Although both models show a good fit of the experimental data, the Pitzer-Simonson equation enables the calculation of the activity coefficients of the NaCl in solvents of any composition, within this range (0 – 20% eth.), whereas the Pitzer model would require a smooth variation of the second and third virial coefficients with solvent composition in order to perform the calculations.

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details on this curve depend on the scan rate, on the reversal potential, on the pre-
treatment of the electrode and on the solution composition. The application of repetitive
cyclic voltammetry is in itself a method of electrode cleaning and the appearance of this
kind of voltammogram is an indication of a clean surface. This fact may constitute the
basis of a method to detect biofilm formation in a flow system since the smallest deposit
on the electrode surface will certainly change the pattern observed when the platinum
electrode surface is clean.

Two types of electrochemical cells were used, a batch cell for cyclic
voltammetry experiments and a flow cell (Figure 2). The microorganism used as a
biofilm producer was *Pseudomonas fluorescens* isolated from river water. The optimum
growth temperature is 27 °C and glucose was used as the limiting substrate. Batch
cultures were performed in 0.5 L glass fermenters with stirring. The fermenter with the
medium that contained 5 g/dm$^3$ glucose, 2.5 g/dm$^3$ peptone and 1.25 g/dm$^3$ yeast
extract, in phosphate buffer at pH=7 (0.3 M Na$_2$HPO$_4$) was autoclaved at 120°C during
20 minutes. The batch fermenter was used as the immersion vessel for the electrodes
where the biofilm was allowed to grow. The flow in the flow cell was achieved with a
peristaltic pump.

![Figure 2](image)

Figure 2 – Schematic view of the flow cell.

Figure 3 shows a series of cyclic voltammograms recorded on a batch cell and
the different cycles show the effect of the different components used in the medium on
the standard voltammograms shown in figure 1. Figure 4 shows the difference in the
voltammetry on the batch cell at a clean electrode in the culture medium and
immediately after the electrode with biofilm is immersed in the same solution. A clear
difference is observed specially in the H$_2$ desorption region. Figure 5 shows the effect of
recycling the potential on an electrode with biofilm.

The above preliminary experiments demonstrate that the platinum electrode and
cyclic voltammetry may constitute the basis of an electrochemical detector of biofilms.
These experiments will now have to be carried out in the flow cell that was constructed
for this purpose.

Figure 6 shows the effect of the flow rate on the cyclic voltammograms recorded
in such cell containing a buffer solution. Experiments where the biofilm is made to
grow on the flow system are now under progress.

![Figure 3](image)

Figure 3 – Cyclic voltammograms recorded on a batch cell at a scan rate of 250 mV/s.
(a) Voltammograms were obtained: (1) in a buffered solution; (2) in a buffered solution with
5 g/dm$^3$ of glucose; (3) in a buffered solution with 2.5 g/dm$^3$ of peptone; (4) in a buffered
solution with 1.25 g/dm$^3$ yeast extract; (5) in a buffered solution with 5 g/dm$^3$ of glucose,
2.5 g/dm$^3$ of peptone and 1.25 g/dm$^3$ of yeast extract.
(b) Voltammograms were obtained: (1) in a buffered solution; (2) in a buffered solution with 5 g/dm$^3$ of glucose and 2.5 g/dm$^3$ of
peptone; (3) in a buffered solution with 5 g/dm$^3$ of glucose and 1.25 g/dm$^3$ of yeast extract; (4) in a buffered solution with 5 g/dm$^3$ of glucose, 2.5 g/dm$^3$ of peptone and 1.25 g/dm$^3$ of yeast
extract.
Figure 4 – Cyclic voltammograms recorded on a batch cell containing the culture medium at a scan rate of 250 mV/s. Voltammograms were obtained: (1) with a clean electrode in the culture medium; (2) immediately after an electrode with biofilm is immersed in the culture medium.

Figure 5 – Cyclic voltammograms recorded on a batch cell at a scan rate of 250 mV/s. Voltammograms were obtained: (1) immediately after the electrode with biofilm is immersed in the buffered solution; (2) after 5 cycles; (3) after 100 cycles.

Figure 6 – Cyclic voltammograms recorded on a flow cell at a scan rate of 100 mV/s. Voltammograms were obtained in a buffered solution: (1) without flow; (2) with a flow rate of 4 mL/min; (3) with a flow rate of 15.8 mL/min; (4) with a flow rate of 33.3 mL/min.


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