

CCXXIX.—*The Colour of Iron Alum.*

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It is well known to chemists that iron ammonium alum occurs in two distinct forms, namely, the more usual form of a violet colour and also a colourless form. Ostwald put forward the theory that

the latter is the pure form, the colour of the other being due to the presence of manganese as an impurity ("Grundlinien der anorganischen Chemie," 1900, 585). This might very easily be the case, and it was with the view of testing the validity of the hypothesis and of investigating the whole question that the following experiments were performed.

1. *Testing the Coloured Variety for Manganese.*—Some of the coloured variety was dissolved in water and the iron precipitated as basic acetate by means of ammonium acetate and acetic acid. This basic acetate was filtered off and thoroughly washed with warm water. The washings were added to the filtrate and the whole was evaporated to small bulk. Ammonium hydroxide was then added, the whole evaporated to dryness, and ignited. If manganese were present, it would be left as manganese oxide. Actually a faint black residue was left, which was tested for manganese by means of the borax bead test. The bead remained colourless both in the oxidising and the reducing flame, showing that the residue did not contain an appreciable quantity of manganese.

2. *Preparation of the Alum by Purifying from Manganese.*—This experiment was performed to test the previous result. Some of the coloured variety was dissolved in water and the iron partly precipitated as basic acetate. This basic acetate was filtered off and thoroughly washed as before. It was then dissolved in dilute sulphuric acid, and the solution divided into two portions, *A* and *B*.

A was converted into the alum. On crystallising, it gave coloured crystals.

In *B*, the iron was again partly precipitated as basic acetate, this basic acetate carefully washed as before, again dissolved in sulphuric acid, and then converted into the alum. This also yielded coloured crystals. It should be noted that both solutions *A* and *B* were strongly acid. Together, experiments 1 and 2 seem to show that the colour was not due to the presence of manganese, but was the colour of the pure salt.

3. *Preparation of Colourless Alum.*—These experiments fall into two divisions :

A. Attempts to prepare the colourless salt from the slightly reduced alum.

B. Attempts to prepare it from alum containing ferric hydroxide:

A. 1. A small quantity of the colourless alum was already available, as it had been prepared by a student in carrying out the preparation of iron alum as a practical exercise. On being tested, this was shown to contain ferrous salt, that is, there had been incomplete oxidation. A portion was oxidised with nitric acid in the presence

of sulphuric acid and allowed to crystallise. The solution yielded coloured crystals.

2. Some of the coloured alum was slightly reduced by means of sulphuric acid and iron filings. This solution yielded coloured crystals.

3. Some ferrous sulphate solution was added to a solution of the coloured alum and the whole allowed to crystallise. Coloured crystals were obtained.

Evidently, then, the loss of colour is not due to the presence of ferrous salts.

B. These experiments were based on the hypothesis that the colourless form might be due to the presence of ferric hydroxide.

1. A solution of the coloured alum was treated with a few drops of ammonium hydroxide and left to crystallise, when faintly brown crystals separated out.

2. Equal quantities of the crystals obtained in the previous experiment and of the violet crystals were dissolved together, and the solution was allowed to crystallise. The crystals obtained were still of a brown colour, but in both experiments the crystals showed no trace of the violet coloration of the original crystals.

3. A solution of the coloured alum in water was boiled for about ten minutes, and then allowed to crystallise, when colourless crystals separated out. It is known that solutions of this alum hydrolyse to an appreciable extent when heated, if strongly acid solutions are not used.

4. Some of the colourless crystals obtained were redissolved in water and the solution was made strongly acid. This yielded coloured crystals.

5. A saturated solution in cold water of the coloured alum was prepared and allowed to crystallise. The crystals did not separate out for about fifteen days and were of a mixed character, some being colourless and some having a faintly violet tinge. The colourless crystals were redissolved in cold acid solution and allowed to crystallise, when the violet crystals were obtained.

Conclusion.

These simple experiments point to the fact that the coloured form of the iron ammonium alum is the pure form of the salt. The colourless variety is due to the presence of ferric hydroxide (probably colloidal), the brown colour of which neutralises the colour of the alum itself. It has also been shown that simply boiling a solution of the alum for a few minutes, bringing about hydrolysis of the salt, produces sufficient ferric hydroxide to neutralise the colour, and to

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make the solution yield colourless crystals, except when strongly acid solutions are used.

In ordinary circumstances, when the alum is being prepared, the solutions are strongly acid, very little hydrolysis takes place, and the coloured form is therefore produced.

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