

SYNERESIS OF SODIUM OLEATE GELS IN ORGANIC SOLVENTS

Part I. Effect of area of gel-surface on the syneresis of sodium oleate gels in pinene

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HOLMES and co-workers¹ have found that the syneresis of silica gels varies directly as the area of gel-surface exposed for syneresis. However, Ferguson and Applebey² find that syneresis in silica gels is independent of the surface exposed. Chapman and Buchanan³ have observed that the syneresis of starch gels prepared in larger tubes is greater than that of the gels prepared in smaller tubes. It is evident that the study of the effect of surface on the syneresis of gels is important and has not so far received much attention. The present investigation deals with the study of this effect in the case of gels of sodium oleate in pinene.

EXPERIMENTAL TECHNIQUE

The following series of experiments were carried out to study the effect of surface area on the syneresis of sodium oleate gels in pinene.

Series A.—Three flat-bottomed dishes of diameters of (1) 4.3 cm., (2) 7.1 cm., (3) 9.8 cm., respectively, were used. It was so arranged that the amount of the gel in each dish was proportional to its surface area. The thickness of the gel layer was practically kept constant.

Series B.—Varying amounts of the gel were taken in the same dish of 4.3 cm. diameter.

Series C.—The same amount of the gel-forming solution was taken in each of the three dishes used in Series A.

For all the experiments a solution of 1% sodium oleate in pinene was prepared by dissolving the requisite amount of sodium oleate in pinene at 140° C., according to the method followed by Prasad and co-workers.⁴

For the experiments in Series A, approximately 5 c.c. of the solution were transferred to dish (1), 14 c.c. to dish (2) and 27 c.c. to dish (3) and then allowed to set in the dishes. For the experiments in Series B, approximately 5 c.c., 10 c.c., 15 c.c., 21 c.c., and 27 c.c. of the solution were transferred to dish (1) and allowed to set. For the experiments in series C, approximately, 27 c.c. of the solution were transferred to each of the three dishes and allowed to set. All the dishes were kept in a thermostat maintained

at $30^\circ \pm 0.1^\circ \text{C}$. In all the cases the amount of syneresis was measured three hours after the gels had set by the method followed by Prasad, Hattiangdi and Mathur.⁴

RESULTS

The results obtained are given in Table I in which the following notations are used:

- D diameter of the dish in cm.,
- h* thickness of the gel layer in cm.,
- s* specific surface in sq. cm. per c.c. [equal to $\frac{\pi D(h + D/2)}{\pi D^2 h/4}$],
- W weight of the gel in grams,
- x* amount of syneresis in grams,
- Y percentage syneresis equal to $\frac{100x}{W}$.

TABLE I

Series	D	<i>h</i>	<i>s</i>	W	X	Y	Y'
A	4.3	0.3521	6.609	4.356	1.196	27.46	..
	7.1	0.3407	6.433	11.500	2.806	24.35	..
	9.8	0.3460	6.187	22.250	5.400	24.56	..
B	4.3	0.3521	6.609	5.356	1.196	27.46	27.46
	4.3	0.6869	3.842	8.500	1.912	22.50	15.97
	4.3	0.9924	2.946	13.284	2.088	17.00	12.25
	4.3	1.3980	2.360	17.306	2.150	12.43	9.81
	4.3	1.8520	2.011	22.920	2.481	10.82	8.36
C	9.8	0.3460	6.187	22.25	5.400	24.56	24.56
	7.1	0.6651	3.568	22.45	4.100	18.26	14.18
	4.3	1.8520	2.011	22.92	2.481	10.82	7.99

DISCUSSION OF RESULTS

It is seen from the above table that (i) if the specific surface is constant, the percentage syneresis is also constant, provided, however, the thickness of the gel is small and is of the order of 0.35 cm. (cf., Series A), (ii) the percentage syneresis depends upon the specific surface, being greater, greater the specific surface (cf., Series B and C), and (iii) the amount of syneresis per unit surface depends upon the thickness of the gel, if it is small,

and is nearly independent of the thickness if it is large. The values of percentage syneresis (Y'), given in the last column of Table I, calculated on the basis of the specific surface, using the value of Y for the gel of the smallest thickness in the B and C Series, show that there is no direct proportionality between s and Y' . This observation is in contradiction to the conclusions of Holmes and co-workers¹ which are not supported even by their own experimental results. It is clear that the syneresis of gels of fair thicknesses is not wholly determined by the specific surface; presumably there are other factors as well which influence it.

The effect of surface area exposed on the syneresis of these gels can be explained as follows:

The number and the size of micelles in a gel depend upon the concentration of the dispersed phase and the temperature to which the gel-forming solutions is allowed to cool. Now, at any temperature, if a fixed volume of a gel sets in vessels of increasing surface area, the number of the micelles at the surface and therefore the number of interfibrillary spaces on the surface of the gel will increase. Since the exudation of the syneretic liquid must take place ultimately through the interfibrillary spaces on the surface of the gel, the increase in the number of such spaces would facilitate the flow of the exuded liquid and hence the amount of the syneresis in the same gel in a given time would depend upon its surface. However, if the height of the gel is increased within small limits an increase in the amount of syneresis may be expected, on account of (i) the increased hydrostatic pressure exerted by the increased column of the gel and (ii) the possible decrease in the stability of the gel on increase in the thickness, provided the increased height does not alter the gel-structure or change the number and size of the fibrils present therein.

SUMMARY

The effect of the area of gel surface exposed on the syneresis of sodium oleate gels in pinene has been determined. It is observed that syneresis is directly proportional to the specific surface per unit volume of the gel, provided the thickness of the gel is small, and nearly constant. When greater thicknesses of the gel are considered syneresis is slightly higher than the value calculated on the basis of the specific surface.

REFERENCES

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4. Prasad, Hattiangi and Mathur .. *Proc. Ind. Acad. Sci.*, 1945, **21 A**, 105.