

were used; 8 lbs. and 10 lbs. borax seemed to cause less root formation at the seed and more surface roots.

4—With optimum moisture plants seem to recover somewhat from the toxic effect of borax when used 6 lbs. per acre, but in short seasons the recovery would be too late for good crop results.

5—The fact that the fertilizer having more than 6 lbs. of borax to the acre prevented seed roots and the root system was largely near the surface, would result in the plants being stunted and probably dying in a dry season.

METHODS FOR DETERMINATION OF BORON

Much work has been done on the distillation method and the government method, both qualitative and quantitative, for determining boron.¹

ANALYST	SAMPLE										Blanks	
	G.	D.	G.	D.	G.	D.	G.	D.	G.	D.	Cc. 0.1 N NaOH	G.
1	0.25	0.27	0.17	0.13	0.11	0.10	0.09	0.09	0.05	0.04	0.4	.07
2	0.25	0.25	0.10	0.13	0.07	0.09	0.08	0.07	0.02	0.05	0.15	..
3	0.25	0.33	0.16	0.20	0.08	0.13	0.14	0.12	0.07	0.09	0.4	1.0
4	0.19	0.18	0.11	0.13	0.09	0.08	0.07	0.08	0.04	0.06	0.00	1.20
5	0.27	0.29	0.15	0.16	0.13	0.09	0.06	0.05	0.08	0.03	0.4	0.4
6	0.19	0.22	E..	..	0.16	0.12	E..	..	0.08	0.04	E..	..
	..	0.20	..	..	..	0.10	..	..	0.05	..	0.9	0.3
7	0.26	..	..	..	0.10	..	..	..	0.05	..	0.2	..
8	0.21	L..	..	..	0.07	L..	..	..	0.04	L..	0.12	..
9	0.21	..	..	..	0.08	..	..	..	0.01	..	..	..
10	RT	RD	..	..	RT	..	..	..	RT	..	..	..
	0.40	0.32	..	..	0.07	..	..	..	0.02	..	..	..
11	(0.05)	..	..	..	0.01	Plus Q..	..	..	0.01	Plus Q..	..	..
	0.22	0.20	..	..	0.08	0.07	..	..	0.03	0.03	0.35	0.35

E—Evaporating distillate to dryness and proceeding as in determining salts.

L—Lipscomb method—Clemson College, S. C.

RT—Results by turmeric method according to Rudnick.

RD—Distillation method according to Rudnick.

Q—More than—by qualitative turmeric test—Swift.

G—Government method—Bureau of Soils.

D—Gladding method—distil with methanol.

Other methods have been suggested, but are, as a rule, modifications of these two. Jones and Anderson¹ of the Vermont Station have suggested a modification which is accurate and speedy. The South Carolina Experiment Station has proposed a method worked out by Lipscomb, Inman and Watkins.²

Five samples of varying percentages of borax were prepared by the writer and analyzed by five different chemists, and three of the samples were analyzed by eleven different chemists. The results are given in the accompanying table.

The borax content in Sample 1 was 0.25 per cent, and in Sample 5 less than 0.01 per cent. The other samples were:

Sample 2—0.5 No. 1 and 0.5 No. 5
Sample 4—0.25 No. 1 and 0.75 No. 5
Sample 3—0.33 No. 1 and 0.66 No. 5

Since this work has been done everyone has had more experience with the borax determinations, and the results as listed under Sample 5, which show from 0.01 up to 0.08 per cent by the government method, have been reduced to 0.01 per cent and less.

CONCLUSIONS

The government method gives accurate results when carefully carried out, but time may be saved by using the Jones and Anderson modification.

All reagents must be free from carbonate.

Separation of the phosphates must be complete and no precipitate should form on standing after the final titration, which point is noted in the government method.

Results should be confirmed by the qualitative test.

Determination of Chlorides in Petroleum²

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In order to determine the corrosiveness of water in petroleum, and the amount of soluble salts which may be crystallized and precipitated when the oil is distilled, a determination of chlorides in the water is generally necessary. Some light petroleum easily give up this water, and a sample can be obtained and readily titrated. There are oils, however, which do not become entirely anhydrous no matter how long they are allowed to settle, though they may eventually reach a point where there is 0.2 to 0.4 per cent of water and sediment. For such oils the method described below has been evolved so that a determination of the chlorides may be easily possible. Various other methods than the one shown have also been tried, but have failed to give concordant results.

OUTLINE OF METHOD

The sample of oil is thoroughly mixed by shaking the can, or other receptacle, in which it has been received, so that whatever salt water is present may be uniformly distributed in the oil, and 500 cc. are carefully measured into a 500-cc. graduated cylinder. The oil is then drained into a 2000-cc. graduated, glass-stoppered cylinder, and 125 cc. of acetone are mea-

sured in the same 500-cc. cylinder. (The U. S. P. grade of acetone may be used, but it must be tested to be sure no chlorides are present.) After the acetone has been added to the oil in the 2000-cc. cylinder, the two are thoroughly mixed by shaking for approximately 3 min. The action of the acetone appears to be two-fold, to reduce the viscosity of the oil, and to take up and collect the salt water. The total volume is now brought up to 2000 cc. with 1375 cc. of distilled water, which is also measured in the 500-cc. cylinder, thus thoroughly cleaning out all chlorides which may have been left in the cylinder. The distilled water, oil, and acetone should be completely mixed for approximately 5 min. Care must be taken in shaking, since too violent an agitation has a tendency to produce a semi-emulsion which will settle out quite slowly. This is especially true of oil which contains much paraffin, and extreme agitation has not been found necessary for complete extraction of the acetone and salt water. The contents of the cylinder are allowed to settle until approximately 500 cc. of the water and acetone have settled out. About 400 cc. of the acetone-water mixture are next drawn off with a glass siphon. If a lit-

¹ *Am. Fertilizer*, March 13, 1920.

² Received January 20, 1921.

¹ *Am. Fertilizer*, April 10, 1920.

² *Ibid.*, February 28, 1920.

the oil comes with it, it is removed by filtering through dry filter paper. An aliquot part, depending on the salt content, is then concentrated for titration with a solution of approximately 0.05 *N* silver nitrate, using potassium chromate as an indicator. From these results the chlorine can be calculated, or, if previous analysis of similar brine has shown it to consist mostly of sodium chloride, it may be calculated as such.

We have tested the accuracy of the method by making a re-treatment of some of the oil which had settled out after the treatment outlined above. A mere trace of chlorides could be found, thus furnishing good proof that the first treatment had effected their almost complete removal.

The method has been used for about a year, and the following check results, expressed as grams of salt per liter of oil, have been obtained:

Gravity of Crude ° Bé.	B. S. & W. Per cent	Water by Dist. Per cent	First Result G.	Second Result G.
30.9	1.0	0.8	0.77	0.75
36.5	2.2	1.6	0.49	0.50
31.3	0.6	0.5	0.72	0.75
35.8	0.9	0.8	0.35	0.37
32.3	1.6	1.1	0.60	0.59
31.4	0.8	0.6	0.67	0.68

ACKNOWLEDGMENT

Experimental work on the method was carried out in this laboratory by Messrs. Philip A. Crosby and John G. Campbell.

LABORATORY AND PLANT

Humidity Control by Means of Sulfuric Acid Solutions, with Critical Compilation of Vapor Pressure Data¹

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NEED FOR HUMIDITY CONTROL IN LABORATORY WORK

In the course of both research and routine laboratory work, many occasions arise when it is desired to maintain a definite humidity in an enclosed space or to produce a stream of air of definite moisture content. In studying the humidity equilibria and rate of drying of various substances, such control is, of course, a prime requisite. There are, however, many other properties of materials which vary greatly with changes in their moisture content. In order to obtain reproducible results in any investigation which relies upon the quantitative measurement of such properties, it is therefore necessary either to test the materials in an atmosphere of a definite humidity, or else, when the time of the test is short compared with the rate of taking up moisture, previously to equilibrate them with a definite humidity.

In cases where only a single humidity is to be used for such tests, this Laboratory has adopted 50 per cent relative humidity as a standard for articles which are to be tested under conditions approximating those prevailing indoors, and 65 per cent humidity to approximate those prevailing outdoors. In many cases, however, it is necessary to make the tests under a variety of conditions. Accurate control of temperature is generally not as important as control of humidity, as the moisture content of most materials varies but little with moderate changes in temperature, providing the relative (not absolute) humidity is kept constant.

The object of this article is not to suggest any new methods of obtaining this humidity control, but merely to present in convenient form the data which this laboratory has compiled from the literature, or found by practical experience, with reference to what seems to be the most satisfactory method of small-scale humidification, namely, the use of sulfuric acid solutions of definite composition.

ADVANTAGES OF SULFURIC ACID SOLUTIONS FOR HUMIDITY CONTROL

Sulfuric acid solutions have many advantages over other materials which might conceivably be used for this purpose. Homogeneous solutions varying from 0 to 100 per cent water can be obtained; the vapor pressure of these solutions has been much more accurately determined than for any other concentrated solutions; the composition, and hence the vapor pressure, of the solutions can be quickly and accurately determined by measuring their density, which varies greatly with changes in composition; their relative vapor pressure (per cent of that of pure water at the same temperature) varies but little with wide changes in temperature; they come to equilibrium rapidly with the surrounding atmosphere; the sulfuric acid itself exerts no appreciable vapor pressure; and finally, material of adequate purity is cheap and readily obtainable.

For the purpose of maintaining a constant humidity in a closed chamber, sulfuric acid solutions have no real competitor under ordinary conditions, since it is merely necessary to place within the chamber some acid of the proper strength with an amount of surface exposed in general somewhat larger than that of any other moist or hygroscopic material present.

When a fairly large stream of humidified air is to be produced it is, of course, possible to obtain it by mixing two streams of air, one of which has been thoroughly dried and one of which has been bubbled through water. By varying the relative amount of the two streams it is possible to obtain any desired humidity. This necessitates, however, both drying and humidifying fairly large amounts of air, and also the maintenance of an absolutely constant ratio between the two streams. It also requires frequent analytical control which, at lower temperatures, necessitates the use of an absorption method. At higher temperatures wet and dry bulb thermometers

¹ Received December 14, 1920.