

Electrochemistry in hydrogel balls

(Hungary)

Background

Hydrogels are examples of new polymers that are regarded as 'smart' materials due to their possible applications. They are polymer chains with a few cross-linking units which creates a matrix that can trap water. Smart gels can shrink or swell up to 1000 times their volume due to changes in pH or temperature.

Follow these steps

1. Prepare the hydrogel balls (this needs to be done in advance). First, wash the hydrogel balls several times in distilled water, then leave them to swell in more distilled water for at least 2 hours. Approximately 500 mL of distilled water is needed to soak 30 hydrogel balls.
2. Place a piece of filter paper onto the tile or Petri dish. Drip some sodium chloride solution onto the filter paper, as an electrolyte.
3. Place two hydrogel balls on the filter paper and insert an electrode into each hydrogel ball.
4. Using a Pasteur pipette, insert some silver nitrate solution into the hole in each hydrogel ball where the electrodes enter it.

5. Clip the cables to the electrodes and the battery. Close the electrical circuit.
6. Observe the changes and record them.
7. Repeat for the other electrolytes.



So what happened?

The equations of the electrolysis reactions are:

Electrolysis of silver nitrate solution:

Cathode (negative electrode): $2\text{Ag}^+(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Ag}(\text{s})$

Anode (positive electrode): $\text{H}_2\text{O}(\text{l}) \rightarrow \frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^-$

Electrolysis of zinc iodide solution:

Cathode (negative): $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$

Anode (positive): $2\text{I}^-(\text{aq}) \rightarrow \text{I}_2(\text{s}) + 2\text{e}^-$

Electrolysis of water:

Cathode (negative): $4\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 2\text{H}_2(\text{g}) + 4\text{OH}^-(\text{aq})$

Anode (positive): $2\text{H}_2\text{O}(\text{l}) \rightarrow \text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^-$

What next?

Anti-microbial uses of hydrogels and metals in medicine to combat MRSA in post-operative care. Nature and uses of aerogels. An interesting video to show the simulation of a miniature steam engine using hydrogel balls is available online.