The Influence of Non-electrolytes on the Coagulation of Ceric Hydroxide Sol Dialysed to Different Extent.

By Mata Prasad and M. V. Nabar.

It has generally been observed that the coagulating concentration of ions for a sol decreases in the presence of some non-electrolytes and increases in the case of others. The sensitisation of sols by non-electrolytes has been observed by Billitzer (*Z. physikal. Chem.*, 1903, **45**, 312), Freundlich and Rona (*Biochem. Z.*, 1917, **81**, 87), Weiser (*J. Phys. Chem.*, 1924, **28**, 1253), Dhar and collaborators and others.

Desai (*Trans. Faraday Soc.*, 1928, **34**, 181), has pointed out that the stability of the colloidal thorium hydroxide decreases as the sol is continuously dialysed. The sensitisation or the protection of the colloid by the non-electrolytes will, therefore, be more prominent as the sol becomes purer. Patel and Desai (*Kolloid Z.*, 1930, **51**, 318) have found that the sensitising influence of alcohols, acetone, urea and sugars increases with the progress of the dialysis of the thorium hydroxide sol and that a pure sol can be coagulated by non-electrolytes alone. In this investigation the influence of non-electrolytes on the coagulation of ceric hydroxide sol by electrolytes has been studied and the effect of the dialysis of the sol on such an influence has also been examined.

Experimental.

5 C. c. of the colloid were taken in a test tube and in another a solution of NaCl, made up to 7 c. c. by adding distilled water, of such concentration as to completely coagulate the sol in 30-40 minutes. The contents of the two test tubes were mixed together a fixed number of times and the time of mixing was noted. The coagulation velocity of the sol was followed by the thermopile method.

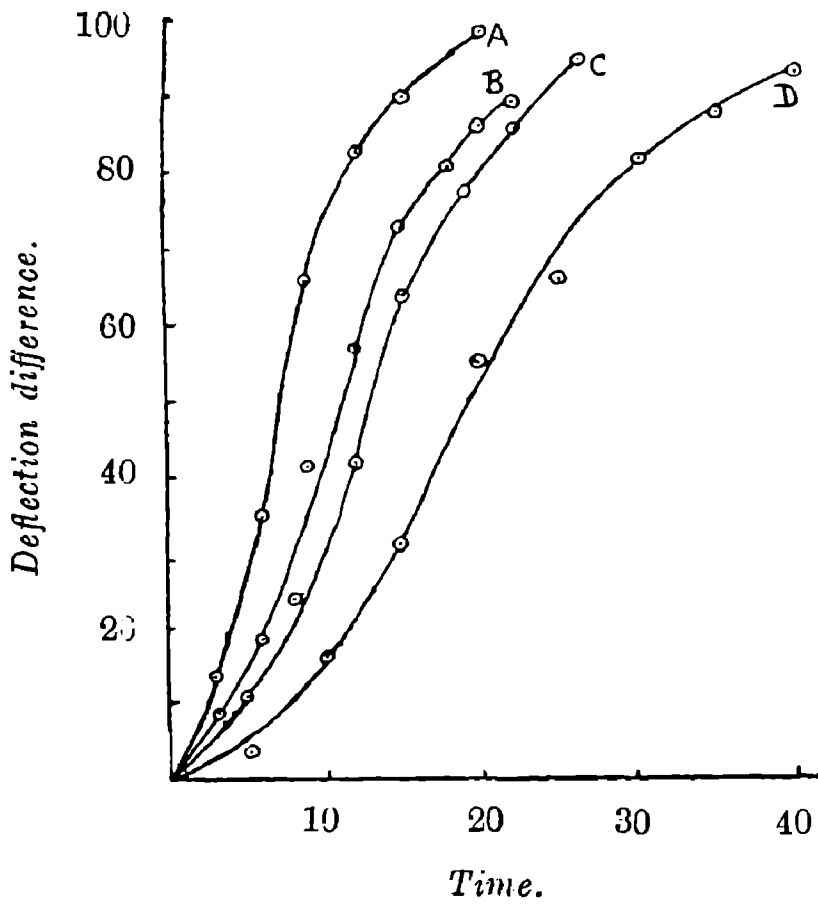
Next, the same amount of NaCl as used in the previous experiments was made up to 7 c.c. by adding different volumes of non-electrolytes and water. This was mixed (the mode of mixing being the same as used in the previous experiment) with 5 c. c. of the sol and the coagulation velocity was followed in the same manner s before.

The non-electrolytes used were methyl, propyl and amyl alcohols, and solutions of glucose and sucrose. Merck's extra pure alcohols were further purified by refluxing and distilling over metallic calcium. Sugars used were Merck's extra pure chemicals. The sol was prepared and dialysed in the same way as described in the previous paper (*J. Indian Chem. Soc.*, 1932, **9**, 609).

The deflection differences were plotted against time and the curves obtained for the coagulation of the sol dialysed for two days in the presence of alcohols and sugars are shown in Figs. 1 and 2

FIG. 1.

Sol dialysed for 2 days.



A—1 c. c. CH_3OH; B—1 c.c. C_3H_7OH;
C—1 c. c. $C_5H_{11}OH$; D—NaCl.

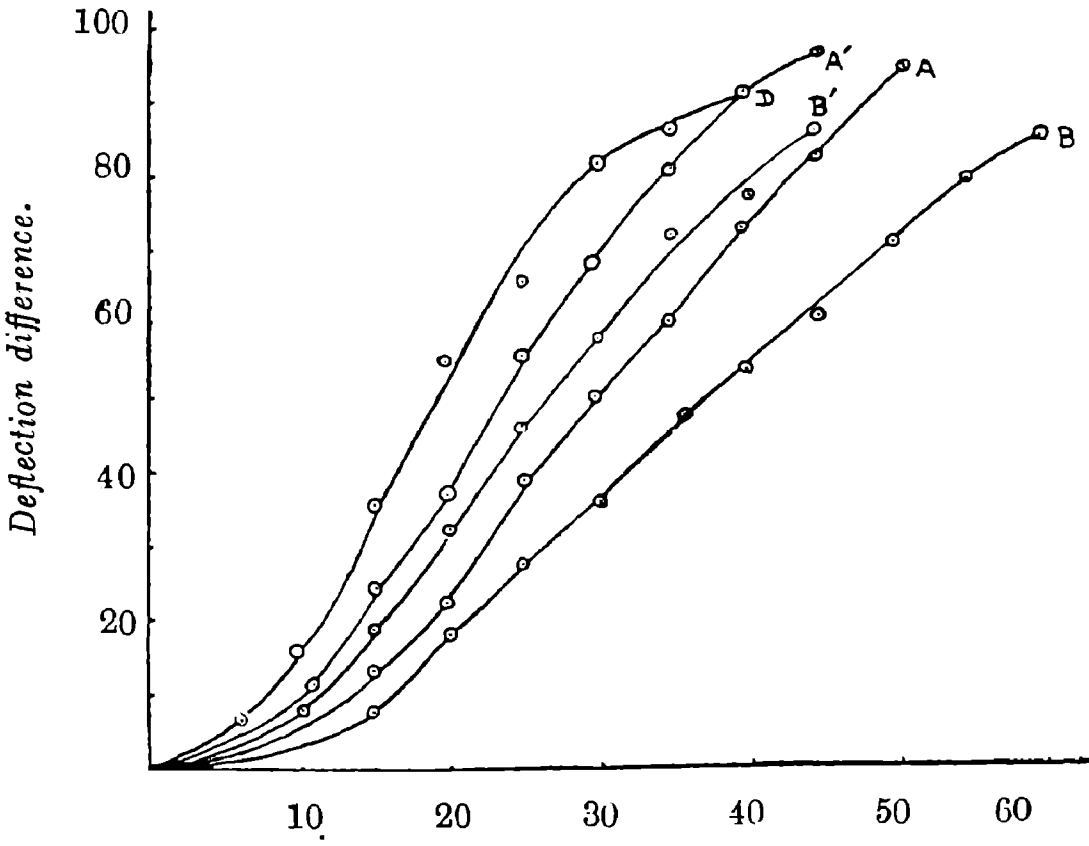
respectively. The inclination of the curves in Fig. 1 shows that the addition of alcohols to a solution of sodium chloride increases the coagulation velocity of the sol and this effect increases as the amount of alcohol is increased. The order of the effectiveness of the alcohol is $CH_3OH > C_3H_7OH > C_5H_{11}OH$, the same as observed by Mukherjee and collaborators (*J. Indian Chem. Soc.*, 1928, **5**, 697).

The coagulation velocity curves with the same amount of alcohol for sol dialysed for 10 days are steeper than those for the sol dialysed for 6 days. This shows that the sensitising action of the alcohols on the sol becomes more pronounced as it becomes purer.

It was also observed that the sol dialysed for 10 and 16 days could be coagulated by alcohols alone, the amount of alcohol required for the same volume of the latter sample was smaller than that for the former. On the addition of alcohol to these samples, the sol either coagulated immediately, or did not coagulate at all, if the quantity of alcohol added was insufficient, but no slow coagulation was observed.

FIG. 2.

Sol dialysed for 2 days.



A and A′—1 c. c. and 0·5 c. c. of *M*/10-glucose;
B and B′—1 c. c. and 0·5 c. c. of *M*/10-sucrose;
D—NaCl.

Fig. 2 shows that sugars exert a protective action on the sol. These results do not support the observation of Patel and Desai (*loc. cit.*) who find that sugars sensitise the thorium hydroxide sol. The protecting influence of sugars on ceric hydroxide sol increases with the progress of dialysis of the sol and with an increase in the amount of sugar added to the sol. The sol dialysed for different days could be coagulated by the same amount of the sodium chloride in the presence of the same amount of glucose but the protection is greater as the sol gets purer. But if the amount of cane sugar added to the sol dialysed for 2 days is mixed with the sol dialysed for 6 and 10 days, no coagulation with the same amount

of sodium chloride takes place. This observation and the curves in Fig. 2 show that cane sugar is a better protective agent than glucose, probably because of the greater number of hydroxyl groups contained in it.

The sensitising action of alcohols cannot be explained by the diminution in the adsorption of the coagulating ion by the ceric hydroxide particles as suggested by Weiser (*loc. cit.*) as in that case the slow coagulation will be observed and coagulation velocity curves may be '**S**' shaped. But as the sensitising effect of the alcohols increases as the sol gets purer, the second view of Weiser (*loc. cit.*) that the non-eletrolytes displace the stabilising ion from the colloidal particles may apply to this case.

Also the addition of alcohols to the sol lowers its dielectric constant and decreases the density of charge on the colloidal particles. Hence the increased rate of coagulation of the sol by mixtures of alcohols and sodium chloride than by sodium chloride alone may be due to the fall in the potential of the particles. The steepness of the coagulation velocity curves is, however, further increased as the sol is dialysed and the potential of the particles is lowered due to the removal of the stablising ions. When the sol gets almost pure, the potential of the colloidal particles is fairly low and the addition of alcohol alone causes a further lowering and therefore the coagulation of the colloid.

The protecting action of the sugars in ceric hydroxide sol may, however, be due to the well known peptising influence of sugars.

Summary.

(1) The coagulation velocity of ceric hydroxide sol has been studied with a mixture of an electrolyte and non-electrolyte with progress of dialysis.

(2) It is found that alcohols sensitise the sol while sugars protect it. The order of the effect of alcohols in their sensitising action is $CH_3OH > C_3H_7OH > C_5H_{11}OH$.

(3) Cane sugar acts as a better protecting agent than glucose.

(4) As the sol gets purer and purer, the sensitising action of the alcohols and the protective action of sugars also increase.

Chemical Laboratory,
Royal Institute of Science,
Bombay.

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