

ON THE INTERFACIAL TENSION BETWEEN GELATIN AND SODIUM ALGINATE SOLUTIONS AND BENZENE

PART II. THE EFFECT OF THE RELATIVE POSITIONS OF THE TWO PHASES ON THE INTERFACIAL TENSION

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Using the systems of benzene and either gelatin solution or sodium alginate described, the results of the sessile drop method depended upon whether the drop was formed from benzene or from the solution. It is suggested that the difference in the results may be accounted for by some form of structure in the solution.

SOLUTIONS of gelatin and sodium alginate above 1 per cent when in contact with benzene became opalescent and considerable difficulty was encountered in photographing the drop of benzene through the solution. The opalescence developed with time and more readily in the stronger solutions. The solutions kept in stoppered tubes with benzene became opalescent after 24 hours, but cleared if the benzene layer was removed. On visual examination of a drop of solution from the bulk or from the interface, particles of irregular size and opaque appearance resembling solid were observed and this suggested the existence of a gel like interfacial film. It is improbable that spontaneous emulsification could have taken place as the interfacial tension values were comparatively high.

Experiments were repeated using a sessile drop of the solution in benzene to enable the drop to be photographed through the clear benzene. Although the experiments were made using the same solutions and with the two systems side by side the results were consistently and appreciably different; those obtained using a sessile drop of solution in benzene being much higher than when a drop of benzene was used as shown in Figures 1 and 2.

DISCUSSION

In Figures 1 and 2 the curves are the average of the replicate experiments. The gelatin solutions showed only a little change in interfacial tension with time after 24 hours and the values at 24 hours were taken as representing equilibrium figure; whereas for sodium alginate 72 hours was found to be suitable. The variation of the results obtained using the two systems is outside the experimental limits.

The two methods are based on the same principle in that the shape of the drop is dependent on the interfacial tension according to Bashforth and Adam's treatment of revolution and thus the ratio of h^2/r^2 is dependent on the interfacial tension. If the solutions possess some form of structure a certain amount of force would be necessary to break down this structure and induce the liquid to flow.

INTERFACIAL TENSION OF HYDROPHILIC COLLOIDS. PART II

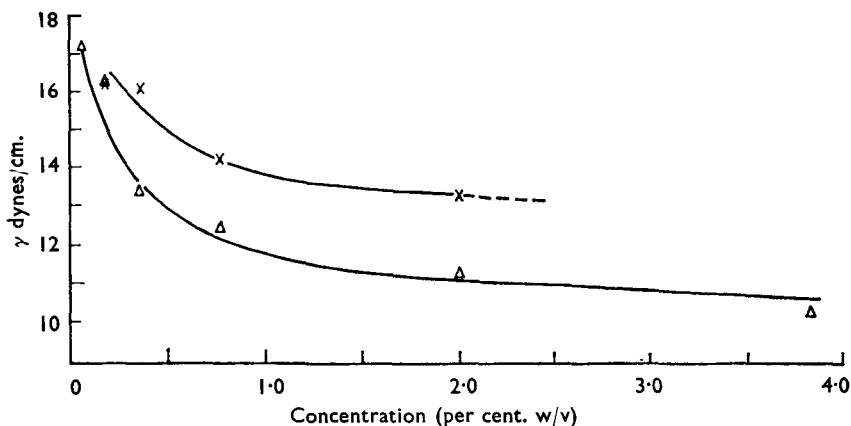


FIG. 1. The effect of the relative positions of the two phases on interfacial tension (temp. = 35°). Values after 24 hours. Gelatin solutions.

× Drop of solution in benzene Δ Drop of benzene in solution

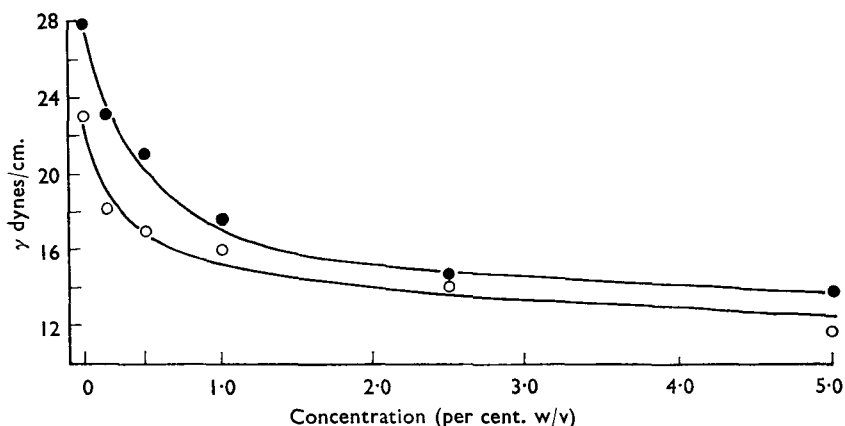


FIG. 2. The effect of the relative positions of the two phases on interfacial tension (temp. = 35°). Values after 72 hours. Sodium alginate solutions.

● Drop of solution in benzene ○ Drop of benzene in solution

The total force at the interface should be the same in both instances since the interfacial tension and the surface area of the drop, whether of benzene or solution, nominally are the same.

Since the drop is altering continuously towards a shape corresponding to the true interfacial tension, a strain will be induced in the structure in the solution. For a given amount of movement of the interface, as shown by the change in 'h', the strain produced in the drop of solution will be very much greater than that induced in the much larger bulk of solution surrounding the drop of benzene. The drop of benzene will therefore flatten to a greater extent than the drop of solution in order to produce the

same amount of strain in the structure so giving a lower result for the interfacial tension which should be nearer to the true value.

If it is possible to assume that the sodium alginate and gelatin solutions possess some form of rigidity or structure within them, then the anomaly of the results could be explained by the above hypothesis.

The strain may arise by the deformation of the structure present in the bulk solution or in the region of the interface. However, it would be expected that the interface would be similar in structure and magnitude in both instances so that it seems reasonable to suppose that the difference in the results is mainly due to a very weak gel-like structure arising in the undisturbed liquid through association between the polar groups in the molecule.

Sheppard¹ and Bogue² have shown that gelatin solutions exhibit both plastic and viscous flow. Using concentrations from 1 to 8 per cent of gelatin, Bogue observed that below 34° gelatin solution showed a plastic flow and had a yield value, whereas above 34° only viscous flow was exhibited. In cases where plastic flow was noticed the solution had a permanent and fixed resistance to deformation which would occur only when a minimum pressure was applied. The transition from gel to sol form exists over a range of temperature and depends upon the concentration of the solution. The experiments were made at 35° where a residual structure may be expected in gelatin solutions. If this structure increased with the age of the solution, then it could account for the results obtained.

It was observed by Belton³ while determining the surface tension of gelatin solution using a bubble pressure method that the pressure required to blow the first bubble was greatest and fell successively until 5 or 6 bubbles were blown. He suggested that the unstirred solution possessed a structure which was broken down in the neighbourhood of the jet, until the surface tension of the stirred solution was observed.

In the case of solutions which possess some form of structure a similar behaviour may be expected. Under these conditions it is difficult to ascertain whether the surface has attained an equilibrium corresponding to the actual interfacial tension or not, and the values obtained should be regarded as relative ones.

REFERENCES

1. Sheppard, *J. phys. Chem.*, 1925, **29**, 1226.
2. Bogue, *ibid.*, 1925, **29**, 1235.
3. Belton, *Trans. Faraday Soc.*, 1939, **35**, 1314.