more fluid; and at 100° its fluidity is perfect, so that different globules may be easily made to run into one. At 50° FAHRENHEIT it becomes a soft and malleable solid, which has the lustre of polished silver; and at about the freezing point of water it becomes harder and brittle, and when broken in fragments, exhibits a crystallized texture, which in the microscope seems composed of beautiful facets of a perfect whiteness and high metallic splendour.

To be converted into vapour, it requires a temperature approaching that of the red heat; and when the experiment is conducted under proper circumstances, it is found unaltered after distillation.

It is a perfect conductor of electricity. When a spark from the VOLTAIC battery of 100 of 6 inches is taken upon a large globule in the atmosphere, the light is green, and combustion takes place at the point of contact only. When a small globule is used, it is completely dissipated with explosion accompanied by a most vivid flame, into alkaline fumes.

It is an excellent conductor of heat.

When water is made to act upon the basis of potash out of the contact of air and preserved by means of a glass tube under naphtha, the decomposition is violent; and there is much heat and noise, but no luminous appearance, and the gas evolved when examined in the mercurial or water pneumatic apparatus is found to be pure hydrogene.

When a globule of the basis of potash is placed upon ice it instantly burns with a bright flame, and a deep hole is made in the ice, which is found to contain a solution of potash.