# *The Self-diffusion Coefficients of Carbon Dioxide, Hydrogen Carbonate Ions and Carbonate Ions in Aqueous Solutions*

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The distribution of natural radiocarbon and man-made radiocarbon in the atmosphere and the ocean depends on the exchange rate of carbon between the atmosphere and the ocean.1) In recent publication Bolin2) has pointed out that this carbon exchange between the atmosphere and the ocean depends on the diffusion of carbonates ions in the sea water.

This short communication will present the results of studies of the self-diffusion of carbon dioxide, hydrogen carbonate ions and carbonate ions in aqueous solutions. The measurements of the self-diffusion coefficients were made using a modified Northrop-McBain type diaphragm cell. Both the upper and the lower compartments of the cell were filled with solutions of the same chemical composition. The solutions contain carbon dioxide, hydrogen carbonate ions, carbonate ions and sodium ions, and they were adjusted to pH 4.0, 8.0 and 12.5. More than 99% of the carbon atoms in the solution were contained as carbon dioxide molecules in the solution of pH 4.0, as hydrogen carbonate ions in the solution of pH 8.0, and as carbonate ions in the solution of pH 12.5. Therefore, each solution could be regarded as a pure solution of these molecules or ions. The concentration of carbon-containing ions in these solutions was held ca. 0.1 F while that of carbon dioxide was ca. 0.06 F. The carbon tracer C-14 was present in the lower compartment of the cell.

After the diffusion had continued for one or two days, barium carbonate was precipitated from the solution in each compartment. By $\beta$-rays assays of these precipitates, the diffusion coefficients of carbon dioxide, hydrogen carbonate ions and carbonate ions in aqueous solutions shown in Table I were obtained. The cell constant was determined by the diffusion of a 0.1 F potassium chloride solution into pure water, assuming a standard value of $1.87\times10^{-5}$ cm$^2$/sec. for the diffusion coefficient of this solution.3)

TABLE I. SELF-DIFFUSION COEFFICIENTS OF $CO_2$, $HCO_3^-$ AND $CO_3^{2-}$ ($10^{-5}$ cm$^2$/sec.)

| Temp., °C | $CO_2$ | $HCO_3^-$ | $CO_3^{2-}$ |
|---|---|---|---|
| 0.0 | 0.953±0.013 | 0.521±0.011 | 0.414±0.011 |
| 25.0 | 1.94 ±0.023 | 1.09 ±0.015 | 0.804±0.008 |
| 30.0 | 2.18 ±0.019 | 1.28 ±0.015 | 0.974±0.005 |

The details of the experimental procedure and a discussion of the hydration of carbon dioxide, hydrogen carbonate ions and carbonate ions in aqueous solutions based on the measured self-diffusion coefficients will be published in the near future in this Bulletin.

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2) B. Bolin, *Tellus*, **12**, 274 (1960).

3) R. H. Stokes, *J. Am. Chem. Soc.*, **72**, 763 (1950).