

during the production of ten crops of cane, therefore one-tenth of these amounts may be taken as a nearest approach to the proportions of lime, potash, and phosphoric acid that are available for the immediate crop."<sup>1</sup>

As it has been said, the principle of this method rests upon the assumption that the solvent used shall compare with the solvents that are actually operating in nature; and that the standards of control of the results of this method are the ascertained results of the natural processes of soil-decomposition in the field. Not any consideration has made it appear advisable to the author that a solvent should be used which is not found among the acids that result from vegetable existence and decay, and which consequently is not used by nature in the field. It has, on the other hand, appeared to him absolutely necessary that, before concluding that the results obtained by the use of any artificial method of examination are rational, and of any authority and value, these results should be subjected, if possible, to comparison with the standard of results actually following from the processes operating in the field.

HAWAIIAN EXPERIMENT STATION.

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[CONTRIBUTIONS FROM THE HAVEMEYER LABORATORIES, COLUMBIA UNIVERSITY, No. 5.]

### TESTS FOR BORIC ACID.

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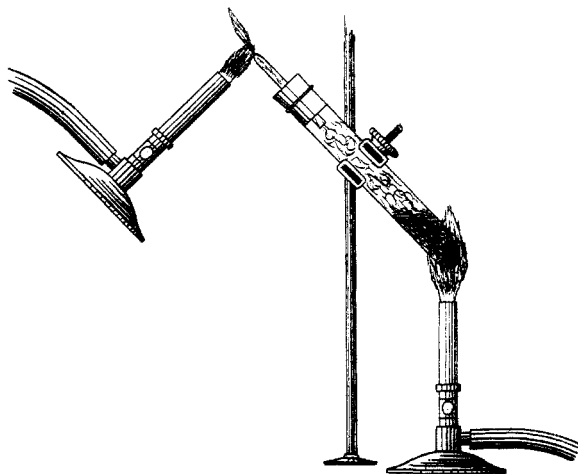
THE following investigation of the various tests for boric acid originated in an attempt to improve on the well-known boric ether or flame test.

In Newth's "Chemical Lecture Experiments," p. 227 (1892), is pictured and described an apparatus for producing this gas on a comparatively large scale. It occurred to us that this might be so modified as to make it useful as a qualitative test, and we devised the apparatus shown in the cut. It consists of a test-tube (six inches), fitted with a cork through which a glass-tube passes, the latter being drawn out so as to form a moderate-sized jet. In the test-tube is placed a mixture of the borate, concentrated sulphuric acid and alcohol, and the cork and jet

<sup>1</sup> See "Lavas and Soils of the Hawaiian Islands," p. 181.

tube inserted. The mixture is heated sufficiently in the Bunsen flame to freely volatilize the alcohol which then escapes through the jet and is burned in the flame of a second Bunsen burner. If boric acid is present, the flame will show its characteristic green tint.

In order to determine whether the test made in this manner was any more delicate than by the old method, solutions of known strength were made up, and comparative tests made of the two methods. In each of these tests, the following quantities of the different substances were taken: Borax solution, one cc.; sulphuric acid (sp. gr. 1.84), two cc.; and alcohol, ten cc. By the usual method, it was possible to detect the boric acid in



a solution, one cc. of which contained 0.01 gram of boron trioxide ( $B_2O_3$ ). With the new apparatus we found that with a solution of one-tenth this strength (one cc. = 0.001 gram boron trioxide), a faint green color was perceptible, thus showing it to be an improvement on the test as usually conducted. Copper and barium salts were subjected to the same test, and it was found they did not interfere, giving no coloration to the flame.

These comparisons completed, we thought it advisable to carry our work still further and determine the degree of sensibility of the other tests in use. The fluoride test was made as follows: A bead of potassium fluoride and acid potassium sul-

phate was made in the loop of a platinum wire, at as low a heat as possible in order that the acid sulphate might not be decomposed. This bead was then dipped in the borax solution and heated in the Bunsen flame. A solution containing 0.01 gram boron trioxide in one cc. gave a faint green flame. With 0.001 gram per cc. no color was visible.

The glycerine test was also tried, the operation being conducted as follows: A bead of acid potassium sulphate was made and dipped into the borax solution, and then ignited sufficiently to decompose the sulphate and liberate the boric acid. After cooling, it was dipped into glycerine, and the latter ignited in the flame. On removing the bead from the flame, the glycerine continues to burn, giving a green flame if any boric acid is present. The limit of sensibility of this method was found to be a solution containing 0.001 gram boron trioxide per cc., this amount giving a faint green tinge to the flame.

Leaving the flame tests we now come to the one with turmeric paper. The solution to be tested was acidified with dilute hydrochloric acid, and the paper moistened with the acidified solution was dried at 100°. A solution containing only 0.0001 gram boron trioxide gave a distinct pink color on the paper, thus proving turmeric to be the most delicate of all.

In comparing the delicacy of the various tests, it is well to remember that the quantity of boric acid actually taking part in the bead and turmeric paper tests, is much less than the amount contained in one cc. of the solution tested. For example in the bead tests, one drop of the solution was sufficient to saturate the bead, and as one cc. was found to contain about fifteen drops the amount of boric acid actually used was only one-fifteenth of that present in one cc. For the turmeric paper test, two drops of the solution were ample.

In the following table the results have been calculated on this basis.

	Limit of test. Gram.	B <sub>2</sub> O <sub>3</sub> actually present in test. Gram.	B <sub>2</sub> O <sub>3</sub> in solution. Per cent.
Boric ether flame (old method) ..	0.01	0.01	1.0
Boric ether flame (new method) .	0.001	0.001	0.1
Glycerine method . . . . .	0.001	0.00006	0.1
Potassium fluoride and acid potassium sulphate method . . . . .	0.01	0.0006	1.0
Turmeric paper method . . . . .	0.0001	0.000013	0.01

Although the test with turmeric paper is by far the most delicate, it is a well-known fact that with the average student in qualitative analysis, the results are very uncertain; should a trifle too much acid be used to liberate the boric acid, the turmeric paper when dried will be brown instead of pink. If insufficient acid be added, there will be no boric acid coloration of the paper, even though considerable borate may be present.

The method that we recommend is intended to supplant the usual watch-glass or porcelain dish method that is in general use in most qualitative laboratories. Our modification of this method not only makes the test more delicate, but may be performed with the simplest apparatus; a test-tube, cork, and small piece of tubing are all that is necessary.

### THE SPECIFIC GRAVITY OF CESIUM.

BY A. E. MENKE.

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THE specific gravity of cesium was determined many years ago by Setteler and given as 1.88. He, however, worked with relatively small quantities of the metal (0.6 and 1.1 gram) as his method of preparation did not allow him to obtain cesium in quantity. I have recently, in collaboration with Prof. Hugo Erdmann of Halle, made cesium on a large scale and it seemed to me advisable to redetermine the specific gravity.

The cesium for this purpose was purified by several redistillations in hydrogen, and then examined spectroscopically. The metal was weighed in hydrogen and then under liquid paraffin giving the following results as the specific gravity referred to water.

No. 1. ....	2.4001
No. 2. ....	2.4004
No. 3. ....	2.3996
No. 4. ....	2.4002
No. 5. ....	2.3998
No. 6. ....	2.4001
Mean .....	2.40003

In each case not less than four grams of metal were employed, and the proper correction made for hydrogen weighing.

These results change the atomic volume of cesium from the figure usually given (70.6 to 55.3) which does not make the drop