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Removal of hydrophobic surface coatings from a non-disintegrating hydrophilic solid in a water stream

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During the dissolution of a solid disc of constant area, A , exposed to solvent flowing at a constant rate, dV/dt , in the apparatus described by Fee (1974), a constant concentration, c , of dissolved solute reflects a constant dissolution rate, dm/dt . V is here the volume of solvent and m is the mass of dissolved solute in the dissolution chamber at time t . Now

$$\frac{dm}{dt} = c \cdot \frac{dV}{dt} \quad \dots \dots \dots (1)$$

and the intrinsic dissolution rate, G , is defined by

$$G = \frac{1}{A} \cdot \frac{dm}{dt} \quad \dots \dots \dots (2)$$

therefore

$$A = \frac{c}{G} \cdot \frac{dV}{dt} \quad \dots \dots \dots (3)$$

When a potassium chloride disc was coated with stearic acid as described by Fee (1974) the depressed values of c and dm/dt increased linearly with time. Differentiation of equation (1) at constant flow rate yields

$$\frac{d^2m}{dt^2} = \frac{dc}{dt} \cdot \frac{dV}{dt} \quad \dots \dots \dots (4)$$

where dc/dt and d^2m/dt^2 are the (constant) rates of increase of concentration and dissolution rate respectively. The effects of coating may be attributed to changes in A or G or both. Observation by optical and scanning electron microscopy of the coated surfaces suggested that the area from which dissolution took place increased with time and that the coating was removed during the test. It is postulated (a) that the hydrophobic coating reduces to zero the rate of dissolution of the substrate directly beneath it and (b) that the value of G for the uncoated area equals that for an uncoated disc at the same solvent flow rate. The uncoated area A of the disc is then given by equation (3) which on differation affords

$$\frac{dA}{dt} = \frac{1}{G} \cdot \frac{dc}{dt} \cdot \frac{dV}{dt} \quad \dots \dots \dots (5)$$

since G is constant at constant flow rate. As dA/dt is constant, the time taken to remove the coating is given by

$$T = (A_T - A_0) \Big/ \frac{dA}{dt} \quad \dots \dots \dots (6)$$

where A_0 is the initial exposed area of the disc (calculated from the value of c at zero time using equation 3) and where A_T is the total area of the disc (1.3273 cm²). There is good

agreement between T calculated from equation (6) and the time taken for c to rise to that for an uncoated disc. This supports postulates (a) and (b) above. Thus the system described by Fee (1974) readily provides a method for determining the rate of removal of coatings from dissolving solids.

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The determination of partition coefficient data using the "AKUFVE" method

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The measurement of partition coefficient data is now a routine part of drug research. Octanol-water partition values are used to study structure-activity relations (Hansch Analysis), and to give insight into absorption properties. Partition data also play an important role in the development of a group contribution approach to solution thermodynamics (Davis, Higuchi & Rytting, 1972). The usual method of measuring partition coefficient values is the laborious shake-flask technique. The values determined from such batch-wise determinations are frequently inaccurate and measurements at different temperatures are difficult. The derived data cannot normally be used to calculate the thermodynamic quantities, enthalpy and entropy. Consequently we have investigated the utility of commercially available Swedish apparatus (AKUFVE) (Reinhardt & Rydberg, 1970). Briefly it consists of a mixer which provides rapid efficient contact between two immiscible solvents, a unique centrifugal separator that ensures rapid "absolute" separation and connections permitting sampling or on-stream measurement of the concentrations of solute in both solvent phases. Equilibrium is normally attained in a matter of minutes. The experimental conditions can be changed at will with the result that a temperature or pH profile can be determined in a few hours. We have assessed the performance of the AKUFVE using a range of compounds (alkyl phenols, weak acids, weak bases) at different solute concentration, temperature, pH, ionic strength and phase volume. Three different solvents (octanol, cyclohexane, chloroform) have been examined. The derived partition values were compared with experimentally determined or literature values obtained in the conventional way (Table 1).

Table 1. Partition of propranolol between water and octanol (22.5°) [pKa = 9.45, log P (free base) (shake flask) = 3.33, 3.65].

pH	4.65	5.53	5.75	6.06	6.32	6.76	7.12	
log P (apparent)	-2.28	-0.41	-0.18	0.22	0.33	0.95	1.58	Mean
log P (free base)	3.61	3.52	3.52	3.59	3.47	3.57	3.65	3.56 ± 0.06

The AKUFVE apparatus provides a rapid and accurate method for determining the partition coefficient values of drug substances in instances where a range of experimental conditions are investigated (e.g. solute concentration, pH, temperature). It will provide an excellent experimental tool for investigation of the thermodynamics of partitioning and the determination of functional group contributions.

The authors wish to thank Mr. P. J. Taylor, I.C.I. Pharmaceuticals for helpful discussions.

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