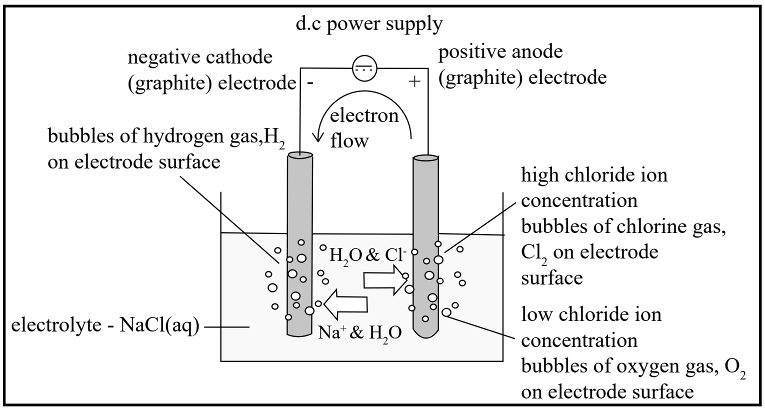
Fig. 6



Brine solutions contain a minimum of 3.5% sodium chloride. During the electrolysis of brine, chlorine gas is produced at the positive electrode, i.e. in high chloride ion, Cl^-, concentrations, the chlorine ion preferentially releases electrons at the positive electrode.

Reaction at the anode: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

In low chloride ion, Cl^-, concentrations, water molecules are preferentially released and oxygen gas is produced at the positive electrode.

Reaction at the anode: $H_2O(l) \rightarrow ½O_2(g) + 2H^+(aq) + 2e^-$

7KHSHFVHHDVRVIRWKHFRFHWDWRHSHHWVFKDHRIFKORHDW WKHDRHDHFRPSOH[DDHRWHH6[WK)RPVOODEVHV%H the electrode potentials that we have been using to compare the tendency for redox processes to occur are all standardised; one of the requirements is 1.00 mol dm^{-3}VROWRVRIRVVWKHFRFHWDWRRIWKHFKORHRVFKDHV WKHHOHFWRHSRWHWDOIRWKHR[DWRDOVRFKDHV7KHDOHEHFRPHV less negative as the concentration increases (i.e., the value gets closer to that IRWKHR[DWRRIDWH,DWRDWHVPRHvFOWWRR[VHDW the anode than predicted due to a phenomenon called overpotential.

Using Electrolysis

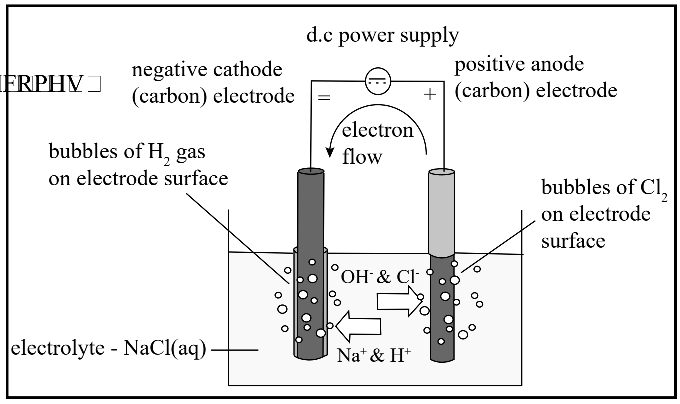
Electrolysis is used to extract metals from minerals and ores, e.g. aluminium, VRPSRWDVVPPDHVPDEDOFP7KHFREWWRIFRSSH VPSRHVHOHFWROVVWRHHFRSSHIRPORSWFRSSH7KH industrial processes using electrolysis includes the production of chlorine, sodium hydroxide, and sodium chlorate. Electrolysis is used to produce oxygen in nuclear submarines and in spacecraft. It is also used in cleaning and preserving metal artefacts and old coins. It is also used to remove rust IRPROHHSDWV(OHFWROVVVHHOHFWRSODW7KVROHV HSRVWDWKOPRIPHWDORHDREMHFW7KVFRPSOHWHIRSDFWFDO RHFRDWHSSRVHVHFRVRWKHSRFWRRIFKHDSMHHOOH

Questions

1. Ions successfully released at the electrodes depend on which three factors?
2. VROWRRISRWDVVPRHHRHVHOHFWROVV6WDWHKFKRI the following statements are true. If a statement is incorrect, provide a correct alternative statement.
   (a) Hydrogen gas is being produced at the cathode and iodine at the anode.
   (b) Potassium ions are reduced to potassium atoms at the cathode.
   (F) EREFROMVREVHHDWRHRIWKHHOHFWRHVHWRWKVKDOI reaction: $2H_2O + 2I^- \rightarrow 2I_2 + 2OH^- + H_2 + 2e^-$
3. VRPFKORHHOHFWROWHVROWREHHRHVHOHF - WROVV7KHHVDKKFRFHWDWRRIVRPRV1D$^+$, and chloride ions, Cl^-7KHHDHOREFRFHWDWRVRIKRH ions, H^+, and hydroxide ions, OH^-, due to the ionisation of water.
   (a) Sketch and label a simple diagram describing the electrode reactions and products of the electrolysis.
   (b) Complete redox half-equations for the reactions occurring at both electrodes. Identify if the reaction is oxidation or reduction.
   (c) Write an overall chemical equation for the electrolysis of brine, sodium chloride solution.
4. D DHOHFWRSODWH[SHPHWDVWHHOFDWKRHVVH 7KHHOHFWROWHVHVDVROWRRIFNHO,,VOSKDWH What should the anode be made of to successfully complete the experiment?
   (b) Complete the redox half-equation for the cathode during the electroplating of steel with nickel.

Answers

1. SRRQRFRPSQSKQURFPF series.
   7KHDWHFRPSRVWRRIWKHHOHFWRHV
   7KHFRFHWDWRRIFRPSHWVSHFHVWKHHOHFWROWH
2. D 7H
   (b) False – Iodine ions are oxidised at the anode.
   F)DOVHERFRORVREVHHDWWKHDRHHWR $2I^- \rightarrow I_2 + 2e^-$
3. (a)



   (E) WFDWKR
   $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ (reduction)
   WDRH $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ (oxidation)
   (c) $2NaCl(aq) + 2H_2O(l) \rightarrow H_2(g) + Cl_2(g) + 2NaOH(aq)$
4. D 1FNHO
   (b) $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

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