

A Thesis on
THE DETERMINATION OF TITANIUM IN BAUXITE
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THESIS.

The Estimation of Titanium in Bauxite.

Until about a decade ago Titanium belonged to the rare metals. As a matter of fact titanium is probably as abounding in nature as copper. The reason why Titanium has had the reputation of being rare is most likely to the fact that its technical application was rather limited and the method of determination difficult.

Recent investigation, by the Department of Chemistry University of Tennessee, proved that titanium occurred in nearly all the vegetable and animal kingdom. It is obtained for commercial purposes from rutile, ilmenite, titanite, octahedrite, brookite, and some other minerals.

Titanium has been used extensively for coloring porcelain, artificial teeth, leather, and textiles. The process is a recent one and was gotten up by an English firm. Dr. Augustea J. Rossi has probably done more for the introduction of Titanium into metallurgical processes than any other man. In his contribution to the Iron Age he summarizes his conclusions concerning titaniferous iron ores as follows:-

1. These ores have been smelted without any difficulty.
2. Their metallurgical treatment has proved a perfect success.
3. The metal they yield, either as a pig metal, iron or steel, possesses special valuable qualities.
4. These ores, which are found in large masses in many states of the union, are almost invariably "Bessemer ores", and as such it is asserted have been used in Pennsylvania furnaces.

5. When containing very large percentages of titanio acid (as much as 38 to 40 per cent. and even 48 to 60 per cent. like the ilmenite of Canada), and consequently a very small amount of iron (32 to 35 per cent. or even less), their treatment though perfectly successful, metalurgically speaking, has not proved economical as to fuel.

In 1907 was poured the first heat of titanium steel ever made in America. The alloy then used experimentally is now widely known for its remarkable effect in improving both steel and iron. During the last three years the great value of titanium in its effect on steel and iron was firmly established, not only in scientific laboratories here and abroad, but in the severest service of large railroads and manufacturers, to whom merit alone appeals. It has been demonstrated that titanium increases the uniformity and ductility of steels; removes gases and prevents blow-holes according to conditions, partially or entirely in proportion to the quantity used. By making steel denser it gives a remarkable increase in resistance to friction and abrasion and power to resist shock or impact. Both tensile and transverse strength of steel are improved materially by titanium also it increases the resistance to torsional and compressive strains. It has been shown by high authority that an improvement in durability of several hundred per cent. has been obtained, by many and is in reach of every one, as the additional cost is very small. Mr. W.C. Brown, President of the New York Central Lines says, " We are pleased with the Ferro Titanium rails which we have bought during the past three years and under the heaviest traffic we have ever had

these rails are giving perfect satisfaction. We have subject them to the most exacting service at the throat of the Grand Central Teriminal Yard; and under traffic which made it necessary to change other rails within six or eight months, the Ferro Titanium rails which have been in service a year show almost no appreciable wear. The Bessemer Rails rolled by the Lackawanna Steel Company for our lines for the past two years, (all of which have been treated with Titanium), have been the best we have ever received, and in many respects we regard them as equal, if not superior, to the average Open Hearth Steel. While the quality is so much better, the cost is insignificant, and we are now specifying Titanium Alloy in all our rails".

The object of the work reported in this paper was the results of determinations made for titanium in Bauxite ores obtained from Georgia, Alabama, and Tennessee.

The method of treating the ores were as follows:-

SOLUTIONS REQUIRED.-

STANDARD TiO_2 . Ignite pure TiO_2 at a dull red heat to a constant weight. Weigh 0.5 gram of the anhydrous powder. Put this in a platinum crucible with 5 grams of pure potassium bisulphate. Melt cautiously and keep at a low red heat for from five to ten minutes until the TiO_2 all desolves and the liquid becomes clear. Partially cool the crucible and add 5 C.C. of concentrated H_2SO_4 , then heat again until the mass liquifies. Cool and put the crucible and all into the beaker containing 200 to 300 c.c. of water containing 5 per cent. of H_2SO_4 . When the fusion is desolved wash and remove the crucible. The TiO_2

should desolve to a clear solution. If any residue remains, filter it out, wash and weigh it and deduct it from the TiO_2 taken using the difference in calculating the standard of the solution. Finally dilute the solution with five per cent. H_2SO_4 till 1 c.c. contains 1 milligram of TiO_2 . Check it by weighing the precipitated TiO_2 from 20 c.c. This can be done by the regular gravimetric process. After weighing, the TiO_2 should be tested for SiO_2 , by treating it with H_2SO_4 and HFl , igniting and weighing the residue. Any loss will be SiO_2 .

TREATMENT OF ORES:- About 5 to 10 grams of each of the sample were prepared and placed in suitable tubes for future use. After this preliminary preparation of the samples a half gram of each of the samples was very finely pulverized and fused with about 5 grams of KHSO_4 . The heat must be started gently at first and then raised to a red heat for at least ten minutes, in which time all the TiO_2 , Fe, etc. should dissolve in the melted salt. Cool the solution, add 5 c.c. of H_2SO_4 , melt again and finally cool and put the crucible into a beaker with 200 c.c. of water containing 5 c.c. H_2SO_4 . Warm the contents of the beaker to about 90°C ., and stir till the solution clears. Filter from the residue and dilute the filtrate to 250 c.c. with 5 per cent. H_2SO_4 . If the residue is dark colored it should be tested for titanium by refusion.

DETERMINATION OF TITANIUM BY COLOR:- The colorimetric method of A. Weller is best suited for this purpose, and is to be preferred over all gravimetric methods. When hydrogen peroxide (H_2O_2) is added to a sulphuric acid solution of titanium, an intense yellow color is produced, the intensity of which is proportional to the amount of TiO_2 . This is a very delicate test qualitatively and

and has been made the basis of a color method.†The results are very satisfactory for ores containing small percentages of titanium. The solution of TiO_2 must be very dilute. The color is probably due to the formation of TiO_3 . It is distinctly shown with less than .02 milligram TiO_2 to the cubic centimeter of the liquid. As some commercial hydrogen peroxide is said to contain flourine as an impurity, it should be tested before being used in the process. Iron salts do not prevent the formation of the color, but as they have a color of their own they modify the tint. The solution should always have the same amount (5per cent.) of H_2SO_4 .

TO ESTIMATE THE TITANIUM:-Put 50 c.c. of the solution (equal 0.1 gram of the ore) into a "Nessler" tube. Into a second similar tube put as much of the standard iron solution as will contain an amount of iron equal to that in 0.1 gram of the ore and dilute this to 50 c.c. with 5 per cent. H_2SO_4 . Add to each tube 5 c.c. of hydrogen peroxide and then add standard TiO_2 solution from a burette to the second tube till the color produced matches that in the first tube. From the volume of the TiO_2 solution used, calculate the amount of titanium added to the second tube which will be the same as that in 0.1 gram of the ore.

The addition of the iron to the standard is nesessary in order that the modification of the titanium color by the iron may be the same in the standard as in the ore.

The Bauxite ores showed presence of TiO_2 as follows:-

No.	Per cent.
I.....	2.22
2.....	1.64
3.....	2.46
4.....	2.57
5.....	5.38
6.....	4.09
7.....	5.15
8.....	3.89
9.....	3.04
10.....	2.39
11.....	3.35
12.....	3.98
13.....	3.91
14.....	2.57
15.....	2.11
16.....	4.21
17.....	5.03
18.....	4.68
19.....	2.30
20.....	1.72
21.....	1.19