

CHEMICAL METHODS FOR ANALYZING RAIL-STEEL.

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By comparing these formulas with those of the bromine and ammonia process, I think a pretty clear view may be had of the different conditions of the two methods, without further comment.

After what has just been shown, there is no disguising the fact that the bromine and ammonia process is more rapid and convenient than the process with fixed alkaline salts; but it should be here pointed out that a great mistake is often committed in saying that it is impossible to free the precipitate from alkali by washing. Professor Eggertz has stated that by means of cold water containing one per cent. of hydrochloric acid the precipitate may be easily freed from alkali. In Germany, where the fixed alkali method is used, this mode of washing is not so frequently known as might be supposed, and at one works I was told that experience went to show that by using chlorine instead of bromine the washing of the precipitate with ordinary hot water could be more easily effected.

When chlorine is used for precipitating the manganese, no ammoniacal salts must be present, otherwise the explosive compound Cl_3N may be formed. On the other hand, in the case of bromine and ammonia, no explosion need be feared.

The different methods, of which the outlines have now been given, yield quite concordant results when carried out by experienced hands, and for rail-steel there is certainly no preference to be given to any of them so far as accuracy goes. According to my own working, the results should not vary more than 0.05 per cent. and the time required for an estimation one day; of course several assays can be made at the same time. As to rapidity, the bromine and ammonia process will no doubt prove the best, for reasons stated above.

There are many volumetric methods for determining manganese, but, as far as I have seen, none is more rapid than the gravimetric method with bromine and ammonia. A new volumetric method has been recently devised in the Stockholm School of Mines and will shortly be published.

SULPHUR DETERMINATION.

I dissolve 5 grammes of steel in aqua regia and separate the silica in the usual way. In the boiling solution, the sulphur is precipitated by means of 2 cc. of a concentrated solution of chloride of barium. Boiling is continued for a short time and the solution is then left to stand during one night.

The sulphate of baryta, before being taken upon the filter, is decanted repeatedly with hot water. Some drops of hydrochloric acid must be added to prevent oxide of iron from being precipitated. By washing carefully in this way accurate results are secured, always provided that the reagents are pure. The purity of the reagents is, indeed, the difficulty in this method, as it is almost exceptional to find the acids bought as "special" free from sulphur. The sulphur must be estimated in the reagents and the necessary deductions made.

There are chemists, however, particularly in Germany, who assert that even with pure reagents you will get too high results by the aqua-regia method. They therefore use the bromine method, leading the gases from the steel dissolving in dilute hydrochloric acid through a solution of bromine in hydrochloric acid. The sulphuretted hydrogen is thus oxidized and can be precipitated in the usual way, by means of chloride of barium.

As far, however, as I have been able to see, the bromine method gives too low results. I have had to determine the sulphur in steel with the aqua-regia method against chemists using the bromine method, and on some occasions I have found 0.08 per cent., while the others have found only half of this, 0.04 per cent. By means of the Eggertz silver plate, however, I easily ascertained that 0.04 per cent. was much too low. The experiment was carried out by hanging a clean, small silver plate over the gases evolved from 0.1 gramme of steel, dissolving in 1.3 cc. of sulphuric acid of 1.23 sp. gr. The plate then got a decidedly more bluish than brownish color, whereas if the percentage of sulphur had been only 0.04 per cent., the color would have been simply brown and not blue at all. This plate method was worked out by Professor Eggertz, and has been for many years in use at all blast furnaces in Sweden for the daily testing of every cast of pig iron. The plate method will yield very good results for percentages of sulphur between 0 and 0.4 per cent., and this is quite sufficient for Swedish irons. But for sulphur over 0.04 per cent., the method is less accurate, except in extremely well-trained hands,

and one can only make a rough estimation, as a rule. The relations of the colors of the plate to the percentage of sulphur is shown by the following table:

No color,	0.00 per cent.
Slightly yellowish,	0.01 "
Yellow,	0.02 "
Yellow-brown,	0.03 "
Brown,	0.04 "
Blue,	0.20 "

Between brown and blue there are numerous variations in color. A certain red tint signifies 0.10 per cent., but this can only be learnt by practice.

APPENDIX.

COLOR TEST FOR CARBON IN IRON AND STEEL.—By V. EGGERTZ.

(Translated from the Swedish by M. Troilius.)

The first description of this method appeared in the *Jernkontorets Annaler*, of 1862, page 54, and in the *Berg- und Hüttenmännische Zeitung*, 1863, page 373. Subsequently, several additions were made to this description in the *Jernkontorets Annaler*, 1874, page 176, and in the *Berg- und Hüttenmännische Zeitung*, 1875, page 440. At that time I considered that it would be practically sufficient to determine the carbon in tenths of a per cent., but I now find that even hundredths of a per cent. are required.

For commercial purposes, however, iron and steel is generally stamped with only whole or half tenths of a per cent. of carbon, it being chiefly for the softer irons and steels with carbon between 0.10 and 0.25 per cent., that the greater accuracy in determining the carbon is required.

Pure hydrate of oxide of iron, containing 0.1 gramme of iron and free from chlorine, will give a yellow-greenish solution when dissolved in 2.5 cc. of nitric acid, specific gravity 1.2. The solution will lighten somewhat on addition of 1.5 cc. of nitric acid, but not so much as when water is added instead of nitric acid. When hot, the solution has a much darker color than when cold. By adding 4 cc. of water in either of these cases, so as to make the bulk up to 8 cc., the iron color will be totally got rid of. Hence the rule for color tests for