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Dependence of Electric Conductivity on Temperature for an Aqueous Solution of Polyvinylalcohol

(Part 1. Experiment)

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The specific electric conductivity of an aqueous solution of polyvinylalcohol was measured over a certain range of temperature and concentration. In the cases of rather small concentration, the result suggests the occurrence of the second order transition. However, as the concentration is increased, the existence of the transition temperature becomes uncertain.

§ 1. Introduction

In general, a specific electric conductivity (K) of aqueous solution of the macromolecular substance is larger than the specific conductivity of solvent (K_i). The difference between K and K_i is so called the specific surface electric conductivity (K_s). The electric current along the boundary face between the macromolecule and the solvent is considered as an origin of K_s by many investigators. Then K_s depends upon the distribution and the behavior of excess ions in the ionic cloud surrounding the macromolecule in the solvent. Besides, the main factors which determine the distribution and the behavior of excess ions in the ionic cloud are the shape of macromolecule in the solution, and the degree of thermal fixation of the structure of the solution. Furthermore, these two factors depend upon the temperature and the concentration of the solution. As a consequence, the measurement of the dependency of surface electric conductivity on the temperature and the concentration of the solution may give us some information for the shape of macromolecule in the solvent, and the structure of the solution at various temperature. From this point of view, the author measured the electric conductivity of the aqueous solution of polyvinylalcohol

over a certain range of temperature and concentration, and the following result is obtained.

§ 2. Experimental method

The electric conductivity was measured by the bridge method. The frequency of the electric source is 3,000 cycles per second. The polyvinylalcohol used in this experiment is the commercial product.

§ 3. Experimental Result

The values of $K_s (=K-K_t)$ are plotted against temperature (T) as shown in Fig. 1, 2, 3 and 4. In the cases of relatively small concentration, the relation between K_s and T is represented by two straight lines which intersect each other. (Figs. 1 and 2) Thus the temperature coefficient of K_s varies discontinuously at a certain temperature T_m .

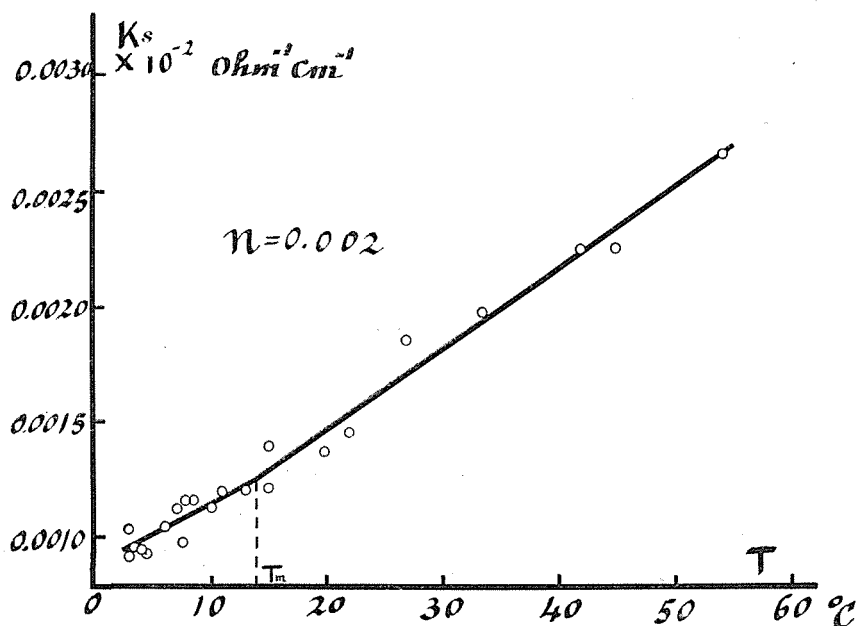


Fig. 1. K_s - T curve for the aqueous solution of polyvinylalcohol whose concentration n is 0.002 in ratio of weight.

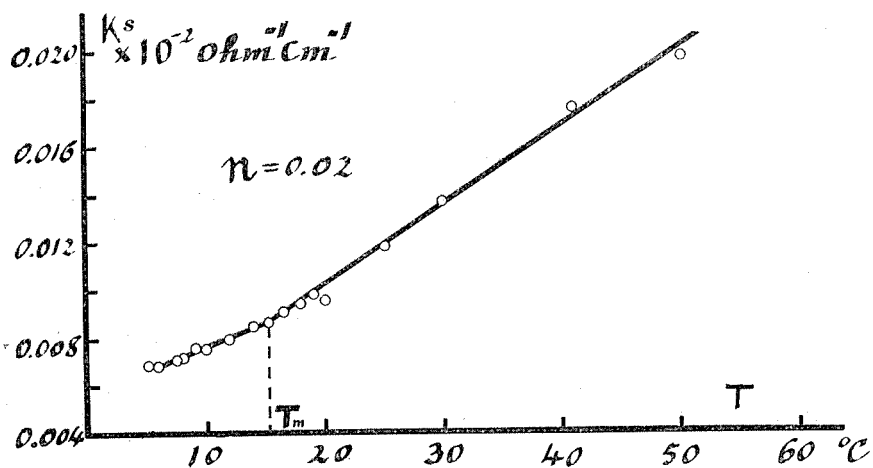


Fig. 2. K_s - T curve for the aqueous solution of polyvinylalcohol whose concentration n is 0.02 in ratio of weight.

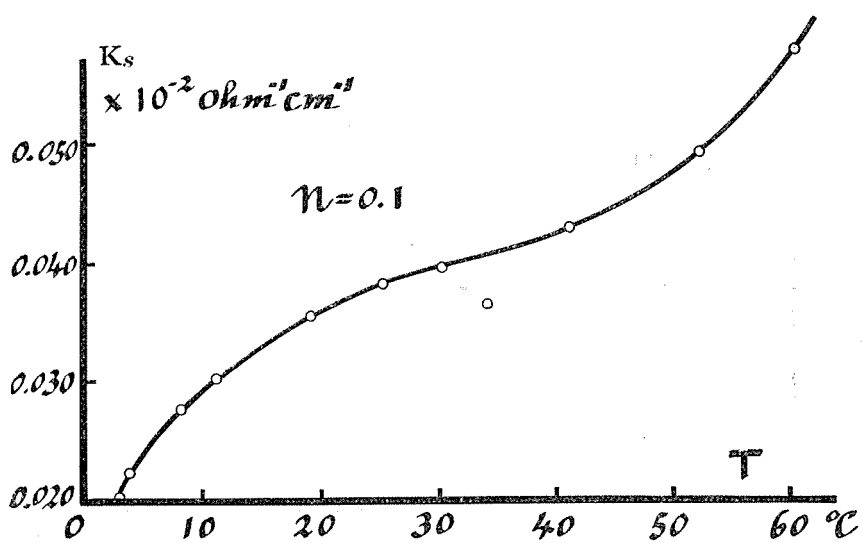


Fig. 3. K_s - T curve for the aqueous solution of polyvinylalcohol whose concentration n is 0.1 in ratio of weight.

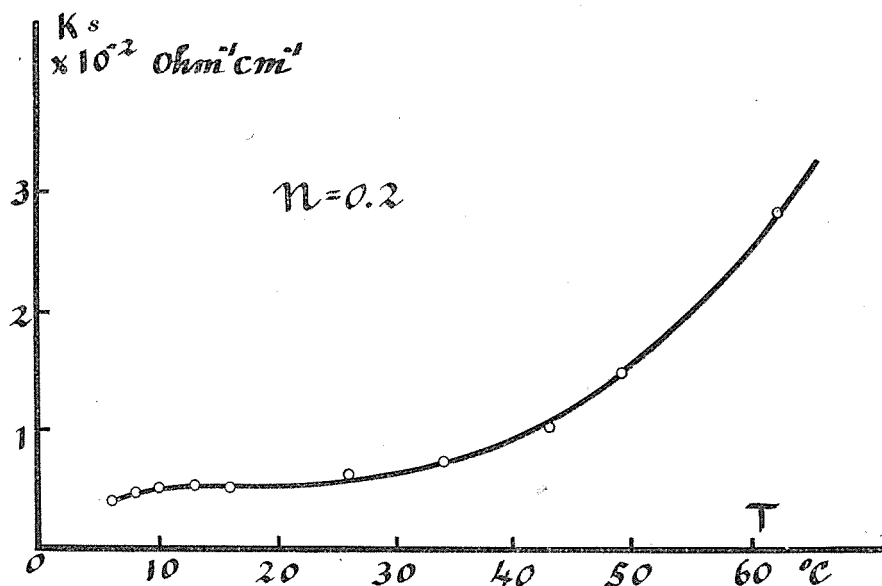


Fig. 4. K_s — T curve for the aqueous solution of polyvinylalcohol whose concentration n is 0.2 in ratio weight.

The values of T_m depend upon the concentration of the solution and the larger the concentration becomes, the higher value T_m takes. On the other hand, in the cases of relatively large concentration, the linear proportionality of K_s to T ceases and the existence of T_m becomes uncertain. (Figs. 3 and 4.)

The above described result should be explained from the standpoint of the second order transition which concerns the temperature variation of the structure of the solution. The theoretical explanation of the result will be given in part II.

References

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