

In not a single experiment was there any evidence of peroxide formation on the anode at the close of the determination. Occasionally there was a slight tinge of yellow on the anode at the very beginning of the electrolysis, but this, however, soon disappeared. The solution after each determination was examined for bismuth and none could be found.

The effect of boric acid on the deposition of other metals is being studied.

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## A SEPARATION OF IRON FROM MANGANESE.

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If to a solution of ferric chloride containing free hydrochloric acid, pyridine, in slight excess, be added, the iron is completely precipitated as hydroxide. Aluminium, chromium, and zinc, under such conditions, are not completely precipitated, while manganese, nickel, and cobalt remain in solution. This method can therefore be used to separate iron from the last three metals. The present paper deals only with the separation of manganese from iron by means of pyridine.

When pyridine is added to a neutral solution of a manganous salt no precipitate is obtained. On warming, the solution slowly oxidizes and the manganese begins to come down. The rate at which oxidation takes place, however, is about one-third as fast as the rate at which a manganous solution oxidizes when treated with ammonium chloride and ammonium hydroxide under similar conditions. If the manganous solution is made acid with a little hydrochloric acid before addition of the pyridine to slight excess, the solution may then be heated for ten minutes without oxidation. Consequently, pyridine possesses considerable advantages over ammonium hydroxide in the separation under question, especially when a large amount of manganese is present. Practically, its only disadvantage is its cost. A very fair separation can be made with one precipitation.

On washing ferric hydroxide precipitated by pyridine, no iron at first appears in the filtrate. As the excess of pyridine is washed out of the precipitate, however, colloidal iron passes through the filter. On washing the precipitate with pyridine water (1:500) the iron is completely retained by the filter.

In the following experiments Merck's pyridine, "Medicinal grade," was used. It was redistilled before using.

Pure iron wire was dissolved in 10 cc. of 4 *N* hydrochloric acid. A few drops of concentrated nitric acid were added and the solution

warmed to oxidize the iron. It was then diluted to 100 cc., warmed, and pyridine added from a burette. The precipitate was washed with pyridine water (1:500):

	Iron taken. Gram.	Iron found. Gram.
No. 1	0.0806	0.0807
" 2	0.0823	0.0824
" 3	0.0798	0.0810

In No. 1, the pyridine was added until the iron was just precipitated. In No. 2 there was an excess of 0.5 cc. of pyridine, and in No. 3 an excess of 1 cc.

Solutions of manganous chloride were then mixed in different proportions with ferric chloride. The amount of free acid was the same as was taken above. The precipitation takes place equally well in the cold or after gently warming. In the following series the manganese in the filtrate was not estimated, the object being to see what kind of a separation was made by a single precipitation. One-half a cubic centimeter in excess of pyridine was used in each case:

	Iron taken. Gram.	Iron found. Gram.	Manganese present. Gram.
No. 1	0.0797	0.0798	0.1405
" 2	0.0790	0.0792	0.0857
" 3	0.0791	0.0792	0.0719
" 4	0.0798	0.0802	0.0610

In the next series both the iron and manganese were estimated in order to see what effect the presence of the pyridine has on the precipitation of the manganese. The manganese cannot be completely precipitated by addition of bromine water to the hot solution. In addition, the formation of pyridine bromide interferes. In No. 1 the manganese was estimated in the usual manner by potassium carbonate. In numbers 2, 3 and 4, *c. p.* sodium hydroxide was used instead of the carbonate, the precipitation being made in porcelain basins:

	Iron.		Manganese.	
	Taken. Gram.	Found. Gram.	Taken. Gram.	Found. Gram.
No. 1	0.0858	0.0862	0.0698	0.0691
" 2	0.1136	0.1133	0.0667	0.0666
" 3	0.1162	0.1155	0.2289	0.2285
" 4	0.1268	0.1264	0.1145	0.1140

The conditions under which aluminum can be separated from manganese and aluminum and iron from beryllium by means of pyridine are under investigation.