

no connecting member between the hip panel points of the suspended span and river arms, the wind pressure on the upper chord of the suspended span being transmitted down the end brace to the bottom chord of the cantilever arms to the earth. The lower part of each pier is built of concrete, set on the solid rock of the river-bed. The upper part of each pier consists of two iron cylinders, filled with concrete, and braced by wrought-iron horizontal struts and diagonal ties. The bracing is protected from drift by timber sheathing on each side of the bracing. The up-stream cylinder was anchored down to the concrete base by two 1½-in. galvanized iron rods, to increase the stability against drift. The smallness of the anchor piers is due to the unusual length of the shore arm as compared with the river span. As usual in the superstructure of combination bridges, the floor beams, joists, floor and railing are of wood. The compression members are of wood, with the exception of the struts and bottom chord panels next the river piers, which are of steel. The tension members are of iron, and the pins of steel; the chord-blocks, post-shoes, etc., being of cast iron. The shore arms were made of unusual length, so as to offer as little obstruction as possible to drift, of which there is considerable in the rainy season. The method of erecting the suspended span, without false work by working out from the river piers, was, to some extent, different from the usual method adopted for iron construction, since the compression members in combination work will not in themselves take tension, nor the tension members take compression; nor will any member take transverse loads or shear. For these reasons it was found necessary in the course of erection to introduce several temporary ties and struts.

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

### Chemistry Applied to Railroads.

#### SECOND SERIES.—CHEMICAL METHODS.

#### II.—METHOD OF DETERMINING FREE CAUSTIC AND CARBONATED ALKALI IN SOAPS.

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(Continued from page 18, Volume LXVII.)

#### OPERATION.

Put into an 8-oz. flask 100 c.c. of an alcoholic solution of stearic acid whose strength in terms of standard alkali is known, and add 5 grams of the soap cut in fine shavings. Allow to dissolve at a temperature near the boiling point of the solution. As soon as solution is complete titrate the excess of stearic acid with standard alkali, using phenolphthaleine as indicator. Now filter the solution through paper or through asbestos in Gooch crucible, using the pump, and wash with absolute alcohol until the last drop of the filtrate, evaporated to dryness on a clean piece of platinum, leaves no residue. Dissolve whatever is left on the filter in warm water, and wash with water until same test as above shows no residue. The solution and washings should amount to about 100 c.c. Add now enough standard sulphuric acid to render the solution distinctly acid to litmus paper after boiling, and boil not less than 15 minutes. Then titrate the excess of acid with standard alkali, using phenolphthaleine as indicator. These two titrations show the total amount of free caustic and carbonated alkali in the soap.

Dissolve another portion of 5 grams of the soap, which has been previously cut in very thin shavings, and after weight has been dried at from 120° to 200° F., in the same kind of a flask, in 100 c.c. of absolute alcohol, using heat as before. As soon as solution is complete filter as before, and wash with hot absolute alcohol until the last drop of the filtrate, evaporated as before, shows no residue. Dissolve whatever is left on the filter in warm water and wash as before; then render

acid with standard sulphuric acid, boil and titrate as before. This last titration gives the amount of carbonated alkali in the sample, and the difference between this and the sum of the first two titrations gives the amount of free caustic alkali in the sample.

#### APPARATUS AND REAGENTS.

The apparatus required by this method is simply flasks, burettes and pipettes, none of which need especial description. We use ring-necked, flat-bottomed flasks, holding about 8 oz., burettes of 50 c.c. capacity, graduated to tenths, which have been calibrated and compared with each other, and 100 c.c. pipettes, which have been compared with the burettes.

The stearic acid solution is made by dissolving 15 grams of stearic acid obtained in the market in 2 liters of commercial 95 per cent. alcohol.

The phenolphthaleine solution is made by dissolving 5 grams of the commercial material in 100 c.c. of 95 per cent. alcohol, and adding caustic potash until the solution shows slight pinkish tint.

The standard alkali and acid solutions are made as follows: Take about 50 grams of the best dry C. P. carbonate of soda, free from silicate, to be obtained in the market. Dissolve in distilled water and filter into a platinum dish. This is to remove any sand or dirt that may be accidentally contained in the soda. Add a little carbon dioxide or a few drops of carbonic acid water, in order to be sure that there is a slight excess of carbonic acid present. Evaporate the solution to dryness at a temperature a little above the boiling point of water, using great care to keep out the dust or dirt. When thoroughly dry transfer to a dry glass-stoppered bottle for further use. Now carefully weigh a clean ¼ oz. platinum crucible and add to it about a gram of the dried carbonate of soda, ignite over a Bunsen burner until the soda is just melted, and weigh. This weight gives the amount of carbonate of soda used, and is the basis of the standardizing. Have previously prepared two solutions made as follows: 1. A solution of distilled water to which has been added about 28.5 grams of concentrated C. P. sulphuric acid per liter. The solution should be thoroughly mixed, and allowed to cool before using. 2. A solution of caustic potash in distilled water, made by adding to it about 50 grams of commercial stick potash per liter, allowing to dissolve, and then adding to it ¼ liter of milk of lime, made by slacking 70 grams of commercial caustic lime and diluting with water to one liter. After the lime is added boil for 10 or 15 minutes; then allow to settle and draw off with a pipette about 50 c.c. of the clear solution, transfer to a beaker, and add a few drops of phenolphthaleine. Then run in from a burette some of the sulphuric acid solution above described, until the last drop just discharges the color, and boil. If five or 10 minutes' boiling does not bring back any of the pink color, the caustic potash solution may be regarded as free from carbonates, and is ready to be proceeded with. If boiling does restore any of the pink color, the boiling with the lime must be continued, or fresh milk of lime added and boiling continued, until the solution is free from carbonates by above test. After carbonates are proven absent, filter the solution into the vessel in which it is to be kept for use, taking care to avoid exposure to the air as much as possible.

The two solutions thus prepared should be rendered homogeneous by stirring or shaking, and should then be allowed to stand until they are both of the temperature of about 70° F. This being accomplished, the strength of each in terms of the other must be known. For this purpose run from a burette 40 c.c. of the acid solution into a beaker, add a few drops of phenolphthaleine, and then titrate with the caustic potash solution. Two or three tests should give the same figure within one or two drops. Preserve the figures thus obtained.

Now put the crucible containing the fused carbonate of soda before described into a beaker, add about 50 c.c. of distilled water, and allow to dissolve. Then add about 50 c.c. of the sulphuric acid solution above described and boil 15 minutes to remove carbon dioxide, taking care that there is no loss due to effervescence. After the boiling is finished titrate the excess of acid with the caustic potash solution, using phenolphthaleine for the indicator. The relation of the acid and alkali being known as before described, it is easy to find the amount of the sulphuric acid solution corresponding to the carbonate of soda taken; but one point still remains uncertain—viz., whether the boiling has removed all the carbon dioxide. To decide this point, add to the solution which has just been titrated with the potash solution, and which the last drop of potash rendered pink, one drop of the acid solution, or enough to just completely discharge the color and boil again. If the color does not reappear on boiling, the figures already obtained may be regarded as satisfactory. If the color does reappear, run in one or two c.c. of the acid and boil again. The amount

of acid thus run in must be added to the 40 c.c. used at first. After boiling, say, five minutes more, titrate with the potash solution, noting how much of it is required to bring back the pink color, and adding this amount to the amount of potash solution previously used. Now test as before for the absence of carbon dioxide, and if it is proven not present, find the total number of c.c. of the sulphuric acid solution, which is equivalent to the carbonate of soda used. From this, as described below, the amount of sulphuric acid ( $\text{H}_2\text{SO}_4$ ) in one c.c. of the acid solution may be obtained. But convenience in the subsequent use of the acid solution makes it desirable that each c.c. of it should contain a definite proportion of the molecular weight of sulphuric acid, say one-fourth or 0.0245 grams  $\text{H}_2\text{SO}_4$ . If sufficiently concentrated C. P. sulphuric acid has been used in making the solution to start with, the figure obtained as above will be larger than this, and, as shown in the calculations below, a certain amount of water must be added, which should be done, the solution being agitated by stirring or shaking, and then allowed to stand until the following day, when a new determination of its strength should be made by means of carbonate of soda, as above described. The figure thus obtained will show whether further addition of water is necessary. When all the water needed has been added, not less than two determinations of the strength of the acid should be made by means of carbonate of soda, as described above, which duplicates should show the value of 1 c.c. to be not less than 0.0244 gram, nor more than 0.0246 gram of sulphuric acid ( $\text{H}_2\text{SO}_4$ ).

The standard acid having been obtained, it remains to make the caustic potash solution so that 1 c.c. equals 1 c.c. of the acid solution. For this purpose run, say, 40 c.c. of the standard acid into a beaker, and titrate with the caustic potash, using phenolphthaleine as indicator. If fairly good caustic potash has been used in making the solution, this operation will show that water must be added. If the operation shows that the solution is too weak, it is better to throw it away and start again, using more of the potash per liter. The figure obtained enables, as is shown below, the amount of water that must be added to be calculated. This amount of water should be added, the solution agitated by stirring or shaking, and allowed to stand until the following day, when a new test should be made. The figure thus obtained will show whether further addition of water is necessary. After all the water has been added, not less than two tests should be made, and each of these should show that the two solutions are alike to within one-tenth of a c.c.

#### CALCULATIONS.

An example of all the calculations is given herewith.

I. *Standardizing the Sulphuric Acid.*—Suppose that 40 c.c. of the sulphuric acid as mixed requires 36.4 c.c. of the caustic potash as mixed to exactly neutralize it, this figure having been obtained by two or three closely agreeing tests. This means that 1 c.c. of the sulphuric acid solution is equal to  $(36.4 \div 40)$  0.91 c.c. of the potash solution, and that 1 c.c. of the potash solution is equal to  $(40 \div 36.4)$  1.0989 c.c. of the acid solution. Next suppose the fused carbonate of soda in the crucible weighs 0.9864 grams, and that 45 c.c. of the sulphuric acid as mixed are run into the solution of this carbonate of soda; also that after boiling it requires 9.2 c.c. of the potash solution to neutralize the excess of acid; also that it is found that the carbon dioxide is not quite all removed by the first boiling, and that 1 c.c. more of the acid is put in for a second boiling, and that after this second boiling it requires 0.4 c.c. of the potash solution to neutralize the excess of acid, and that test shows that the second boiling removed all the carbon dioxide. It is evident that  $46 (45 + 1)$  c.c. of the acid have been used all together, and that  $9.6 (9.2 + .4)$  c.c. of the potash solution have been used to neutralize the excess of acid. But 1 c.c. of the potash solution is equal to 1.0989 c.c. of the acid, or 9.6 c.c. of the potash solution are equal to  $(1.0989 \times 9.6)$  10.55 c.c. of the acid solution. Hence the amount of the acid solution used up by the 0.9864 gram of carbonate of soda is  $35.45 (46 - 10.55)$  c.c. or 1 c.c. of the acid solution is equivalent to  $(0.9864 \div 35.45)$  0.027825 gram carbonate of soda; but the ratio of the molecular weights of carbonate of soda ( $\text{Na}_2\text{CO}_3$ ) to sulphuric acid ( $\text{H}_2\text{SO}_4$ ) is as 106 to 98. Hence each c.c. of the sulphuric acid solution contains  $(106 \div 98 \div 0.027825 \div x)$  0.025725 gram sulphuric acid. But, as previously stated, it is more convenient to have the acid and alkali solutions some even ratio of the molecular weight, and therefore a solution is wanted which contains  $(98 \div 4)$  0.0245 gram of sulphuric acid per cubic centimeter. To obtain this, water must be added to the solution in question. The amount of this is found by the following ratio,  $a : b :: x : c$ , in which  $a$  represents the strength of the acid as

determined, in this case 0.025725 gram,  $b$  the strength of acid desired, in this case 0.0245 gram,  $c$  the total volume of the solution we are working with, say, 15000 c.c., and  $x$  the volume of the solution after the water is added, which in the case supposed is  $(0.025725 \times 15000 \div 0.0245)$  15750, or  $(15750 - 15000)$  750 c.c. of water must be added.

II. *Standardizing the Caustic Potash Solution.*—Suppose that it is found that 40 c.c. of the standard acid require 31.2 c.c. of caustic potash solution as made to exactly neutralize it. This means that water must be added, and the amount may be found by the proportion,  $a : b :: x : c$ , in which  $a$  represents the number of c.c. of standard acid used, in this case 40;  $b$  the number of c.c. of potash solution used, in this case 31.2;  $c$  the total volume of the solution we are working with, say, 15000 c.c., and  $x$  the volume of the solution after the water is added, which in the case supposed is  $(40 \times 15000 \div 31.2)$  19230, or  $(19230 - 15000)$  4230 c.c. of water must be added. The reaction between sulphuric acid and caustic potash being represented by the equation  $\text{H}_2\text{SO}_4 + (\text{KOH})_2 = \text{K}_2\text{SO}_4 + (\text{H}_2\text{O})_2$ , or by weight  $98 + 112.2 = 174.2 + 36$ , it must be remembered that, since 1 c.c. of each solution is the equivalent of the other, the actual amount of caustic potash (KOH) in each c.c. of the solution is  $(112.2 \div 4)$  0.02805 gram—that is, if a solution containing any substance which reacts with sulphuric acid is so made that 1 c.c. equals 1 c.c. of the acid, the value of 1 c.c. of the solution in question may be found by writing the equation which expresses the reactions, together with the molecular weights, and dividing the molecular weight as given in the equation of the substance sought by the same figure that is required to give the known strength of the standard sulphuric acid. Further, the quotients thus obtained may be used interchangeably, according to the work in hand. Thus 1 c.c. of the standard sulphuric acid or 1 c.c. of the standard caustic potash is the equivalent of 1 c.c. of a solution containing 0.02355 gram of potash ( $\text{K}_2\text{O}$ ), or of 0.020 gram of caustic soda ( $\text{NaOH}$ ), or of 0.0155 gram of soda ( $\text{Na}_2\text{O}$ ), or of 0.0265 gram of carbonate of soda.

III. *Caustic and Carbonated Alkali in Soap.*—Suppose 100 c.c. of the stearic acid solution requires 6 c.c. of the standard potash solution to exactly neutralize it, and that after the soap has been dissolved in this it requires 4.3 c.c. of standard potash solution to exactly neutralize the excess of stearic acid. Also suppose that to the water solution of the material left on the filter from the first 5 grams, 5 c.c. of standard acid are added, and that after boiling 3.2 c.c. of standard potash are required to exactly neutralize the excess. It is clear that the total caustic and carbonated alkali in the 5 grams of soap under test are the equivalent of  $(6 - 4.3 = 1.7) + (5 - 3.2 = 1.8)$  4.5 c.c. of standard potash solution. Next suppose that to the water solution of the material left on the filter from the second 5 grams 5 c.c. of standard acid are added, and that after boiling it requires 2.9 c.c. of standard potash to exactly neutralize the excess. It is obvious that the carbonated alkali in the sample under test is equivalent to  $(5 - 2.9)$  2.1 c.c. of the standard potash solution, also that the caustic alkali in the sample is equivalent to  $(4.5 - 2.1)$  2.4 c.c. of the standard potash solution. But each c.c. of the standard potash solution is equivalent to 0.0265 gram of carbonate of soda, and to 0.020 gram of caustic soda. Hence the 5 grams of soap contains 0.05565 gram of carbonate of soda and 0.048 gram of caustic soda or  $(5 : 100 :: 0.05565 : x)$  1.13 per cent. of carbonate and  $(5 : 100 :: 0.048 : x)$  0.96 per cent. of caustic soda.

Notes and precautions on this method will follow.

#### PROCEEDINGS OF SOCIETIES.

**Boston Society of Civil Engineers.**—A regular meeting was held on February 15. Mr. W. E. McClintock gave an account of the work of the Massachusetts Highway Commission, illustrated by lantern views showing the condition of the roads throughout the State. Mr. E. W. Howe showed by lantern views the kind of roads built by the Boston Park Department, and Mr. E. F. Foss gave some of the streets in Chicago and Buffalo. A general discussion on road construction followed.

**The New York Railroad Club** held its regular March meeting on the evening of the 16th. Mr. Dixon, of the Rogers Locomotive Works, read a paper on the Locomotive Boiler, which was followed by a discussion turning chiefly on the methods of staying the fire-box, and especially the crown-sheet. In the course of the discussion it was stated that the chief trouble with the Belpaire form of boiler lay in the leakage which was apt to occur between the flat, top sheet over the fire-box and the shell, owing to the unequal expansions which occur.