Salt.	From solubility experiments. I.	From solubility experiments. II.	From the conductivity.
TlCl	86.5	86.5	86.6
TlSCN	86.7	86.6	85.6
$TlBrO_3$	89.9	91.9	89.0

These entirely distinct methods, freezing-point-lowering and solubility-effect, lead therefore to nearly the same dissociation-values. That the electrical conductivity furnishes essentially correct dissociation-values in the case of di-ionic salts in moderately dilute solution, is therefore probable. At any rate, more weighty reasons than those brought forward by van Laar must be discovered before this method should be discredited.

THE ERROR IN CARBON DETERMINATIONS MADE WITH THE USE OF WEIGHED POTASH BULBS.

BY GEORGE AUCHY.

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THE difficulty, or impossibility even, of obtaining good carbon results in damp weather has been so often spoken of that anything further on the same subject would seem superfluous. Nevertheless the writer ventures a few remarks. In determining carbon by the dry combustion method it was found that, after the prolong had been in use a few times, a loss of moisture occurred as shown by the gain in weight of a potash bulb containing strong sulphuric acid, placed after the prolong. But it was later discovered that this loss was mainly due to the fact of the copper oxide in the preheating furnace being too fine and packed in too tightly. With coarser copper oxide, and a consequently easier passage of gas and air, and therefore less force and speed in aspiration, the amount of moisture lost from the prolong was much lessened, and the increase in the loss very steady and gradual so that a determination of it by means of a sulphuric acid bulb[1] would only be necessary once in a while, and might be altogether dispensed with by a frequent change in the calcium chloride of the prolong. This agrees with Dr. Drown's experience who found by many trials that the prolong retained all the moisture passing into it from the potash bulbs; but, while still using the sulphuric acid bulb, some gains in its

[1] Or better, a small calcium-chloride tube, as it exposes less surface for the condensation of moisture on a damp day.

weight far in excess of that due to the moisture escaping from the prolong occurred. These were followed in one or two determinations afterward by losses of weight sufficiently large to make the weight of the bulb a minus quantity. This gain in weight could only be attributed to an unusual condensation of moisture on the outside surface of the bulbs, and the loss in weight to a return to normal conditions in this respect. The idea was suggested that the sulphuric bulbs might be made useful in measuring and determining the amount of moisture condensing on the potash bulbs; that is, the amount of moisture condensing on the sulphuric bulbs, found by subtracting the amount of inside moisture gained from the prolong if any, from the total gain in weight of the bulbs, might be taken to be the amount of moisture also condensing on the potash bulbs, and the necessary correction in the weight of the latter could then easily be made. But C. B. Dudley somewhere refers to a method of overcoming this difficulty of moisture condensation suggested by Andrew A. Blair which seemed much easier; this was to have an empty potash bulb on the opposite pan of the balance when weighing. This method of Blair's was accordingly tried, retaining, however, the sulphuric acid bulbs as a check. A succession of damp days gave abundant opportunity, and it was found that the unusual gains and losses in the weight of the sulphuric-acid bulbs still continued to occur. But the empty potash bulbs were not of the same type as those to be weighed as directed by Blair. The potash bulbs were of the Geissler form and the empty bulbs of the Liebig form, for convenience in weighing, since the latter shape leaves the pan entirely empty for the weights. As the total surface area of the two bulbs was about the same, the difference in shape was thought to be of no consequence, but from the results it seemed that, either this difference in shape caused a difference in moisture condensation; or the passage of gas, air, and moisture, through the potash and sulphuric bulbs, caused a slight heat which gave a different condensation from that on the empty bulbs; or, the condensation of moisture occurred without rule and uniformity; that is, might occur on the one set of bulbs without occurring also at the same time on the others or not to the same degree and *vice versa*. Tests made by simply

allowing all three of the bulbs stand instead of passing gas and air through two of them as in a determination seemed to show the latter of these theories to be correct. The condensation seems at times to take place entirely at random, so to speak. A condensation on the one bulb does not necessarily mean a condensation on the others, and neither the empty bulbs on the opposite pan nor the weighed sulphuric-acid bulbs are therefore to be depended upon as a means of counteracting, or estimating the moisture condensing on the potash bulbs. The results were as follows :

Time of standing.	Gain or loss of weight in terms of carbon.	
	Potash bulbs.	Sulphuric bulbs.
Hours.	Per cent.	Per cent.
1	—0.007	—0.014
12	—0.008	—0.007
1	—0.008	—0.006
12	—0.004	—0.001
12	0.012	0.012
12	0.039	0.018
12	—0.014	—0.005
12	0.004	0.044
12	0.002	0.005
1	0.000	—0.002
12	0.011	0.010
1	0.004	0.007
12	0.008	0.006
12	0.005	—0.008
1	—0.013	—0.001
12	0.003	0.014
12	0.026	0.027
1	0.006	—0.024
12	—0.032	—0.026
12	—0.012	0.010
1	—0.004	—0.006
12	—0.006	0.007
12	—0.013	—0.006
1	—0.007	0.004
12	—0.008	—0.003
1	0.006	0.015
1	0.000	0.000
12	—0.023	0.008
1	0.032	0.026
1	—0.012	—0.004
12	—0.006	0.007
1	—0.012	—0.010
12	0.015	0.029
1	—0.009	—0.010

In taking these weights the empty bulbs on the opposite pan of the balance were used.

Provided the sulphuric bulbs be used to estimate the outside condensation of moisture, and empty bulbs on the opposite pan be also used, what is the error from moisture condensation in a determination? To gain some idea the following tests were made. The first column of results gives the results as they were obtained without any correction for moisture condensation and the very great source of error brought into the process by the use of these sulphuric bulbs, if their gain in weight be always attributed solely to inside moisture from the prolong, is seen by the results of this column. The second column gives the results after being corrected for moisture condensation by the indication of the sulphuric-acid bulbs, assuming the moisture condensing on the potash bulbs to be just equal to that on the sulphuric bulbs. The empty bulbs on the opposite pan were also used.

No.	Apparent result. Per cent.	Corrected result as indicated by sulphuric bulbs. Per cent.	True result obtained in dry weather. Per cent.	Error. Per cent.	Moisture condensed on sulphuric bulbs in terms of carbon. Per cent.	Moisture condensed on potash bulbs in terms of carbon. Per cent.
237	0.976	0.904	0.904	0.000	0.036	0.036
237	0.827	0.927	0.904	0.023	—0.050	—0.027
264	0.024	0.032	0.031	0.001	—0.005	—0.002
278	0.953	0.993	0.983	0.010	—0.020	—0.010
278	1.075	0.975	0.983	0.008	0.050	0.027
1.05	1.096	1.09	1.056[1]	0.034	0.000	0.039
1.05	1.106	1.104	1.056	0.048	0.000	0.048
1.05	1.15	1.033	1.056	0.023	0.058	0.035
1.05	1.077	1.057	1.056	0.001	0.010	0.010
1.00	0.94	1.06	1.00	0.060	—0.062	0.002
0.625	0.641	0.631	0.625	0.006	0.005	0.011
Dummy	0.024	0.016	0.005	—0.021	0.020	—0.003
"	0.111	0.015	0.005	—0.010	0.048	0.058
"	—0.034	0.036	0.005	0.031	0.035	0.004
"	0.038	0.018	0.005	0.013	0.020	0.023
"	—0.032	0.024	0.005	0.019	0.028	0.009
"	—0.011	0.011	0.001	0.010	—0.011	0.000
B1	1.125	1.095	1.10	0.005	0.016	0.010
238	0.824	0.935	0.905	0.029	—0.055	—0.025

In the following the "true" result was found by taking the averages of the corrected results:

[1] Booth, Garrett, and Blair's result, 1.053. Result by wet method, 1.063. By dry method, 1.05. Average, 1.056.

No.	Apparent result. Per cent.	Corrected result as indicated by sulphuric bulbs. Per cent.	True result obtained in dry weather. Per cent.	Error. Per cent.	Moisture condensed on sulphuric bulbs in terms of carbon. Per cent.	Moisture condensed on potash bulbs in terms of carbon. Per cent.
284	0.272	0.152	0.163	0.011	0.064	0.045
284	0.117	0.177	0.163	0.014	—0.030	—0.016
301	0.18	0.14	0.118	0.022	0.020	0.040
301	0.095	0.137	0.118	0.019	—0.020	—0.003
301	0.119	0.105	0.118	0.013	0.007	—0.006
301	0.134	0.09	0.118	0.028	0.022	0.006
314	0.705	0.805	0.775	0.030	—0.050	—0.020
314	0.89	0.75	0.775	0.025	0.070	0.045
295	0.045	0.095	0.087	0.008	—0.025	—0.017
295	0.135	0.090	0.087	0.003	—0.023	—0.025
295	0.115	0.055	0.087	0.032	0.030	—0.001
295	0.092	0.077	0.087	0.010	0.007	—0.003

The greatest error is 0.06 per cent. though in most of the tests it does not exceed 0.03 per cent., which, in high carbon steels at least, is for ordinary purposes permissible. But 0.06 per cent. is, of course, too great an error. How may it be reduced to within reasonable limits? Probably by using smaller bulbs as is the custom of Dudley; or probably by using small soda-lime tubes as does Stillman, who in his book, "Engineering Chemistry," says that "they are much more convenient and less liable to variation in weight."

The error is, of course, completely eliminated in such methods as that of the Pittsburg Testing Laboratory described by Handy in this Journal, in which barium hydroxide is the absorbent; the barium carbonate is filtered off, and the excess of hydroxide titrated with standard acid, or, where the carbon dioxid is measured, with corrections for pressure, etc.

In the method described in this article, the question arises, why trouble to use the sulphuric bulbs and the empty bulbs in the opposite pan of the balance, if the condensation of moisture is not at the same occasion equal, nor nearly so in many cases, on all the bulbs used?

The following comparisons of errors were made. These figures are not the results but the errors only. For results (but of the sulphuric bulb column only) see the preceding table:

No. of determination.	Error, using sulphuric bulbs. Per cent.	Error, only potash bulbs used. Per cent.
237	0.000	0.036
237	0.023	0.027
264	0.001	0.002
278	0.010	0.010
278	0.008	0.027
D	0.021	0.003
D	0.010	0.058
D	0.031	0.004
D	0.013	0.023
D	0.019	0.009
D	0.010	0.000
B1	0.005	0.010
238	0.029	0.025
284	0.011	0.045
284	0.014	0.016
1.05	0.034	0.039
1.05	0.048	0.049
1.05	0.023	0.035
1.00	0.060	0.003
0.625	0.006	0.011
301	0.022	0.040
301	0.019	0.003
301	0.013	0.006
301	0.028	0.006
314	0.030	0.020
314	0.025	0.045
295	0.008	0.017
295	0.008	0.025
295	0.032	0.001
295	0.010	0.003
1.05	0.001	0.010

There is no marked difference in favor of the results obtained by use of sulphuric bulbs. But in actual work, the errors on that side would in many cases be not so extreme, as here indicated, as the operator could average. For instance, in the extreme case "1.00," the error is 0.060 per cent., the condensation of moisture on the sulphuric bulb amounting to —0.062 per cent. Now the operator could not, of course, tell whether the condensation on the potash bulb was also —0.062 per cent. or nothing at all, or somewhere between. If it also occurs to that amount on the potash bulbs, then the true result is 1.06 per cent. If it does not occur at all on the potash bulbs then

the result is 1.00 per cent. By averaging he would get a result of 1.03 per cent. which would not be more than 0.03 per cent. away from the truth in either case, and might be much closer than that, so that in this way it is sometimes advantageous to use the sulphuric bulbs, but whether this advantage is sufficient to compensate for the double labor of weighing two bulbs is perhaps doubtful. In cases where the condensation is on the potash bulbs only as in "1.05", of the first table, and none happens on the sulphuric bulbs, there of course the latter are of no use whatever and the whole error falls on the result as much so as if they had not been used; also if the moisture condensation is confined to the sulphuric bulbs, they are of no avail except to introduce an error into the result, not more than 0.030 per cent. however, although the table shows this to be of infrequent occurrence, both bulbs being usually affected, though rarely to the same degree. As before said, the true remedy is doubtless in the use of smaller bulbs, or in the substitution of soda-lime tubes.

In getting the dummy result it is obviously better to use a small calcium-chloride tube than the potash bulbs; as the dummy result, if any, is simply due, if a preheating furnace be used, to moisture escaping absorption by the drying train, no potash need be used; and also in determining the moisture escaping the prolong, it is better to use the small calcium-chloride tube, making several tests. The dummy results in the table show the impossibility of getting anything like absolute blanks, or anything like true blanks by the usual method in very damp weather.

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THE CHEMISTRY OF CASCARA SAGRADA.[1]

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THE most generally used medicines are most probably laxative medicines, and the most generally used laxative medicine is most probably cascara sagrada bark. This is due to the remarkable property it possesses of being a tonic as well as a laxative, and in no less degree to the fact that its action is

[1] Presented by the Special Research Committee at the Forty-Fifth Annual Meeting of the American Pharmaceutical Association, August, 1897.