uranyl phosphate ($UO_2NH_4PO_4$) was filtered on an asbestos felt contained in the platinum cone which had been previously moistened with a 2% solution of ammonium acetate. After carefully washing the precipitate with the 2% ammonium acetate solution the cone and contents were transferred to a funnel of convenient size and the precipitate was dissolved and washed into a 150 cc. Erlenmeyer flask with the use of a 16% solution of sulfuric acid. This solution was then treated in turn with titanous sulfate and bismuth trioxide and titrated with potassium permanganate exactly as described in the process for the estimation of uranium. The results obtained are given in Table III.

STORRS, CONN.

EXPERIMENTS ON THE DISTILLATION OF LIQUID AIR IN A MAGNETIC FIELD.[1]

BY R. S. MCBRIDE.

Received April 20, 1915.

In a letter to the Bureau of Standards dated February 8, 1912, Mr. A. Cressy Morrison of New York City, suggested that the magnetic properties of liquid oxygen were such as perhaps to make possible an improvement in the separation of oxygen and nitrogen by distillation of liquid air in a strong magnetic field and requested the Bureau to investigate this point. No extended search of the literature was made, but it was believed that this possibility had not been previously tested. Although there was no evident theoretical ground for the belief that the separation might be improved by this method, the possibilities seemed sufficient to justify the Bureau in making the preliminary tests which are described below.

It was found necessary to use small Dewar tubes so that the evolution of the gas would be sufficiently slow and uniform to make possible accurate sampling at different stages of the distillation. For each comparison the tubes, which were about 2.8 cm. inside diameter and 20 cm. long, were first filled with a sample of the liquid air to chill them, then emptied, filled with equal quantities (25 to 50 cc.) of the liquid and one was placed in position between the poles of a powerful electromagnet and the other entirely outside the magnetic field.

Samples of the gases coming off from the tubes were collected over water at known intervals and analyzed. By comparison of the results obtained from the two simultaneous distillations, the influence of the magnetic field was determinable. Since the speed of evaporation could not be made exactly the same in the two distillations which were to be compared, the quantity of gas evolved during the intervals between collection of samples was measured roughly and the comparison between dis-

[1] Published with the permission of the Director, Bureau of Standards, Washington.

tillations made on the basis of percentage of the total samples evaporated. From the analyses of the samples and the known intervals expressed in percentage of total gas, the curves were drawn to show the difference in composition of the gas given off at different stages of the distillation. From these results values were calculated to show approximately the composition of the liquid at different stages of the distillation.

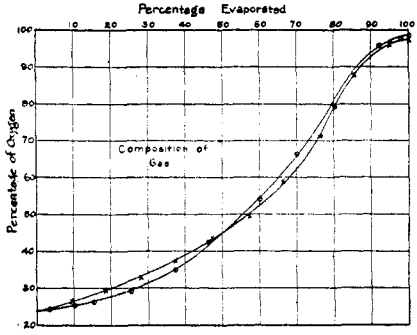
In the first comparison the tube was placed directly between the poles of the magnet, giving a field of approximately 10,000 lines of force per square centimeter, but in the other three comparisons this field was directed by placing beneath the tube and in contact with one pole piece a small iron block so shaped as to increase the intensity of the field through the space occupied by the liquid. Under these conditions it was impossible to estimate with any precision the exact strength of this field through the liquid; without filings and block it would have been one of 8,000 lines of force. In the last comparison both the tubes contained, in addition to the liquid air, slightly less than 20 cc. of fine iron filings, suggested by Mr. Morrison as a means of directing the field.

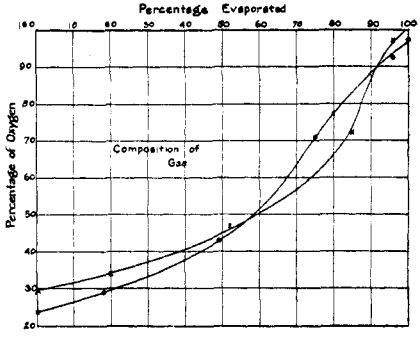
In each experiment the rate of evaporation was slightly (5–10%) greater in the magnetic field, which may have had some influence on the separation. This effect may have been because of difference in the tubes themselves, difference in radiation and temperature conditions (one tube being warmed slightly by proximity to the poles of the magnet) or because of the larger liquid surface, caused by the attraction of the liquid toward the poles.

By examination of the figures it can be seen that in each comparison less oxygen came off during the early part of the distillation in the magnetic field than in a similar distillation outside the magnetic field. It is evident, therefore, that there was a tendency toward a better separation and it appears that the magnetic field has some beneficial influence upon the separation, although the limited number of experiments made did not conclusively prove this point. The results of Plate 4, when compared with those given in Plates 2 and 3, indicate that the filings, if of any influence, did not improve the separation.

The separation of two miscible liquids of approximately the same boiling point by a fractional distillation depends, of course, primarily upon the difference in the partial vapor pressure of each of the constituent liquids at the boiling point of their mixtures. Unless we assume, therefore, that the vapor tension of liquid oxygen is, in effect, changed by the influence of a strong magnetic field (due either to real change in the equilibrium pressure or to a mechanical holding back of oxygen in the field) it is difficult to explain why such field should produce any effect upon the fractional separation of the gases.

It has been impossible for the author to continue this investigation





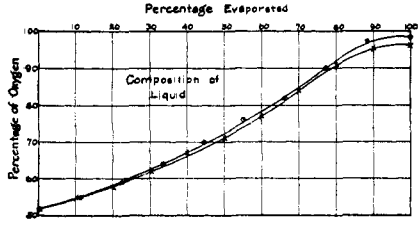


PLATE 1

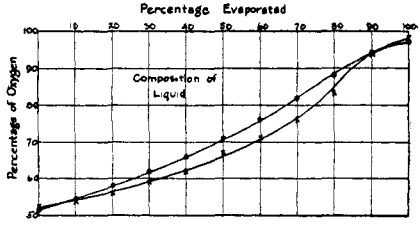
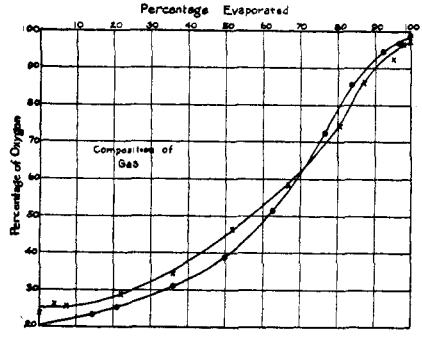
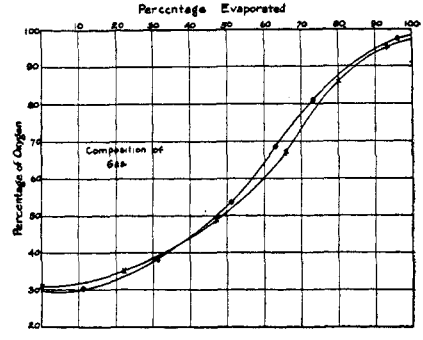


PLATE 2





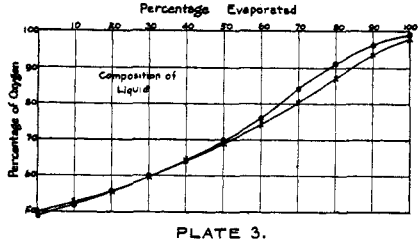


PLATE 3.

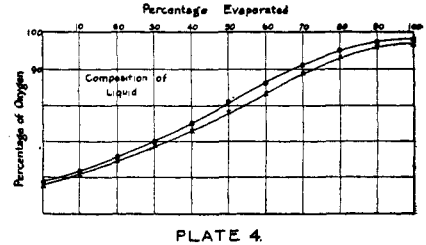


PLATE 4.

CHARTS SHOWING RELATIVE CHARACTER OF DISTILLATION CURVES OF LIQUID AIR

x Ordinary distillation.

⊙ Distillation in magnetic field.

in order to determine the influence of the many important factors which would affect the results and it, therefore, is undesirable to draw any final conclusions as to the magnitude or the importance of the separation of the gases by distillation within a magnetic field either upon a small or a large scale.

The author desires to express this thanks for the assistance rendered by Mr. F. J. Bates and Mr. F. P. Phelps in the operation of the large magnet and in the magnetic calculations and to Mr. F. S. Durston for the preparation of the liquid air required for the work.

BUREAU OF STANDARDS,
WASHINGTON, D. C.

[CONTRIBUTION FROM THE WOLCOTT GIBBS MEMORIAL LABORATORY OF HARVARD UNIVERSITY.]

A SYNTHERMAL REGULATOR, A DEVICE FOR AUTOMATICALLY MAINTAINING AN ADIABATIC CONDITION IN CALORIMETRY.

BY THEODORE W. RICHARDS AND GEORGE D. OSGOOD.

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The method of adiabatic calorimetry, as recently developed in the Harvard Chemical Laboratories, demands that the bath surrounding the calorimeter should be changed in temperature at the same rate as the calorimeter itself, so that no heat should be lost or gained during the calorimetric determination. The outside bath has therefore, been heated or cooled either by a suitable chemical reaction, or by hot or cold water, or by electricity,[1] so as to keep pace with the inside. Heretofore this quantitative identity of temperature has usually been established from moment to moment by the experimenter, who has observed both temperatures, and acted accordingly. That this technique is feasible and accurate has been abundantly proved; but, nevertheless, with quick reactions the method makes considerable demands upon the operator; accordingly, it seemed worth while to arrange an automatic device for relieving him of strain. Such a device might be called a "synthermal regulator."

Obvious methods for accomplishing this end will occur to any one familiar with this kind of problem. A multiple thermocouple or a pair of resistance thermometers might be connected with a delicate galvanometer in such a fashion that any inequality in the temperature of the two baths would cause a deflection in a galvanometer, and thus through a relay operate a mechanism for equalizing the temperature, but it would be difficult to provide an adequate relay. A differential mercury-, or, better, a differential gas-thermometer might be used to attain the object sought, and this seemed much more promising. Because the relay seemed to be the

[1] Richards, THIS JOURNAL, 31, 1280 (1909); see also Benedict and Higgins, *Ibid.*, 32, 462 (1910).