## COPYING MANUSCRIPTS ON MOTION PICTURE FILM

IN Dr. Seidell's article,[1] "Reforms in Chemical Publication (Documentation)," reference was made to the increased probability of the fulfilment of his aim if there was available suitable apparatus for photographing manuscripts on 16 mm film.

Such a device known as a "copying camera" using 35 mm film, 100 foot lengths, was developed at the Sterling Library, Yale University, some months ago by Messrs. F. G. Ludwig and L. H. Ott.

It proved so satisfactory that since that time they have built a number for use in various other institutions, such as the Library of Congress and the New York Public Library. The camera at the last-mentioned institution has been used for making permanent records of newspapers, which of course would survive only a short period of actual handling.

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# SPECIAL ARTICLES

## DEUTERIUM CONTENT OF NATURAL BUTANE

SEVERAL examples of deuterium enrichment in products of plant and animal life have been reported.[1] As the result of an investigation which we have had under way for some months we find that natural butane from the Burbank (Oklahoma) oil field contains approximately 30 per cent. more deuterium than corresponds to the deuterium content of ordinary hydrogen. This figure is in almost exact agreement with that reported by Dole[2] for Oklahoma kerosene, which indicates a probable typical enrichment of Oklahoma oil and gas deposits. It is also in agreement with the figure more recently reported by Greene and Voskuyl[3] for natural gas from northern Pennsylvania.

The question naturally arises as to whether this enrichment is typical of the deuterium distribution of the geological age in which these deposits were formed, or of the chemistry either of the growth or decay of the organic life responsible for the deposits. If the results obtained by Scott,[4] for free water associated with Pennsylvania petroleum, can be correlated properly with those for the Oklahoma deposits it would appear that the chemical explanation is the more plausible.

The butane which we employed was obtained by fractional distillation of natural gas condensate from the Burbank, Oklahoma, field and consisted of approximately 98 per cent. n-butane and 2 per cent. iso-butane.

The butane was burned at a quartz jet out of contact with the atmosphere in an excess of tank oxygen (prepared by the Linde process). The hot gases were passed through a quartz tube filled with copper oxide and heated to about 900° C., to insure complete oxidation. The steam was condensed in a Pyrex bulb surrounded with ice and water and provided with a condenser through which ice water was circulated. Two successive samples of about 100 cc each were collected. The deuterium content of the water of combustion was determined by means of the buoyancy balance.[5] Prior to the measurement final purification was effected by distillation from alkaline permanganate. The two 100 cc samples of the water were reduced to approximately 40 cc each by three successive distillations from Pyrex stills, with 10 cc discarded at the beginning and end of each distillation. The first two distillations were carried out in the presence of potassium permanganate and potassium hydroxide, the last without any added reagent.

The results are shown in Table I, in which the first line gives the results obtained with the water as it was collected from the still and the second line, the readings obtained after boiling out the samples to remove possible air or $CO_2$ contamination. The apparent change in Sample 1 is not regarded as significant. After the readings recorded in the second line the samples were mixed and refluxed over night with alkaline permanganate, in a Pyrex still. After two subsequent distillations, the second without permanganate, in which equal end portions were discarded as before the density was redetermined with the result shown in the third line of the table. The straight average of these five determinations was taken as the most reliable value.

TABLE I

BECKMANN READINGS AT WHICH THE FLOAT BALANCED IN THE PURIFIED WATER OF COMBUSTION

| | Sample 1 | Sample 2 |
|---|---|---|
| Direct from still | 3.310 ± 0.002° | 3.310 ± 0.002° |
| After boiling out | 3.315 ± 0.002 | 3.311 ± 0.002 |
| After refluxing | 3.313 ± 0.001 | |
| Value chosen | 3.312 ± 0.002 | |

[1] SCIENCE, 80: 2064, 70–72, 1934.

[1] Washburn and Smith, SCIENCE, 79: 188, 1934.

[2] Dole, *Jour. Chem. Physics*, 2: 337, 1934; *Jour. Am. Chem. Soc.*, 56: 999, 1934.

[3] Greene and Voskuyl, *Jour. Am. Chem. Soc.*, 56, 1649, 1934.

[4] Scott, SCIENCE, 79: 565, 1933.

[5] Lewis and MacDonald, *Jour. Chem. Physics*, 1: 341, 1933.

Two 100 cc samples of ordinary distilled water were then given a similar treatment, except for the final refluxing, which was omitted. The results are shown in Table II. The high values first obtained with

TABLE II

BECKMANN READINGS AT WHICH THE FLOAT BALANCED IN PURIFIED ORDINARY WATER

| | Sample 1 | Sample 2 |
|---|---|---|
| Direct from still | 3.289 ± 0.001° | 3.282 ± 0.002° |
| After boiling out | 3.289 ± 0.002 | 3.279 ± 0.002 |
| Following one more distillation without $KMnO_4$ | 3.280 ± 0.001 | 3.280 ± 0.001 |
| Value chosen | 3.280 ± 0.002 | |

Sample 1 were apparently due to a little contamination by spray carried over in the first distillations, as evidenced by the result obtained after a fourth distillation. Accordingly, the first two readings on this sample were disregarded in obtaining the final average.

From these results we take $\Delta$ T, for the butane sample as compared with ordinary water, as 0.032 (± 0.003° C.) which is equivalent to 8.3 (± 0.7) ppm. excess in density. It is probable that a portion of this density increment is due to $O^{18}$ enrichment in the tank oxygen which was used.[6, 7] If the heavy oxygen enrichment in our tank oxygen corresponded to that of Smith,[6] the density increase due to deuterium would then be 6.1 ppm. It is improbable that our oxygen would differ from this enough to be significant in the conclusions which we may draw.

On the basis of Bleakney and Gould's[8] work which fixes the deuterium/hydrogen ratio in ordinary water at 1 to 5,000, corresponding to a 21 ppm. influence on the density of ordinary water as compared with pure protium water, the 6 ppm. density increase in the water of combustion from butane corresponds to a 30 per cent. increase in deuterium.

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## THE RESPONSE OF THE NORMAL GUINEA PIG TO THE ADMINISTRATION OF LIVER EXTRACTS[1]

NUMEROUS attempts have been made in the past to obtain a valid biological indicator of the hematopoietic activity of liver extracts which are therapeutically potent in pernicious anemia. As far as the writer is aware, this has not been accomplished. The phenomenon which is briefly described in the present communication consists in a rise in the percentage and in the absolute number of reticulocytes in the peripheral blood of a majority of normal guinea pigs, following the oral or parenteral administration to them of any therapeutically active liver extract. The capacity to react in this fashion to subsequent injections of such an extract is apparently maintained indefinitely. This reaction is exceedingly sensitive, for the minimum amount of fresh porcine liver, from which the extract is derived and which will evoke a response, is in the neighborhood of .6 mg per kilogram of guinea pig. This amount of liver is equivalent to one Guinea Pig Unit (G.P.U.) of hematopoietic activity; conversely, one hundred grams of fresh porcine liver may be said to contain approximately 164,000 G.P.U. That the reticulocyte response of the reactive guinea pig is intimately related to the true hematopoietic action of liver in pernicious anemia is rendered highly probable by numerous control experiments. The best evidence that the response is concerned solely with the hematopoietic materials in liver is furnished by the facts that the extract of the liver of a patient dying in a relapse of pernicious anemia, when assayed on guinea pigs, effected no demonstrable response, yielding an activity of less than 12 G.P.U. per 100 gm of fresh liver, whereas the liver of a non-anemic patient, when extracted and assayed in an identical fashion, showed an activity of approximately 164,000 G.P.U. per 100 gm of liver.

The response of the normal guinea pig to liver extracts may well be conditioned by the fact that such animals, both reactive as well as non-reactive ones, possess a richly megaloblastic bone marrow. Two sets of experimental results further offer evidence that the reactive guinea pig is endowed with a deficiency state that simulates the condition in pernicious anemia. In the first place, an extract of a reactive guinea pig's liver, when assayed on reactive animals, exhibited a hematopoietic activity of only 31,000 G.P.U., while the extract of a non-reactive animal's liver showed an activity of 164,000 G.P.U. Secondly, a mixture of Castle's intrinsic and extrinsic factors, when administered orally to guinea pigs in the form of normal human gastric juice and beef muscle, elicited a reticulocyte response differing in no way from that following the administration of therapeutically active liver extracts; while the extrinsic factor alone, or extrinsic

[6] Smith, *Jour. Chem. Physics*, 2: 298, 1934; SCIENCE, 79: 454, 1934.
[7] Klar and Krauss, *Naturwiss.*, 22: 119, 1934.
[8] Bleakney and Gould, *Phys. Rev.*, 44: 265, 1933.

[1] This investigation has been aided by grants from the Council on Pharmacy and Chemistry of the American Medical Association, and from the William W. Wellington Memorial Research Fund of the Harvard Medical School.