THE DETERMINATION OF DIFFUSION COEFFICIENTS OF SURFACTANTS USING THE POROUS FRIT METHOD

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The original porous frit method, described by Wall and others (1952), employed the suspension of a solution-filled porous frit from a balance into a large volume of solution of different concentration.   The change in the apparent weight of the frit with time was recorded and from the data the diffusion co-efficient was calculated using the equation:

$$\log W = \frac{-Dt\ \pi^2}{2.303(2L)^2} + \log 2\ LAK\ (C_1 - C_0)\frac{8}{\pi^2}$$

where W = (weight of frit at time t) − (weight of frit after infinite time), 2L = geometrical thickness of frit, A = cross-sectional area of frit, C_1 = initial concentration of solute at any point inside the frit, C_0 = the concentration in the frit at t = ∞ t = time, D = diffusion coefficient of solute, K = constant which converts concentration to density, assuming a linear relationship between these two parameters.   A plot of log W against time should yield a straight line of slope − $D\pi^2$/2.303 $(2L)^2$ for any given frit.   This is determined by using a solute solvent system of known diffusion coefficient.

In this work the porous frit technique has been modified to extend to the measurements of the diffusion coefficients of sodium lauryl sulphate (NaLS) and dodecyltrimetylammonium bromide (DTAB).   The values presented in Table 1 show a comparison of the diffusion coefficients obtained using Wall's technique (D weight) to the results obtained by the modified technique (D conc.) and in the case of NaLS literature values (D lit.) reported by Brudney and Saunders (1955)[a] and Stigter and others (1955)[b].

Table 1.   The diffusion coefficients of NaLS and DTAB at 25°.

	Concentration moles l^{-1}	D lit. x 10^6 cm^2 sec^{-1}	D weight x 10^6 cm^2 sec^{-1}	D conc. x 10^6 cm^2 sec^{-1}
NaLS	0.005	6.5[a]	3.7	6.1
	0.030	1.1[b]	3.8	1.0
DTAB	0.007		3.1	4.0
	0.020		2.1	1.0

When surfactants are used as solutes the relationship between density and concentration is not linear due to the CMC.   The measurement of the apparent weight of the frit is therefore not acceptable.   To overcome this, concentrations have been used in place of weights, being monitored conductimetrically.

When the concentration is measured rather than the weight of the frit the dependence on density is eliminated and the results obtained for NaLS are in good agreement with the literature values.   Replicate experiments using this system give results which show a coefficient of variation of 2%

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Stigter, D., Williams, R.J. & Mysels, K.J. (1955). Ibid., 59, 330-335.
Wall, F.T. Grieger, P.F. & Childers, C.W. (1952). J. Am. Chem. Soc., 74, 3562-3567.