THE ISOTOPIC FRACTIONATION OF WATER BY DISTILLATION.

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In the course of purifying water by distillation, we found always some small difference in density between the first and last portions of the distillate. In order to ascertain whether this difference in density is due to the isotopic fractionation of water or to some impurities dissolved therein, we carried out a fractional distillation of a considerable amount of water and measured the densities of its most and least volatile fractions respectively.

The method employed was as follows: The distilling flask was made of glass and fitted with a glass still of Hempel type, 3.5 cm. wide and 17 cm. long, which was filled with glass beads having 4 to 5 mm. diameter up to 6 to 7 cm. height. During the distillation a continuous flow of air free from carbon dioxide was sent through the still column. The distillation was carried out in three stages; namely, in the first stage, a given volume of water was equally divided into the distillate (D_1) and the residue (R_1); in the second stage, both the distillate (D_1) and the residue (R_1) from the first stage were again equally divided by distillation into

the distillate and the residue respectively. We may designate the distillate obtained by the second distillation from the first distillate (D_1) D_2 and at the same time the residue obtained by distilling the residue (R_1) in the first stage may be designated R_2; then in the third stage, both D_2 and R_2 were again divided equally by distillation into the distillate and the residue respectively and the distillate (D_3) obtained from D_2 and the residue (R_3) remained after distilling R_2 were saved for the comparison of their respective densities.

The two fractions thus obtained were at first carefully purified in the same way as described in the preceding paper,[1] the purity being checked by measuring the electrolytic conductivity. Then their densities were compared with that of normal water by a sensitive quartz bouyancy balance. The most volatile part (D_3) which was the last portion of the distillate saved was found to be lighter than ordinary water by 2.5 parts per million (p.p.m.) and the residue (R_3) saved for the density measurement showed an increase in density by 3.8 p.p.m. The difference between these two parts was 6.3 p.p.m. which might be due to the isotopic fractionation of water, if no impurity was occluded during the process of the purification.

Hall and Jones[2] called attention to the fact that a considerable isotopic fractionation occurred during the distillation of highly enriched heavy water under the atmospheric pressure. Our result shows that it is also important to take into consideration the above fact even in the distillation of ordinary water under the atmospheric pressure.

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(1) M. Harada and T. Titani, this Bulletin, **9** (1934), 457.
(2) N. F. Hall and T. O. Jones, *J. Am. Chem. Soc.*, **56** (1934), 749.