XVI. A new method of analysing the ores of iron, and crude iron

Professor Fuchs

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it in a retort until vapours of sulphuric acid pass over, whereby there is at the same time the advantage of having an acid of 1.85 sp. gr.

In the distillation of sulphuric acid several precautions have been proposed to avoid the sudden jerks (*stossweise*) in the boiling of the acid, yet most of them are by cautious equal heating, even the platina wire, unnecessary, and I have at last even distilled without this over an open fire, without ever meeting with an accident. But it is very necessary that the neck of the retort is not too long and is as broad as possible, and that the receiver does not lie immediately on the neck of the retort, but is separated from it by a platina wire, and that an equal fire be kept up, which is best attained by using charcoal. The retort is filled two-thirds with sulphuric acid, placed with the usual precautions in the sand bath, and at first a good fire kept up until strong vapours ascend from the acid; the fire is then diminished, and the acid comes to boil gently. Care should be taken, by keeping up an equal fire, that the acid does not cease boiling; should this happen, it is not necessary to interrupt the distillation, but the fire must be cautiously increased, that the acid may not enter suddenly into a too violent ebullition.

XVI. *A new Method of analysing the Ores of Iron, and Crude Iron.* By Professor FUCHS*.

THIS process is founded upon the fact, that hydrochloric acid is incapable of dissolving metallic copper, provided the air be excluded; but if a piece of copper be put into a solution of a persalt of iron in hydrochloric acid, the persalt is converted into a protosalt, and a quantity of copper is dissolved, forming a protosalt of copper exactly equivalent to the quantity of peroxide of iron contained in the solution.

Into a solution of peroxide of iron in hydrochloric acid put a piece of copper, whose weight is accurately known; boil it well until no more copper is dissolved; weigh the undissolved copper after having cleaned and dried it, and thus ascertain how much copper has been dissolved. The quantity of peroxide of iron contained in the solution is to that of the copper dissolved as their respective equivalents, viz. as 40 to 31.7. Therefore if 31.7 copper be dissolved, it indicates 40 as the quantity of peroxide of iron originally contained in solution.

When the peroxide and protoxide are both present, two experiments are necessary to determine their respective quan-

* Extracted from the Transactions of the Royal Bavarian Academy.

tities. The quantity of peroxide is ascertained in the manner just indicated. To determine the quantity of protoxide the whole of the iron must be brought into the state of peroxide, and from the amount of the peroxide thus obtained must be deducted the quantity of peroxide in the first experiment, and the remainder reduced to the protoxide by calculation.

The following precautions must be observed in order to obtain accurate results. The copper must be in a state of purity. The hydrochloric acid must be also pure, tolerably concentrated, and employed in excess. Nitric acid should not be used for bringing the iron to the state of peroxide, but either a stream of chlorine, or what is preferable, chlorate of potash. Upon adding the piece of copper to the solution it must immediately be brought to the boiling point, and kept there in order to prevent access of air. Previously to removing the undissolved copper from the solution, hot water is to be added till the vessel is quite full; this is to be poured off and fresh hot water to be added: the copper, which is generally covered with a brownish coating, is then carefully washed in cold water, dried at a gentle heat, and then weighed. The foregoing process has this advantage; that the substances ordinarily met with in iron ores,—such as silica, alumina, magnesia, lime, oxide of titanium, oxides of manganese, the phosphoric and sulphuric acids, &c.—do not in any way interfere with the accuracy of the results. An iron ore containing arsenic, however, cannot be analysed on this principle, as blackish gray scales of arseniuret of copper are deposited on the metallic copper.

This process is applicable to the examination of cast iron, or iron of other kinds, and also for the comparison of one sort of iron with another.

Among many experiments which were made, M. Fuchs relates the following.

Exp. 1. 50 grains of very soft English iron were dissolved in hydrochloric acid, and brought to the state of peroxide by chlorate of potash; 85·8 grains of pure copper were boiled in this solution, of which 56·2 grains were dissolved. Therefore as $31\cdot7 : 28 :: 56\cdot2 : 49\cdot46$, which is equal to 98·92 per cent. of pure iron; a repetition of this experiment gave 99·19 per cent.

Exp. 2. 50 grains of pianoforte wires were examined, which indicated 98·75 per cent. of pure iron. The iron in this experiment was peroxidized by a current of chlorine; a considerable deposit of carbon was formed during the process of solution in hydrochloric acid, which, however, disappeared upon passing chlorine through the solution.

Exp. 3. 50 grains of gray and white cast iron from Bergen were examined, and gave 94·33 per cent. of pure iron: the impurities, on examination, were found to consist of

Carbon ... 3·43
Silica 1·75
Phosphorus 0·37
Sulphur ... 0·12.

———— 5·67

Exp. 4. 70 grains of crystallized carbonate of iron from Lobenstein, examined, gave equal to 56·9 per cent. of protoxide, equivalent to 91·68 per cent. of carbonate of the protoxide; the other constituents consisted of carbonate of the protoxide of manganese and carbonate of lime and magnesia.

Exp. 5. 70 grains of specular iron ore from Gleissing in the Fichtelgebirge, gave upon examination a quantity equal to 92·30 per cent. of peroxide of iron, and 7·40 per cent of silica, leaving only a loss of 0·3 per cent.

Exp. 6. Crystallized magnetic iron, containing both protoxide and peroxide, was next examined. 50 grains were dissolved in hydrochloric acid, to which chlorate of potash was added to bring the whole of the iron to the state of peroxide. 40·71 grains of copper were dissolved, which is equivalent to 51·36 of peroxide of iron, or 102·72 per cent. Another portion of 50 grains was dissolved without the addition of chlorate of potash; the copper taken up was only 27·1 grains, equivalent to 34·2 grains of peroxide of iron, or 68·4 per cent.; this deducted from 102·72 indicated by the first 50 grains, gives 34·32, corresponding to 30·88 protoxide of iron: consequently this mineral gave 68·40 peroxide of iron

30·88 protoxide of iron
0·72 loss.

————
100·00

This process is applicable in many instances to the determination of the quantity of copper contained in ores of that metal.

The ore of copper is to be dissolved in hydrochloric acid, care being taken that the whole of the copper is converted into oxide or chloride; the solution is then to be boiled with copper (the necessary precautions having been first duly observed), until it assumes a pale olive-green tint, and becomes colourless on being diluted with water. If no oxide of iron be present, precisely the same quantity of copper will be transferred to the solution as was originally contained therein; the quantity of copper remaining is to be subtracted from the quantity of reguline copper employed in the experiment, in

order to ascertain the amount of copper contained in the copper ore examined. 100 grains of pure malachite were examined in this manner, and gave equal to 57·5 of pure copper, which is very nearly the quantity that should be obtained ; had the quantity of copper dissolved proved considerably less, it would have shown that the malachite was not in a state of purity.

XVII. *On the Electricity of Steam*. By JOHN WILLIAMS, Esq.
To the Editors of the *Philosophical Magazine and Journal*.

GENTLEMEN,

EARLY in November last, I read in your Journal a communication from Mr. Armstrong, of Newcastle-upon-Tyne, on the subject of the electricity observed in a jet of steam issuing from the boiler of a high-pressure steam engine*. I felt much interested on reading this account, as I doubt not that it will eventually lead to some valuable discoveries relative to meteorology and atmospherical electricity, subjects which have occupied much of my attention for more than forty years past.

Volta's experiment of dropping a red-hot coal into a vessel of water placed on the insulated cap of an electrometer, was repeated by me in various ways and on a large scale ; and from the results, I came to a conclusion that the positive electricity observed in the steam-cloud on its *immediate formation* was simply the effect of evaporation, and not, as some electricians have supposed, of a decomposition of the water into its primitive elements. And I imagine, that when steam under great pressure, and, consequently, of a high temperature, is liberated, and in the act of expanding and mixing with atmospheric air, it has its capacity for electricity increased ; and that a similar process is continually in action in the ordinary course of evaporation from the surfaces of water, leaves of vegetables, and moist soil, with this difference ; that in the latter natural processes the resulting electricity of the rising vapour is of low intensity, and not discoverable by our ordinary electrometers.

These reflections led me to the consideration of the cause of volcanic lightning, and particularly of the shape generally assumed by the enormous cloud of smoke, as described by Sir William Hamilton on viewing an eruption of Vesuvius.

* [Papers on this subject have appeared in our Numbers for November, December, and January ; vol. xvii. p. 370, 375, 449, 452, and 457 ; present volume, p. 14, 50, and 95.—*EDIT.*]