

& others, 1973) thus hindering steroid incorporation.  $\Delta G^\circ$  also increased with increased steroid polarity. The steroids interacted exothermically with the surfactants.

$\Delta S$  was negative for hydrocortisone and dexamethasone and became positive for the less polar testosterone and progesterone. Two opposing factors account for this. (1) Crowding of the solubilized steroid in the micelle occurs with negative entropy change. (2) Configuration entropy of the solubilized molecules increases due to the breakup of the water structure surrounding nonpolar hydrocarbon molecules or groups. Effect 1 governs the solubilization of hydrocortisone and dexamethasone while effect 2 controls that of testosterone and progesterone.

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#### A method of testing the applicability of the diffusion layer dissolution model

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Fee, Grant & Newton (1973) reported an empirical equation connecting the Reynolds number,  $Re$ , of solvent flow and the intrinsic dissolution rate of a compressed disc of potassium chloride at  $37^\circ$  measured in a specially designed continuous flow apparatus. From this relationship the thickness  $h$  of the diffusion layer in the dissolution model of Nernst (1904) was calculated at various Reynolds numbers (Table 1). These  $h$  values were compared with those (Table 1) calculated from the physical constants of the system using equation (1) which Levich (1962) derived for flow past a flat disc.

$$h = 3x^{\frac{1}{2}} D^{1/3} (\eta/\rho)^{1/6} u^{-1/2} \quad \dots \quad (1)$$

where  $x$  is the distance from the upstream edge of the disc measured along an axis parallel to the direction of flow (mean value  $3.25 \times 10^{-3}$  m),  $D$  is the diffusion coefficient of the solute ( $3.20 \times 10^{-9}$  m<sup>2</sup> s<sup>-1</sup>),  $\eta$  is the dynamic viscosity of the medium ( $6.915 \times 10^{-4}$  kg m<sup>-1</sup> s<sup>-1</sup>),  $\rho$  is the density of the medium ( $993.4$  kg m<sup>-3</sup>) and  $u$  is the characteristic linear flow velocity of the system. Now  $u$  was calculated from  $Re$  using the equation

$$u = \eta Re / \rho d \quad \dots \quad (2)$$

where  $d$  is the mean hydraulic diameter of the dissolution chamber (0.0312 m) and the other quantities are defined above.

Table 1. *Thickness  $h$  of the diffusion layer at various Reynolds numbers.*

Reynolds number	360	1335	3000	4500	6000
$h/\mu\text{m}$ (experimental)	115	100	82	71	62
$h/\mu\text{m}$ (equations 1 & 2)	265	137	92	75	65

The disagreement between corresponding values of  $h$  at low  $Re$  in Table 1 is attributed to the predominance of natural over forced convection. Considering the approximations made in deriving equation (1) the agreement between corresponding  $h$  values is good at high  $Re$  where forced convection predominates. Furthermore, the asymmetric pattern of erosion of the solid disc by the solvent is exactly as predicted by Levich (1962) for a diffusion controlled process. The validity of the diffusion layer model in the present system is supported by the effect of viscosity of the medium on the dissolution rate of potassium chloride in water (Zdanovskii, 1951).

Thus, by enabling dissolution rates to be expressed in terms of  $Re$  the apparatus of Fee & others (1973) provides a simple means of testing the applicability of the diffusion layer model for dissolving solids.

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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 cm<sup>2</sup>). There is good