Hospital Production of Concentrated Haemodialysis Solution at Minimal Cost

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The Renal Unit of St Thomas’s Hospital incorporates a chemical manufacturing plant for the production of concentrated (x35) haemodialysis solution. The plant has been in use for nine months and current production runs at 1,000 litres per week.

Figure 1. Chemical manufacturing plant.
Key: (1) Reaction vessel; (2) Automatic water metering and dispensing apparatus; (3) Pumping of liquid chemicals from drums; (4) Transfer of powdered chemicals by overhead hoist; (5) Weighing machine; (6) Vacuum pump; (7) Continuous recording pH meter; (8) Recirculating pump; (9) Filter
METHOD

PLANT (Figures 1 and 2)

The centre of the plant is an enclosed reaction vessel. The vessel is glass-lined, has a water cooling jacket and a stirrer. A pH electrode is sited at the midpoint of the vessel; the remote meter produces a continuous record of the pH within the vessel.

Liquid chemicals are pumped from their drums into a container on the platform weighing machine for weighing. Powdered chemicals are moved to the platform by an overhead powered hoist. All chemicals are transferred from the weighing machine to the reaction vessel by vacuum pumping, a separate hose being used for liquid and powdered chemicals, all of which are transferred individually.

PROCESS

(1) The reaction vessel is primed with base exchange softened water from an automatic water metering and dispensing apparatus.
(2) Caustic soda liquor is pumped into the reaction vessel. Glacial acetic acid is added and the reaction to form sodium acetate and water occurs:

\[
\text{NaOH} + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}
\]

This reaction is exothermic and the heat is dissipated through the water cooling jacket. This permits the use of a general purpose, rather than a high temperature pH electrode. The addition of glacial acetic acid is titrated against the pH recorded within the reaction vessel, and the addition is continued until the pH falls to 7.7. Since the pH of sodium acetate is in the range 8-10, there is a slight excess of acid at pH 7.7. 628 g of caustic soda liquor (46.8% w/w NaOH) and 441 g of acetic acid are required to prepare 1 kg of sodium acetate.

(3) Powdered sodium chloride, dextrose, calcium chloride, magnesium chloride and potassium chloride are then weighed out and transferred to the reaction vessel by vacuum pumping. Homogeneity of the solution is achieved by stirring with a propellor.

(4) Following chemical analysis for quality control the solution is recirculated to and from the reaction vessel through a 3 \( \mu \) filter. Filtration through a 2 \( \mu \) filter is subsequently carried out during recirculation between storage tanks and bed station outlets. Parallel filters ensure that a standby filter is always available. The concentrate is continuously recirculated in this manner in order to prevent 'layering' of the solution.

**RESULTS**

**QUALITY**

Results of chemical analysis of the first 25 batches of fluid (diluted x35) were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na (mEq/l)</td>
<td>130.5</td>
<td>± 1.819</td>
<td>126-134</td>
</tr>
<tr>
<td>K (mEq/l)</td>
<td>1.025</td>
<td>± 0.070</td>
<td>0.9-1.2</td>
</tr>
<tr>
<td>Ca (mEq/l)</td>
<td>2.919</td>
<td>± 0.141</td>
<td>2.75-3.1</td>
</tr>
<tr>
<td>Mg (mEq/l)</td>
<td>1.488</td>
<td>± 0.044</td>
<td>1.4-1.6</td>
</tr>
<tr>
<td>Cl (mEq/l)</td>
<td>92.56</td>
<td>± 1.26</td>
<td>91-95</td>
</tr>
</tbody>
</table>

**COST**

The total cost of development and installation of the manufacturing plant was £6000.

The production of one batch of concentrate sufficient for the needs of the unit requires one operator for half a day each week. The cost of producing 1,000 litres of concentrate is £31.15. This includes wages and replacement of filters. The cheapest commercially available solution taken in bulk.
delivery in London costs £112.5 per 1,000 litres. The estimated annual saving is therefore £4,230. With the plant operating at its present 10% capacity it will therefore pay for itself in less than two years.

FOOTNOTE

Further technical details are available from Dr A J Wing, St Thomas's Hospital Renal Unit, Lambeth Hospital, Brook Drive, London, SE11.