Enrichment of Nitrogen in the Isotope N^{15}

In a previous letter[1] we described briefly the production and analysis of samples of methane which were enriched in the carbon isotope, C^{13}, by diffusion in a Hertz apparatus. Further diffusions with methane have given a considerably greater enrichment than that reported. Two samples showed an intensity ratio of 3.3 to 1 for the bands due to $C^{12}C^{12}$ and $C^{12}C^{13}$, corresponding to an abundance of 13.1 atomic percent for C^{13}. The head due to $C^{13}C^{13}$ could also be measured on these plates,[2] and its intensity was consistent with that of $C^{12}C^{13}$. This methane has been used by one of us to photograph the $C^{13}N^{14}$ bands under high dispersion, and from these a value for the mass ratio of the carbon isotopes has been obtained.[3]

The method has now been applied to nitrogen gas, with satisfactory results. Abundance measurements were made by observations on the isotope heads[4] accompanying the 1,0 and 2,0 bands of the second positive system of N_2. According to Urey and Murphy,[5] N^{15} is present in ordinary nitrogen to one part in 350, so that these heads due to $N^{14}N^{15}$ should have an intensity of 1/175 that of the main heads due to $N^{14}N^{14}$. A sample of 300 cc of nitrogen ($p=6$ mm) from the first diffusion gave an intensity ratio of 1/16.5. This means an abundance of 3 atomic percent of N^{15}, an enrichment by a factor of slightly greater than 10. With this gas it should be possible to measure the bands due to $C^{12}N^{15}$, and so to obtain an accurate value of the mass ratio of the nitrogen isotopes.

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[1] Wooldridge and Jenkins, Phys. Rev. 49, 404 (1936).
[2] Due to an error in the reproduction of the figure in our previous letter, the triple dot designating this head was considerably displaced. The other two heads were correctly marked, and the three heads, due to $C^{12}C^{12}$, $C^{12}C^{13}$, and $C^{13}C^{13}$, should to the eye appear equally spaced.
[3] Jenkins and Wooldridge, paper given at the Washington meeting of the American Physical Society, April 30, 1936.
[4] G. Herzberg, Zeits. f. physik. Chemie B9, 43 (1930).
[5] H. C. Urey and G. M. Murphy, Phys. Rev. 41, 141 (1932).

A Spectrographic Method of Measuring Carbon Dioxide Concentration

Chemical methods of estimating the CO_2 concentration in a mixture of gases, such as in air, require very accurate temperature control and are slow in action. For example, in a continuous flow method[1] used in this laboratory the temperature of the electrolytic cell must be held constant to better than 0.01°C and about 30 minutes are required to obtain an individual reading. The physical method of observing the heat conductivity of the gas also requires an extremely accurate temperature control. This latter method measures a physical property of all gases, thus when used it is necessary to know the other gases present and make the proper corrections for them. Recently (November 21, 1935) a spectrographic method was tested in this laboratory and found to be very successful.

This method makes use of the high opacity of CO_2 gas to radiation in the region of one of its fundamental absorp-tion bands. The spectral region used is a band from 4.2 to 4.3μ, so chosen because water vapor and practically all of the other gases or vapors commonly found in air are transparent to this radiation. Radiation of this wavelength is isolated from a suitable source (Nernst filament) by means of an infrared spectrograph and allowed to fall upon a vacuum thermocouple after passing through a known optical path length of air contained in an absorption tube. The apparatus is calibrated by filling the absorption tube with air free from CO_2 then with air of a known concentration of CO_2 and the galvanometer deflections observed. For the range of concentrations from zero to 0.10 percent CO_2 an 86 cm optical path length is used. With this arrangement the sensitivity of the apparatus is such that a one-millimeter deflection represents one-ten thousandth of one percent CO_2. Shorter path lengths enable the measurement of greater concentrations. Two millimeters of pure CO_2 at N.T.P. transmit only 22 percent of the radiation 4.2 to 4.3μ.

The particular advantages of this spectrographic method are: (1) The sensitivity is as great as that of the best chemical method, (2) it gives instantaneous measurements (galvanometer response 5 seconds), (3) the measurements are independent of the humidity of the air and also independent of the presence of practically all of the other gases or vapors commonly found in air, (4) for ordinary room temperatures and pressures the apparatus has very small temperature and pressure corrections (3°C or 7 mm pressure change cause about 1 percent change in sensitivity), and (5) it can be recalibrated in a few seconds, which enables the use of full sensitivity. The same arrangement can be used to observe small concentrations of other gases by selecting radiation of appropriate wave-lengths.

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[1] E. C. White, J. Am. Chem. Soc. 50, 2148 (1928).

Focusing Effect of Double Crystal Spectrometer

The focusing effect of the double crystal spectrometer in the antiparallel position recently discussed by Parratt[1] was developed in detail by the author[2] and later used by A. H. Barnes.[3]

If $\Delta\theta$ is the difference in Bragg angle between the x-ray which passes through the axis of the second crystal and any other x-ray, then the two rays will intersect at a distance from the axis equal to $\sin \Delta\theta/\sin 3\Delta\theta$ (approximately one-third) the distance from the target to the axis. In addition to the focus "fixed in space" there is also a focus "moving with the second crystal" which is three times as far from the axis, i.e., at a distance equal to the x-ray path from the target to the axis.

The advantage of placing slits or ionization chamber windows at these foci was pointed out by the author.

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            April 18, 1936.

[1] Parratt, Rev. Sci. Inst. 6, 389 (1935).
[2] R. C. Spencer, Phys. Rev. 38, 620 (1931).
[3] A. H. Barnes, Phys. Rev. 44, 141 (1933).