In the crop mentioned above to replace the phosphoric acid and potash carried off from one acre by the melons alone, not taking into account the vines and roots, would require:

	Pounds.
Acid phosphate (thirteen per cent. P_2O_5)	100
Muriate of potash (fifty per cent. K_2O)	160

A fair crop of melons upon good land, however, is usually considered to be about one-third of the above large crop or about one-half carload. If we estimate then the amounts of phosphoric acid and potash required for an average crop of fair character, such a crop will take from the soil materials to replace which will require about:

	Pounds.
Acid phosphate	$33\frac{1}{3}$
Muriate of potash	$53\frac{1}{3}$

This will give about four and one-half pounds of available phosphoric acid to an acre, and about twenty-seven pounds of pure potash to an acre. The usual goods on the market guarantee about ten per cent. of available phosphoric acid and about one per cent. of potash. The use of 300 pounds of such goods upon each acre of watermelons, furnishes thirty pounds of available phosphoric acid, or about six and one-half times as much as is needed to replace what is carried off by the watermelons. It also furnishes about three pounds of potash, which is only one-ninth of what is carried off by the crop removed. This being the case it shows with what advantage and economy the watermelon grower can replace a large proportion of his phosphoric acid with potash.

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A MODIFIED FORM OF THE EBULLIOSCOPE.

BY H. W. WILEY.

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THE determination of the alcohol in wines and beers, from the temperature of the vapors given off on boiling at atmospheric pressures, has long been practiced. The instrument by means of which this determination is made is known as the ebullioscope or ebulliometer. The use of this instrument

was proposed many years ago by Tabarié, and it has been improved by Malligand, Salleron and others.

It is evident that if so simple an apparatus could be made to give accurate data, it would come into general use for ordinary purposes. The difficulties which have attended the use of the ebullioscope, however, have been of such a nature as to render the data given by it somewhat unreliable. Among these difficulties may be mentioned the fact that a wine or beer contains a considerable quantity of dissolved matters, which serve to render the temperature of the boiling liquid higher than the temperature of a mixture of a similar percentage of alcohol with water. While the temperature of the vapors emitted are, theoretically, not influenced in a marked degree by the initial temperature at which they are formed, nevertheless, in practice it has been shown that the tendency of the higher initial boiling point is to give a higher reading to the thermometer whose bulb is surrounded by the emitted vapors.

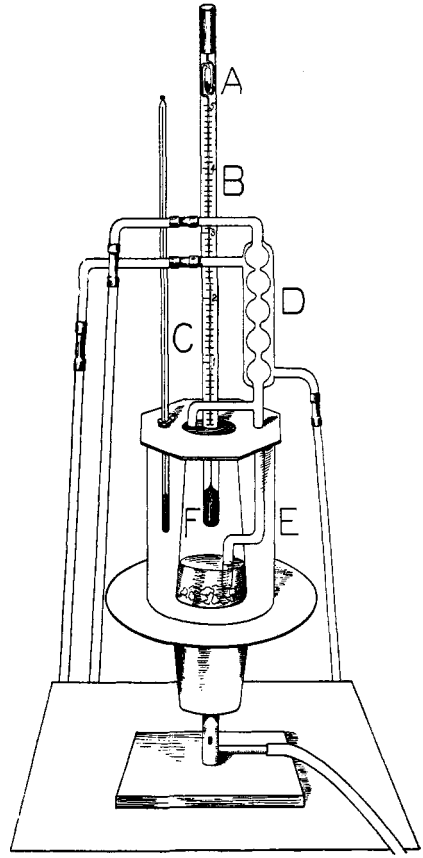
Another difficulty attending the use of the ebullioscope is found in the fact that the percentage of alcohol in the vapors emitted is much greater than in the residual liquid. As a result, it is difficult to establish a balance between the condensed vapors and the liquid remaining in the flask, in such a manner as to secure a continuous evolution of a vapor containing a definite proportion of alcohol.

In the third place, it has been customary to return the condensed vapors through the apparatus in such a way that they come in contact with the uncondensed vapors surrounding the thermometer. By this means the vapors surrounding the bulb of the thermometer are subjected to changes of temperature which render it difficult to get a mean reading of the height of the mercurial column in the instrument. The variations which the mercurial column may undergo amount, in some instances, to two or three-tenths of a degree and as each tenth of a degree represents approximately a tenth of a per cent. of alcohol, it is not difficult to see that these variations would tend to lead to erroneous results.

In the fourth place, barometric changes, which are constantly taking place in the atmosphere, change the boiling point of the

vapor of water so that it is frequently necessary to check the instrument with pure water, in order to have an initial temperature for the calculations.

In the apparatus which is presented, an effort has been made to remedy the difficulties which have been mentioned above. The apparatus consists of the flask *F*, which is closed by a rubber stopper carrying the large thermometer *B* and a tube leading to the condenser *D*. The vapors which are given off during ebullition are condensed in *D* and return to the flask through the tube, as indicated in the figure, entering the flask below the surface of the liquid therein.



The flask is heated by a gas lamp and is placed upon a circular disk of asbestos in such a way as to entirely cover the hole in the center of the asbestos disk, which is a little smaller than the bottom of the flask. The whole apparatus is protected from external influences of temperature by the glass cylinder *E*, which rests upon the asbestos disk below and is covered with a detachable, stiff rubber cloth disk above.

The thermometer *C* indicates the temperature of the ambient air between *F* and *E*. The reading of the thermometer *B* should always be made at a given temperature of the ambient air, as indicated by *C*. The tube leading from the top of the conden-

ser *D* to the left, is made long and is left open at its lower extremity, in order to secure atmospheric pressure in *F*, and at the same time prevent the diffusion of the alcohol vapors through *D*.

The flame of the lamp is so regulated as to bring the temperature of the thermometer *C* to about 90° in ten minutes for substances not containing over five per cent. of alcohol. After boiling for a few minutes, the temperature, as indicated in the thermometer *B*, is constant, and the readings of the thermometer should be made at intervals of about half a minute for two minutes. Some pieces of scrap platinum placed in the flask will prevent bumping and secure a more uniform evolution of vapor.

Slight variations, due to the changes in temperature of the vapor, are thus reduced to a minimum effect upon the final results.

The apparatus is easily operated, is quickly charged and discharged and with it at least three determinations of alcohol can be made in an hour.

The thermometer used is the same as is employed for the determination of freezing and boiling points in the ascertainment of molecular weights. The reading of the thermometer is arbitrary, but the degrees indicated are centigrade. The thermometer is set in the first place by putting the bulb in water containing sixteen grams of common salt to 100 cc. When the water is fully boiling, the excess of mercury is removed from the column in the receptacle at the top and then, on placing in ordinary boiling water, the column of mercury will be found a little above the 5° mark. This will allow a variation in all of 5° in the temperature, and a thermometer thus set can be used for the estimation of percentages of alcohol from one to five and a half, by volume. When the liquor contains a larger percentage of alcohol than this, it is advisable to dilute it until it reaches the standard mentioned.

In order to avoid frequent checking of the thermometer, rendered necessary by changes in barometric pressure, I use a second apparatus made exactly as the one described, in which

water is kept constantly boiling. It is only necessary in this case to read the two thermometers at the same instant in order to make any necessary correction required by changes in barometric pressure.

It is not my purpose here to submit a table showing the percentages of alcohol corresponding to any given depression in the temperature of the boiling vapor. It is only necessary to call attention to the fact that for the percentages named, the platted line showing the variation in depression from 0° to five per cent. by volume of alcohol is practically straight and that for each 0.8° change in the boiling point of the vapor, there is a change of about one per cent by volume of alcohol. This rule can be safely applied for practical purposes to all liquors containing not more than five and five-tenths per cent. of alcohol. For instance, if, in a given case, the temperature of the vapor of boiling water, as marked by the thermometer, is 5.155°, and the temperature of the vapor of a sample of beer is 2.345°, the depression is equivalent to 2.810°, and the percentage of alcohol by volume is therefore 2.81 divided by 0.80 = 3.51.

The thermometer used is graduated to hundredths of a degree and is read by means of a cathetometer, which will easily give readings to five thousandths of a degree.

The reading of the thermometer is facilitated by covering the bulb with a test-tube containing water. The high specific heat of the water distributes evenly any little variations of temperature which otherwise would cause the mercurial column in thermometer *B* to oscillate. The water jacket also serves as a protection against the projection of any particles of the boiling liquor directly against the bulb of the thermometer.

It is believed that this apparatus is the best form of ebullioscope which has yet been offered for practical use to analysts.