

Appendix C: Symbols

| Symbol | Meaning | Eqn. involved |
|--------------------------|---|---------------|
| * | bulk superscript | (3) |
| a_m | m-th coefficient of the unknown function expansion | (4) |
| c | electroactive species concentration | (3) |
| D_e | diffusion coefficient of electroactive species in electrolyte medium | (3) |
| e | electrolyte layer subscript | (A-2), Fig. 1 |
| f_3 | “weight” function in computing $L_{m,n}$ | (6), (5) |
| F | Faraday constant | (3) |
| h_e, h_m | auxiliary function to compute edge effect index η | (12), (10) |
| i | dimensional current | (3) |
| $i_{d,e}$ | diffusion limited steady state current for unshielded electrode in electrolyte medium | (3) |
| $j_{o,o}$ | auxiliary function | (15) |
| J_ν | Bessel function of order ν | (5) |
| $L_{m,n}$ | coefficient of a_m in the nth. equation | (4), (5) |
| m | membrane layer subscript | (A-2), Fig. 1 |
| n | number of exchanged electrons | (3) |
| $p(r,z)$ | partial pressure of electroactive species | (3) |
| P_ℓ | Permeability of electroactive species in layer ℓ (e,m,s) | (A-2) |
| r | radial co-ordinate | (A-1), Fig. 1 |
| r_c | cathode (or electrode) radius. Distance normalisation factor | Fig. 1 |
| s | sample layer subscript | (A-2), Fig. 1 |
| u | non-dimensional partial pressure p/p^* | (A-1) |
| w | ratio of the thickness of the layers | (17) |
| z | axial co-ordinate | (A-1), Fig. 1 |
| z_e | distance from cathode to the electrolyte-membrane interface normalised with respect to the cathode radius r_c | Fig. 1 |
| z_m | distance from cathode to the membrane-sample interface normalised with respect to the cathode radius r_c | Fig. 1 |
| ϵ_1, ϵ_2 | non-dimensional ratio of permeabilities (e1 and e2 in Mathematica code) | (1) |
| η_ℓ | edge effect index of layer ℓ (e,m,s) | (7) |
| Φ | Lerch Phi function $\Phi(x, s, v) = \sum_{n=0}^{\infty} \frac{x^n}{(v+n)^s}$ | (17) |

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Figure captions:

Fig 1 Geometry modelled for the membrane covered inlaid disk electrode. Gradient lines are plotted so that 1/10 of the overall flux of the electroactive species flows inside any "tube" defined by any two adjacent lines. This plot corresponds to $z_e=0.5$, $z_m=1$, $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-10} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$.

Fig 2 Gradient lines for $z_e=0.5$, $z_m=0.6$, $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-10} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$. Edge effect indices: $\eta_s=0.1961$, $\eta_m=0.0021$, $\eta_e=0.8018$.

Fig 3 Gradient lines for $z_e=0.2$, $z_m=0.7$, $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-10} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$. Edge effect indices: $\eta_s=0.1549$, $\eta_m=0.0267$, $\eta_e=0.8184$.

Fig 4 Flux lines for $z_e=0.5$, $z_m=1$, $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-11} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$. Edge effect indices: $\eta_s=0.0177$, $\eta_m=0.0012$, $\eta_e=0.9811$.

Fig 5 Effect of the membrane permeability on the non-dimensional current for fixed electrolyte layer thickness ($z_e=0.5$) and electrolyte and sample permeabilities ($P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$). Three thickness are compared: $z_m-z_e=0.5$ (\times marker), $z_m-z_e=2$ (continuous line) and $z_m-z_e=8$ (\square marker).

Fig 6 Effect of changing the thickness of the membrane ($\epsilon_1 = \epsilon_2 = 0.9214$, e.g. $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-11} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$) with a fixed electrolyte layer ($z_e = 2$) on the non-dimensional current.

Fig 7 Effect of moving a fixed membrane ($z_m - z_e = 0.5$, $\epsilon_1 = \epsilon_2 = 0.9214$, e.g. $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-11} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$) on the non-dimensional current.

Fig 8 Effect of changing the electrode radius (sample-membrane interface height: $15 \mu\text{m}$; membrane-electrolyte interface height: $10 \mu\text{m}$; $\epsilon_1 = \epsilon_2 = 0.9214$, e.g. $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-10} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$) on the non-dimensional current. Markers \blacksquare stand for the approximate expression (13) and markers \circ stand for expression (16).

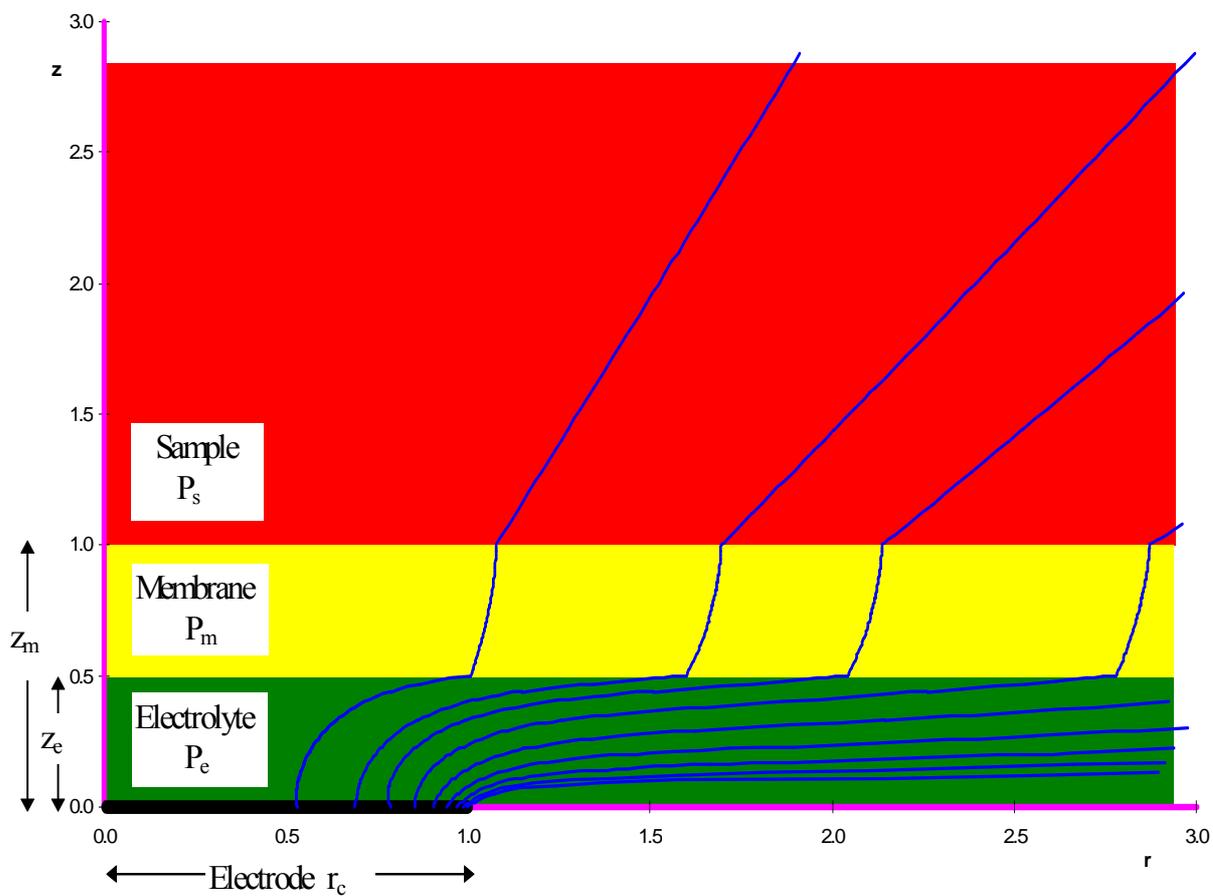


Fig. 1

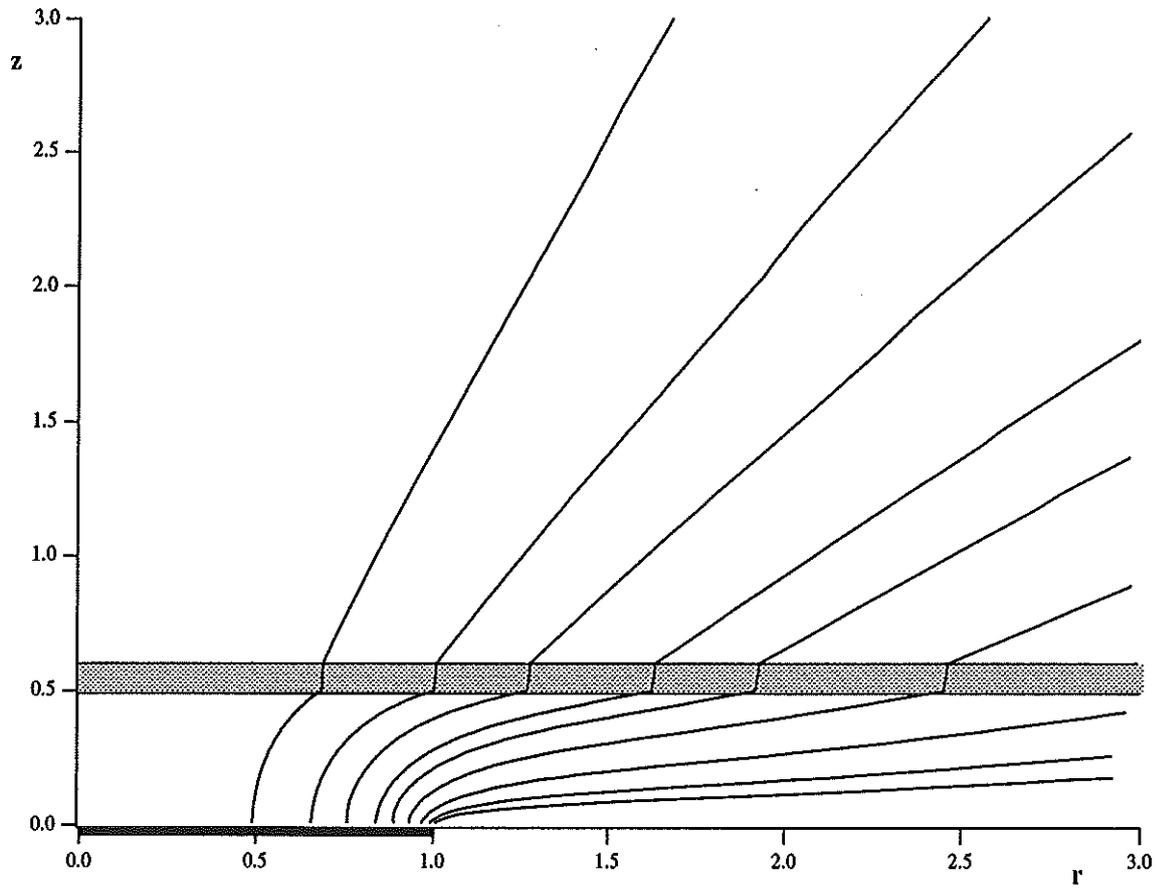


Fig 2

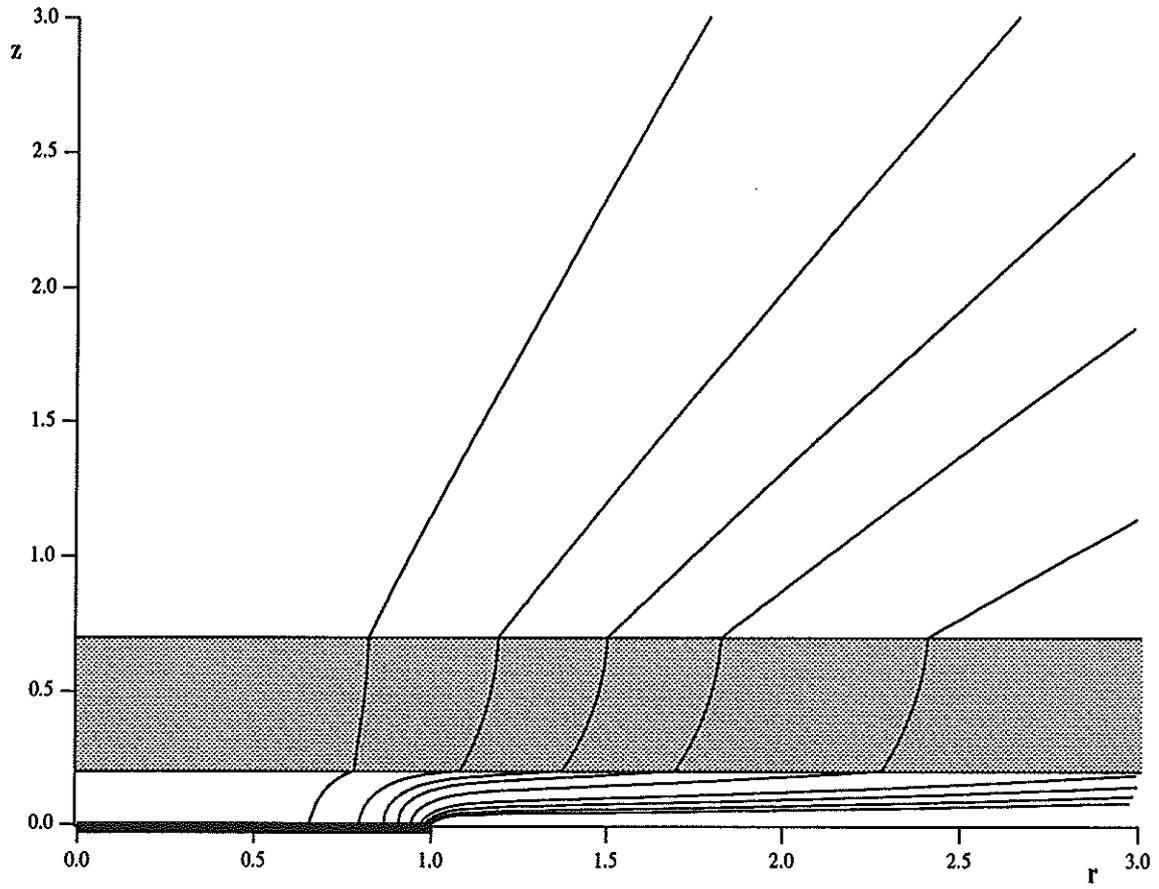


Fig 3

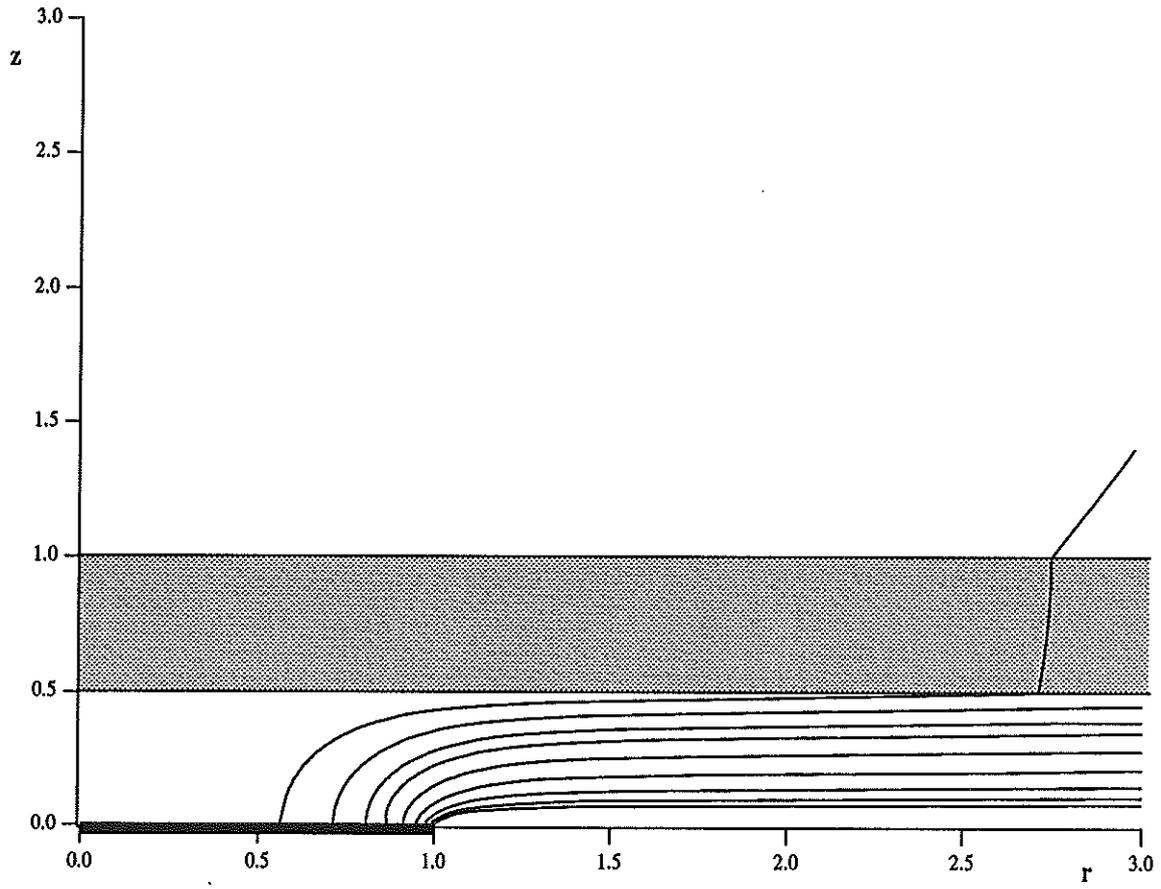


Fig 4

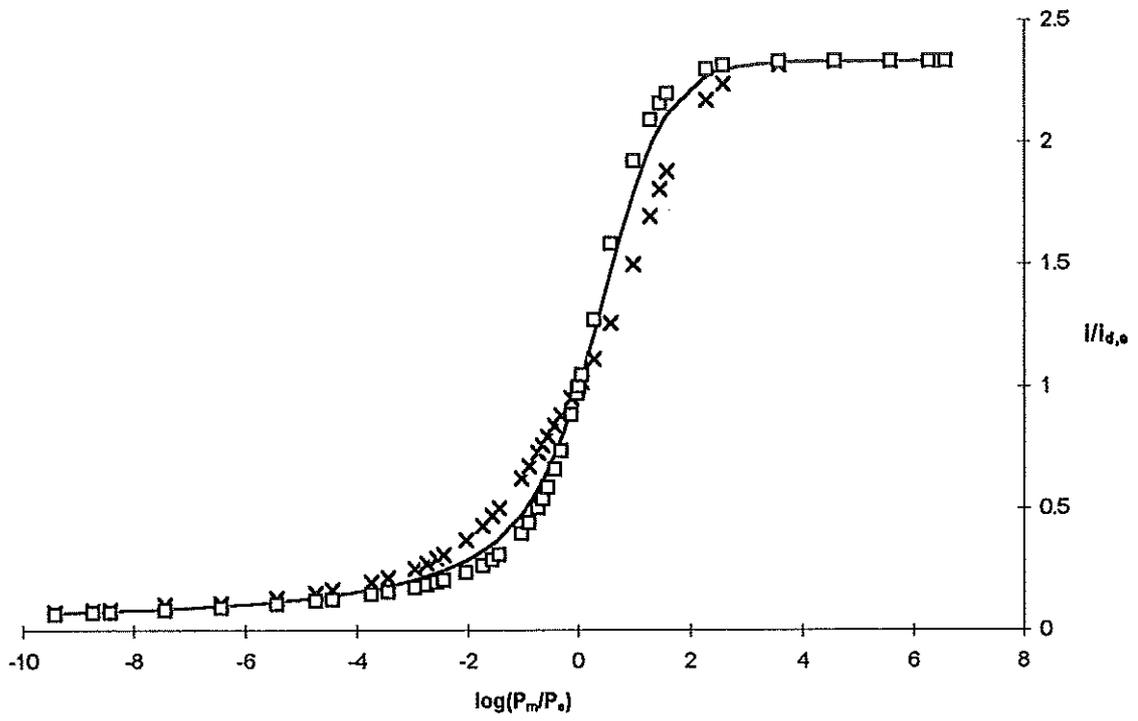


Fig 5

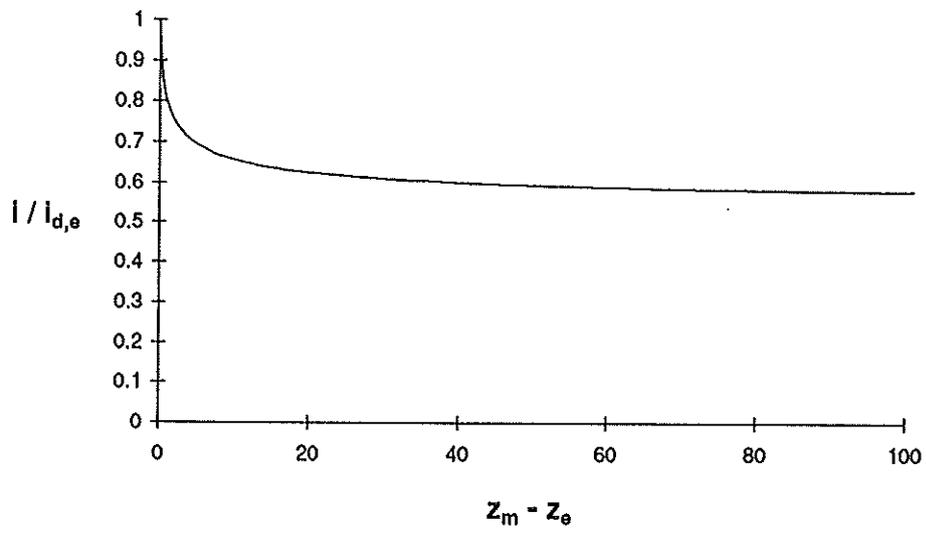


Fig 6

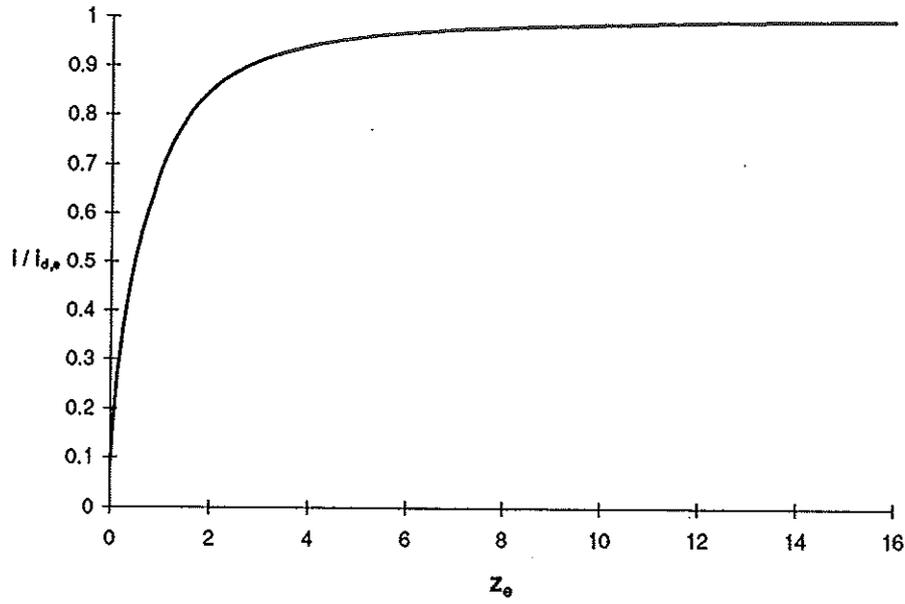


Fig 7

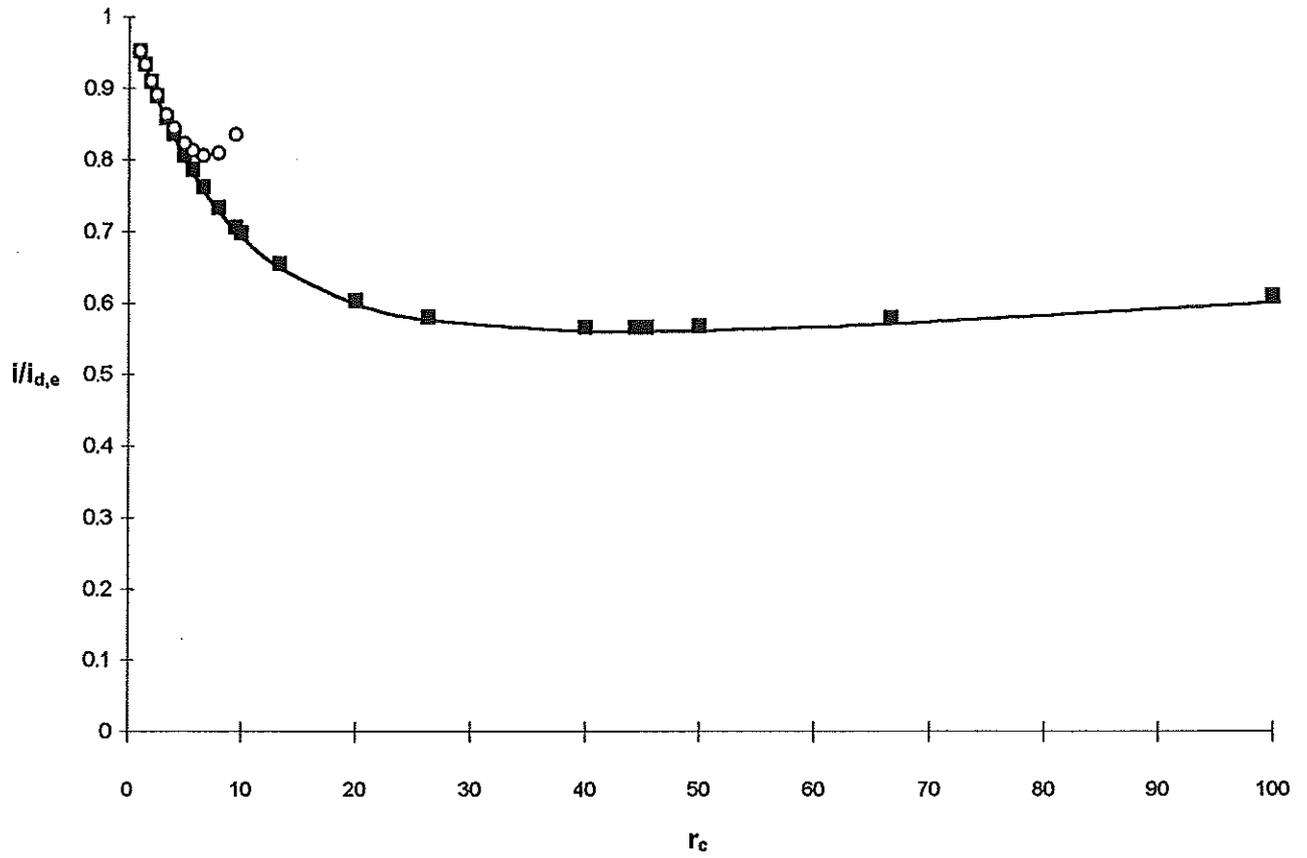
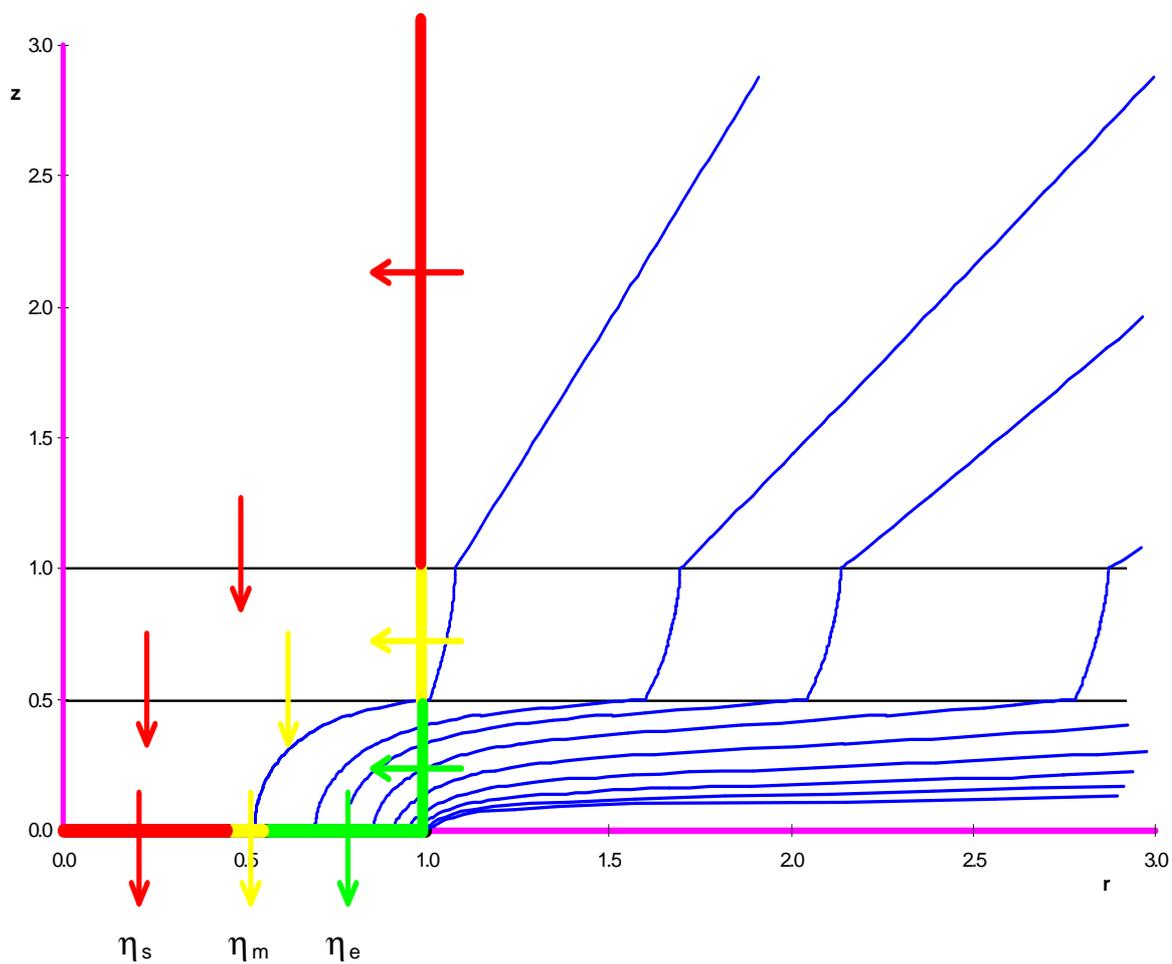


Fig 8

Edge effect indices: not shown in article Galceran 121 (1996) 1863



Index of edge effect contribution in the membrane covered inlaid disk electrode. Parameters $z_e=0.5$, $z_m=1$, $P_e=P_s=2.69 \cdot 10^{-9} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$, $P_m=1.1 \cdot 10^{-10} \text{ mol m}^{-1} \text{ s}^{-1} \text{ atm}^{-1}$. Edge effect indices: $\eta_s=0.0860$, $\eta_m=0.0018$, $\eta_e=0.9032$.