$$t-20^\circ=\frac{790{,}000}{\left\{2004\times[0.303+0.000027(t+20)]\right\}+\begin{array}{l}\left\{136\times[0.37+0.00027(t+20)]\right\}\\+\left\{128\times[0.34+0.00015(t+20)]\right\}\end{array}}$$

from which $t=1000^\circ$.

An extremely interesting fact is here brought out; *viz.*, that the clinker, leaving the kiln at 1200°, is hotter than the mixture of gases in the kiln. It is its heat of combination which causes this, and which accounts for the anomaly. In fact, the heat of combination probably heats the clinker even hotter than 1200°, in the interior of the kiln. In other words, when the ingredients of the cement are brought to their combination point by the gases in the kiln, a point practically about 1000° C., they ignite and combine, like a pile of anthracite coal igniting when heated to redness, and become, by their own heat of chemical combination, much hotter than the temperature to which the gases have heated them.

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DETERMINATIONS OF ALKALIES IN THE PRESENCE OF BORATES.

BY K. JACOBI.

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DISSOLVE 2 grams of the substance to be determined in hydrochloric acid, evaporate to dryness and bake for an hour. After cooling, add dilute hydrochloric acid, boil and filter off the silica. Precipitate iron oxide and alumina by slight excess of ammonia and the calcium oxide by ammonium oxalate. Precipitate the magnesia by ammonium phosphate and remove the excess of phosphoric acid by adding pure ferric chloride to the solution and precipitating the ferric phosphate with ammonia, which, of course, will also remove the excess of iron. Generally—at least as regards deposits in this country—when borates occur in large amounts, there are no bases other than those mentioned. Should any sulphates be present, the sulphuric acid ought to be determined separately and taken into account when the final calculation is made. Now evaporate the solution to dryness with 40-50 cc. of strong nitric acid and repeat a second time with 20 cc. to insure complete removal of ammonium salts. Take up in hydrochloric acid (strong), evaporate to dryness and repeat. After the second evaporation, add water, boil, filter into a tared platinum dish and run slowly down to dryness. Place dish over a Bunsen burner and heat *very* gradually—it is best to have the dish covered—until finally it comes to a dull red heat, where it should be kept for ten minutes. This will render the boric acid anhydrous and expel the last traces of ammonium compounds, should any be left. Cool in a desiccator and weigh.

The contents are: Anhydrous boric acid (B_2O_3), sodium (potassium) chloride and sodium borate ($Na_2B_2O_4$). The existence of the latter is explained by the following reaction, which takes place only at high temperatures:

$$2H_3BO_3+2NaCl = Na_2B_2O_4+2HCl+2H_2O.$$

Next dissolve the contents of the dish in hot water, cool and determine the sodium existing in the borate by titrating with N/2 sulphuric acid, using methyl orange as indicator. The total boric acid is now determined by titration with N/2 potassium hydroxide in the presence of an excess of glycerine and with phenolphthaleïn as an indicator. The sum of the boric acid and sodium oxide (in the borate) subtracted from the total weight of contents in the dish, gives the sodium chloride, from which sodium oxide is calculated (by multiplying by 0.53077) and added to the sodium oxide first determined by titration. If there is any potassium present, it must be determined in a separate portion.

EXPERIMENTAL.

Three samples of sodium carbonate of known composition were mixed with chemically pure boric acid, and hydrochloric acid was added.

	I. Gram.	II. Gram.	III. Gram.
Weight of sodium oxide in carbonate ..	0.0588	0.1176	0.2352
Weight of boric acid (approximate)....	0.1250	0.2500	0.5000

These mixtures were evaporated to dryness in a platinum dish, heated gently at first, increasing very slowly until a low red heat was reached, where they were kept for ten minutes, after which they were cooled and weighed.

	I. Gram.	II. Gram.	III. Gram.
Total weight of contents	0.1367	0.2941	0.6595

Boiling water was next added, the dish cooled and the sodium oxide titrated with N/2 sulphuric acid with methyl orange as indicator.

	I.	II.	III.
	cc.	cc.	cc.
Titrations were	0.70	1.30	1.10
	Gram.	Gram.	Gram.
which, multiplied by factor 0.0155, gives sodium oxide	0.01085	0.02015	0.01705

Phenolphthaleïn was now added with excess of glycerine, and the solution titrated with N/2 potassium hydroxide.

	I.	II.	III.
	cc.	cc.	cc.
Titrations were	2.55	5.60	13.80
Correction for glycerine	0.40	0.40	0.40
Leaving	2.15	5.20	13.40
	Gram.	Gram.	Gram.
Which, multiplied by factor 0.0175, gives boric acid (B_2O_3)	0.03763	0.09100	0.23450

The boric acid and sodium oxide were then added together in each instance and their sum deducted from the weight of the contents in the platinum dish after dehydration.

	I. Gram.	II. Gram.	III. Gram.
Weight of contents in dish	0.13670	0.29410	0.65950
Sum of boric acid and sodium oxide	0.04848	0.11115	0.25155
Leaves sodium chloride	0.08822	0.18295	0.40795
Multiplying by 0.53077 to convert into sodium oxide gives	0.04682	0.09710	0.21652
Sodium oxide found by titration	0.01085	0.02015	0.01705
Total sodium oxide found	0.0577	0.1173	0.2336
Sodium oxide taken	0.0588	0.1176	0.2336
Difference	—0.0011	—0.0003	—0.0016

Below are given three analyses of different materials. It will be seen that the figures for sodium oxide, found by actual analysis, correspond well with those found by difference.

	I.	II.	III.
Carbonaceous matter	....	....	0.63
Silica	14.88	0.19	9.71
Alumina and iron oxide	5.38	0.26	1.86
Lime	1.11	26.96	44.56
Magnesia	0.10	trace	3.65
Carbonic acid	5.12	....	33.04
Sulphuric anhydride	1.19	0.28	0.20
Boric anhydride	24.09	49.87	2.00
Moisture	14.81	0.33	....
Combined water	7.52	21.91	2.36
Sodium chloride	5.21	trace	trace
Sodium oxide	20.78	0.44	1.76

If the per cent. of the sodium oxide were taken by difference, it would be:

	I. Per cent.	II. Per cent.	III. Per cent.
	20.59	0.20	1.99
Difference	+0.19	+0.24	—0.23

Another method is to drive off the boric acid by repeated evaporations with methyl alcohol and then to determine the alkalies by one of the ordinary methods, but it is open to the following objections:

(1) The evaporation must be repeated six or seven times and even then there is some boric acid left.

(2) It leaves an undesirable residue of carbonaceous matter which is very hard to get rid of.

On this account I think the method first mentioned is to be preferred.

RAPID DETERMINATION OF BORIC ACID IN BORAX.

BY K. JACOBI.

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THE well-known method of titrating boric acid in the presence of glycerine depends upon the fact that solutions containing boric acid are neutral to methyl orange, but acid toward phenolphthaleïn and very distinctly so in the presence of glycerine. When titrated with alkali, after adding glycerine, the neutral point corresponds to the conversion of the boric acid to a metaborate, $K_2B_2O_4$. I have found that if glycerine is added to a solution of borax, the solution becomes acid toward phenolphthaleïn, and on titration, the neutral point corresponds to the formation of the metaborate, as before. It is evident that, in this case, just one-half as much alkali will be required as would have been required if all of the boric acid were in a free state. In practical effect, the reaction for titration is:

$$Na_2B_4O_7+2NaOH = 2Na_2B_2O_4+H_2O.$$

The method is as follows: Dissolve 2 to 4 grams of borax in water, add excess of glycerine, a few drops of phenolphthaleïn and titrate with N/2 potassium hydroxide. Deduct the correction for the glycerine from the number of cubic centimeters used and multiply by 0.0175. The product is one-half of the total boric acid present. Carbonates interfere with the end-reaction.