*The Abnormal Relation between the Viscosities and the Temperatures of Sodium Carbonate Solution**

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(Received June 29, 1959)

It has been reported that the ultrasonic velocity and electric conductivity of the dilute solution of sodium sulfate present the abnormalities at the temperatures near the transition points of the saturated solution coexisting with the solid states[1,2].

But the reason why these abnormalities are caused is not fully explained in these reports. Therefore, this communication is to report that the abnormal relation between the viscosities and the temperatures was discovered in sodium carbonate solution.

The author believes that this result is a clue to the behavior of the aqueous solution, containing the inorganic compounds which have the transition-points in the saturated solutions.

In the viscosity measurements was used Ubbelohde suspended level viscometer,

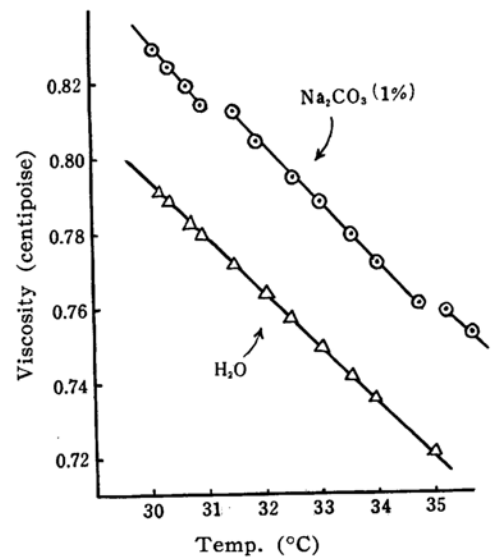

Fig. 1. Plot of viscosity against temperature for 1% Na_2CO_3 aqueous solution and distilled water.

* Presented at 12th Annual Meeting of the Chemical Society of Japan, Kyoto, April 2, 1959.

1) T. Sasaki and T. Yasunaga, *Chem. and Chem. Ind. (Kagaku to Kogyo)*, **7**, 146 (1954).

2) K. Hirano, *J. Chem. Soc. Japan, Pure Chem. Sec. (Nippon Kagaku Zasshi)*, **79**, 648 (1958).

the length and diameter of whose capillary are 20 cm. and 0.33 mm., respectively, and this viscometer being used, the flow time of distilled water 7 cc. was 2280 seconds at 25°C, and in this determination a kinetic energy correction was negligible. The temperature measurements were made with accuracy of ±0.01°C. At intervals of 0.5°C from 25 to 40°C, the flow time of 1% sodium carbonate solution and distilled water were measured using a stop watch. The results were shown in Fig. 1. From these results, it is seen that the changes of viscosity with temperatures were not smooth at about 31 and 35°C.

TABLE I. ENTHALPIES OF ACTIVATION FOR VISCOUS FLOW OF Na_2CO_3

Temp. range (°C)	Enthalpy of activation for viscous flow (kcal./mol.)
Below 30.93	5.11
31.43~34.90	3.11
35.29 and over	2.63

These two points of temperature correspond to the two transition points of the saturated sodium carbonate coexisting with the solid.

Eyring and coworkers[3] have applied the theory of absolute reaction rates to viscous flow and obtained following relation

$$\eta = hN/V \cdot \exp \Delta F^*/RT$$

where ΔF^* is the free energy of activation for viscous flow, V is the molar volume and the other constants have the usual significance. By using this relation the enthalpies of activation for viscous flow were calculated. The values of the enthalpies at below 30.9°C, 31.4~34.9°C and above 35.3°C are different from each other, and the data are shown in Table I.

The viscosity measurements are being made on solutions of sodium carbonate with various concentrations and dilute solutions of other compounds (e.g., Na_2HPO_4).

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3) S. Glasstone, K. J. Laidler and H. Eyring, "The Theory of Rate Processes", McGraw-Hill Book Co., Inc., New York (1941).