



## XII. The action of dried hydrochloric-acid gas on iceland spar

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inch. After the elevator has been started the supply of water may be reduced till just sufficient to raise the mercury. The quantity of water then used to keep it going is very small. I may add, in conclusion, that the air-compressor is also used in the laboratory for supplying a blowpipe and small gas-furnace, and other lecture-apparatus in which compressed air is required.

Oxford, June 11, 1892.

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XII. *The Action of Dried Hydrochloric-Acid Gas on Iceland Spar.* By R. E. HUGHES, *B.Sc., Scholar of Jesus College, Oxford,* and F. R. L. WILSON, *B.A., Scholar of Keble College, Oxford* \*.

KOHLRAUSCH asserts that all pure substances are electrolytes, and if the assumption of Ostwald be true that chemical reactions take place only between the electrolytic ions, it follows that no reactions are possible between pure substances, and only become possible in the presence of some body which is capable of producing the electrolytic dissociation.

Inasmuch as the majority of chemical reactions take place in the presence of water or some other solvent, and since the experiments of Dixon on the explosion of mixtures of dried gases, Wanklyn on the action of dry chlorine on metals, Baker on the combustion of dry substances, and Veley on the action of dry sulphuretted hydrogen on oxide of calcium, prove that the presence of water is an essential condition for these reactions to take place, it seemed an interesting question to determine whether dried hydrochloric-acid gas is capable of displacing carbon dioxide from carbonates.

Therefore, at the suggestion of Mr. V. H. Veley, M.A., we have undertaken an investigation with this object in view.

It must be mentioned that the action of liquefied hydrochloric acid on various carbonates has been investigated by Gore, as a result of which he found that, with the exception of calcium carbonate, all the carbonates investigated showed a more or less complete conversion into the chlorides.

Wiedemann, in the British Association Report for 1887, states that "Dr. Gore has shown that if you put anhydrous liquefied hydrochloric acid upon carbonate of lime, the carbonic acid is chased away and calcium chloride is formed"; but what evidence there is for such a statement we are at a loss to determine.

\* Communicated by Professor Odling, F.R.S.

We wish it to be distinctly understood that these experiments are only of a preliminary character, and that the method adopted for drying this exceedingly hygroscopic gas was probably not sufficient to insure absolute freedom from moisture.

The apparatus which was used in these investigations was as follows :—

To two of the branches of a three-way tube were attached respectively a Kipps' apparatus for the production of carbon dioxide, and a flask in which was generated the hydrochloric acid (the hydrochloric acid being made either from concentrated sulphuric acid and sodium chloride or by dropping concentrated sulphuric acid into a saturated solution of hydrochloric acid in water). The current of gas was regulated by means of stopcocks.

The gas passing from the three-way tube bubbled through concentrated sulphuric acid, whence it was conducted through the purifying and drying apparatus, which was made up of, firstly, a tube filled with copper turnings to remove any chlorine that might be present, next through four straight tubes containing small lumps of pumice moistened with concentrated sulphuric acid previously boiled, each of which tubes was about a foot in length, then it passed through two tubes containing pumice and phosphorus pentoxide, of lengths respectively 6 and 18 inches.

Finally, the gas was led through a series of four pentoxide bulbs, to which was attached the experimental tube contained in an air-bath, beyond which was placed a drying-tube of calcium chloride; the issuing gas was passed into a wash-bottle containing sodium hydrate.

The method of experiment was this :—

Carbon dioxide having been passed through the apparatus for a sufficient length of time to remove the air, the experimental tube, being maintained at a temperature of about 130° Centigrade, was sealed and weighed.

The tube was replaced, the ends were cut off, and a stream of hydrochloric-acid gas was passed through for about an hour; the current of hydrochloric-acid gas was then stopped and carbon dioxide was driven through to remove the hydrochloric acid. It was, however, found so difficult to remove the hydrochloric acid from the sulphuric-acid drying-tubes, that these were replaced by a series of calcium-chloride tubes, with the result that in a short time the last traces of hydrochloric acid were removed.

The tube was again sealed, it having been raised to a temperature of about 130° Centigrade before sealing. It was then weighed together with the ends previously cut off.

Experiments were undertaken at the temperature of the laboratory and at about 100° Centigrade.

The weight of the Iceland spar taken in an experiment conducted at the temperature of the laboratory was

·8705 gram.

The weight after the passage of the hydrochloric-acid gas was

·8712 gram.

The difference shows an increase of weight equal to

·0007 gram,

or a percentage increase of ·08.

Another experiment, conducted at the temperature of 95°–110° Centigrade, gave the following results:—

The weight of Iceland spar taken . . . . . = ·6196 gram.

The weight after passage of hydrochloric-

acid gas . . . . . = ·62025,

which shows an increase . . . . . = ·00065,

or a percentage increase . . . . . = ·1.

The theoretical increase is 29 per cent.

In order to compare our experiments with the dried gas with the case in which the gas was not dry, the hydrochloric acid before passing over the carbonate was caused to take up moisture by passing through a tube in which moist glass wool had been placed. This showed a very considerable action, and the numbers are as follows:—

The weight of calcium carbonate taken . = ·68735 gram.

The weight of the carbonate after the

passage of the hydrochloric-acid gas = ·70735.

The increase shown is . . . . . ·02.

Comparing this experiment with moist hydrochloric acid with those in which the dried gas was used, we find that if the action on the carbonate when moist hydrochloric-acid gas was used be 100, then the action on the carbonate when dried hydrochloric-acid gas was used becomes 2·66 and 3.

If a piece of dry blue litmus-paper was placed in the tube through which the dried gas was passing, no change of colour was observed; but if the gas was allowed to take up a small quantity of moisture, then an immediate change to a red colour was noticed.

Glacial acetic acid was shown by Marsh to have no action on litmus, and Gore showed the same for the liquefied dried hydrochloric acid.

An experiment was undertaken on the action of dried hydrochloric-acid gas on witherite at the temperature of the laboratory.

The conditions of the experiment were the same as those under which the experiments with calcium carbonate were made.

The weight of barium carbonate (witherite) used was  
 ·9976.

The weight after the passage of dried hydrochloric-acid gas  
 was ·9984,  
 which shows an increased weight of  
 ·0008,  
 or a percentage increase in weight of  
 ·08,

whereas the theoretical increase is 14·7 per cent.

Thus the action of dried hydrochloric-acid gas on witherite is nearly double the amount of its action on Iceland spar.

The specimen of witherite used was fairly pure, but in performing further experiments on the carbonate of barium the precipitated pure carbonate will be used. Incidentally it was noticed that the dried gas had no action upon cellulose, whereas a moistened filter-paper placed in the current of the gas became rapidly converted into a gum-like mass which was probably hydrocellulose.

In conclusion, we wish to point out that the variations in weight which we observed were so minute that no definite assertion can be made of an action having taken place; and the slight variations observed may be due to experimental errors, and to the imprisonment or entanglement of the molecules of hydrochloric-acid gas amongst the finely-divided particles of the Iceland spar or witherite.

We propose to repeat and extend the investigations on these and other carbonates, using greater weights of the substances experimented upon, longer times of exposure of these substances to the action of the gas, and more elaborate precautions to ensure the absence of moisture.

XIII. *On the Calculation of the Illuminating-Power of Hydrocarbons and their Mixtures.* By R. H. M. BOSANQUET, F.R.S.\*

WHILE reading recently the work of Percy Frankland † on the illuminating-power of gases, the following considerations suggested themselves. In considering mixtures of marsh-gas with ethylene, &c., it is observed by P. Frankland that such mixtures give a greater illuminating effect than mixtures with hydrogen. The marsh-gas is regarded simply as a diluent, and the explanation of its greater power is sought in the greater amount of heat which

\* Communicated by the Author.

† Chemical Journal, 1884-85.