

Studies on the Coagulation of Cobalt ferrocyanide sol by Light Extinction technique at the same stage of Coagulation given by the same Extinction value

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With 2 Figures

Summary

Cobalt ferrocyanide sol was prepared and the relation between electrolyte concentration and time of coagulation was studied with KCl, NaCl, NH_4Cl , BaCl_2 and AlCl_3 in the light of BHATTACHARYA'S equation by employing light extinction technique. Different concentrations of the electrolyte were added and times for a particular stage of coagulation given by the same extinction value were graphically determined. The plot of $1/C - a$ and t , for the same stage of coagulation was found to be linear in agreement of the equation:

$$1/C - a = n/m \cdot t + 1/m.$$

Introduction

In continuation to previous publications¹⁾²⁾, we have extended our studies to the coagulation of cobalt ferrocyanide sol in the light of BHATTACHARYA'S equation³⁾ employing light extinction technique. In latter communications⁴⁻⁶⁾, this equation was applied to study the effect of ageing, dialysis and various non-electrolytes on the coagulation of $\text{Fe}(\text{OH})_3$ sol. Recently MALIK et al.⁷⁾ have studied the coagulation of cobalt ferrocyanide sol in the aspect of acclimatisation and ionic antagonism, using visible technique.

1) M. SINGH et al., Kolloid-Z. **189**, 149 (1963).

2) M. SINGH et al., J. Indian chem. Soc. **41**, 85 (1964).

3) A. K. BHATTACHARYA et al., J. Indian chem. Soc. **28**, 179 (1951); J. Colloid Sci. **10**, 551 (1955).

4) M. SINGH et al., J. prakt. Chem. **30**, 155 (1965).

5) M. SINGH et al., J. Indian chem. Soc. (in press).

6) M. SINGH et al., J. Indian chem. Soc. (in press).

7) W. U. MALIK and I. A. KHAN, J. Indian chem. Soc. **42**, 619 (1965).

The work described in this paper deals with the study of slow coagulation of cobalt ferrocyanide sol by a more precise technique, at three stages of coagulation given by corresponding values of extinction.

Experimental

A colloidal solution of cobalt ferrocyanide of concentration 2.5 g/litre was prepared by the method reported by MALIK et al. (loc. cit.). The sol was dialysed in a parchment paper bag against distilled water until it was free from potassium ferrocyanide. Electrolytes used were of A. R., B. D. H. quality and all solutions were prepared in doubly distilled water.

Time of coagulation by light extinction was determined by using a photoelectric Colorimeter (GALLENKAMP). A red filter was used. The pointer of the instrument was adjusted to zero of the scale by taking doubly distilled water in the tube. A mixture of, 2.5 c.c. sol + X c.c. electrolyte + (2.5 - x) c.c. water (Total volume being 5 c.c.) was taken in another tube and light extinction was noted with time. The values of the extinction (Φ) were plotted against time and the same stage of coagulation was determined by drawing a line parallel to the time axis at a suitable value of Φ to cut the $\Phi - t$ curves (Fig. 1, should be on example for these curves). The time

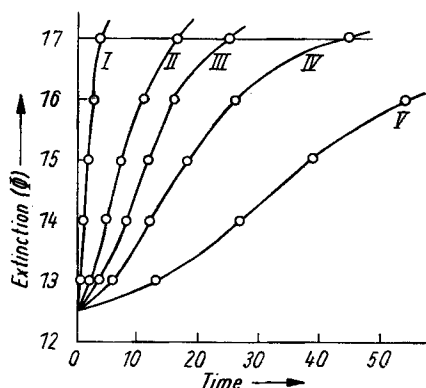


Fig. 1.

$\Phi - t$ curves with KCl. I - conc. = 100 mM/l, II - conc. = 90 mM/l. III - conc. = 84 mM/l, IV - conc. = 80 mM/l V - conc. = 72 mM/l.

intervals at the same stage of coagulation for different concentration of electrolyte could now be easily read from these curves. The values of a , m and n were then calculated by usual method as reported in our earlier communications (loc. cit.).

Observations

Table 1

(See Fig. 2)

Values of constants a, m, and n

Coagulating electrolyte	Coagulation stage expressed in Extinction (Φ)	a (m.moles/litre)	m (m.moles/litre)	n (min. ⁻¹)
NaCl	17	50.0	83.30	0.2080
	20	50.0	83.30	0.0930
	22	50.0	83.30	0.0716
KCl	17	60.0	42.50	1.126
	20	—	—	—
	22	—	—	—
NH ₄ Cl	17	70.0	60.60	0.1630
	20	70.0	60.60	0.0642
	22	70.0	60.60	0.0466
BaCl ₂	17	0.20	0.384	0.1152
	20	0.20	0.384	0.0270
	22	—	—	—
AlCl ₃	17	—	—	—
	20	0.150	0.380	0.290
	22	0.150	0.380	0.1078

Discussion

In Fig. 1, extinction — time curves have been drawn for different concentrations of the electrolyte, KCl, the curves for NaCl, NH₄Cl, BaCl₂ and AlCl₃ are analogous. The S-shaped nature of these curves indicates that the process of slow coagulation is of an autocatalytic nature. From these curves, times of coagulation at three stages of coagulation, $\Phi = 17, 20$ and 22 were found out for different concentrations of the electrolyte. Thus knowing "C" and "t", graphs were plotted between C and $1/t$. From these curves "a", was found out. In order to calculate the values of "m" and "n", $1/C - a$ was

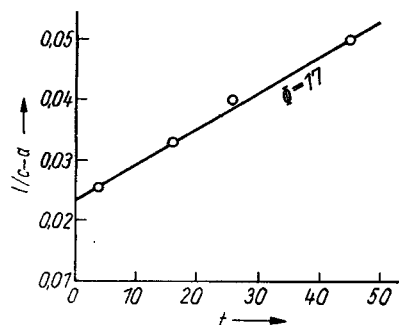


Fig. 2.

 $1/c-a$ vs $t \cdot (\Phi = 17)$ Electrolyte — KCl

plotted against t (Fig. 2). The values of a , m , and n at three stages of coagulation given by three extinction (Φ) values have been summarised in table 1.

The constants a , m , n of the equation, $C = a + \frac{m \cdot 1/t}{n + 1/t}$ have already been interpreted by BHATTACHARYA and coworkers (loc. cit.) where "a" has been defined as the critical stability concentration of the electrolyte for the sol by which the coagulation does not take place within measurable time and is related to the process of slow coagulation. "m" represents the concentration of the electrolyte above the critical value "a", which will produce instantaneous coagulation. "n" is connected with the sensitiveness or susceptibility of the sol to the electrolyte.

From table 1, it is clear that the values of "a" for mono, bi and trivalent precipitating ions are in accordance with the SCHULZE-HARDY rule. The values of "m" are in the decreasing order with the increasing values of the precipitating ions. It is clear from the table that the values of "a" and "m" remain constant at three stages of coagulation, showing that they are independent of the rate of aggregation of particles. This fact has also been confirmed by BHATTACHARYA et al.⁸⁾ who studied the coagulation of gold and Sb_2S_3 sols at different stages of coagulation given by corresponding values of extinction (Φ).

It is interesting to observe in the table that the order of decrease in the values of "n", at three stages of coagulation, directly indicates the greater and greater degree of aggregation of the coagulating particles. From the variations in the values of "n" at different stages of coagulation, it becomes evident that n depends upon all the factors which determine the stability of sol, and hence it can assume a definite value with different concentrations of the electrolyte at a particular stage of coagulation or degree of aggregation of the colloidal particles. When the same stage of coagulation is reached, where the net effect of the physical factors determining the stability of the sol may be visualized to remain the same on adding different concentrations of the electrolyte, "n" will have a constant value corresponding to the same degree of aggregation. This has been actually observed (see plots of $1/C - a$ vs. t).

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⁸⁾ A. K. BHATTACHARYA and A. KUMAR, *Agra University Journal of Research Sci.* **12**, 101 (1963).

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