THE CHLOR-ALKALI INDUSTRY 13 AUGUST 2013

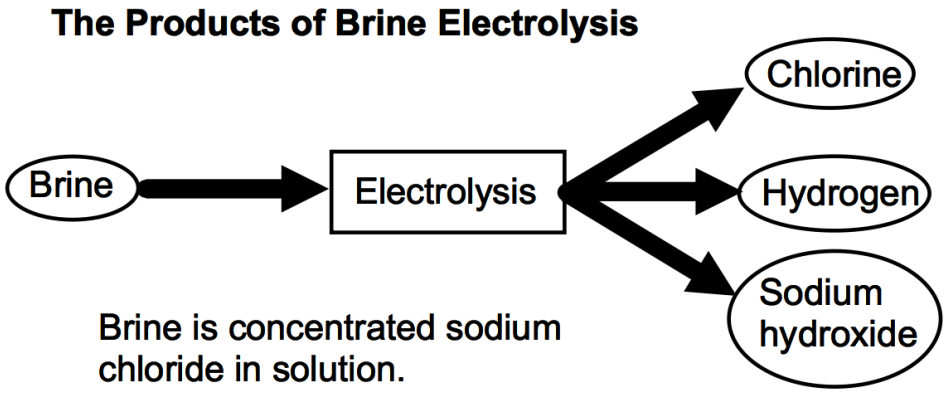
Lesson Description

In this lesson, we:

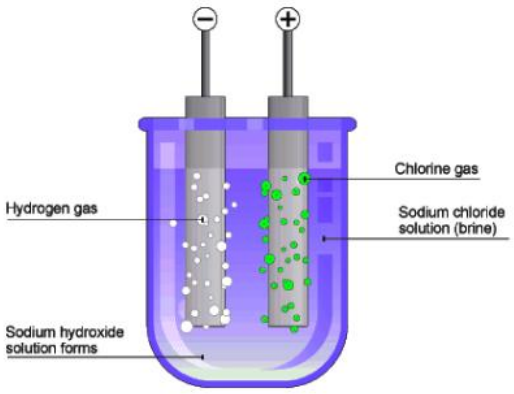
- Understand and identify the products of the electrolysis of brine.
- Use REDOX to explain the reactions occurring.
- Distinguish the different type of cells used in the chlor-alkali industry.

Key Concepts

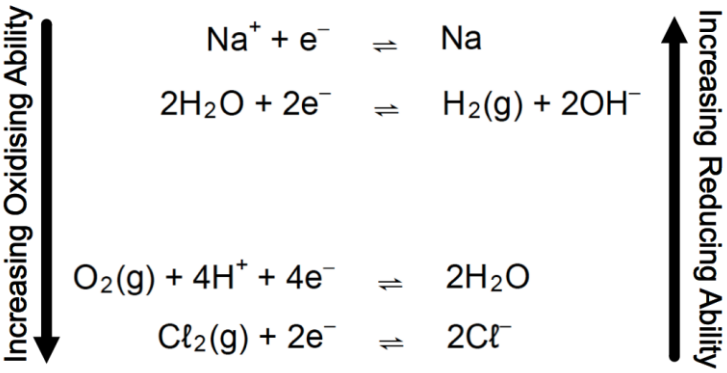
Brine Electrolysis



When NaCl(s) dissolves in water, it separates into two ions:



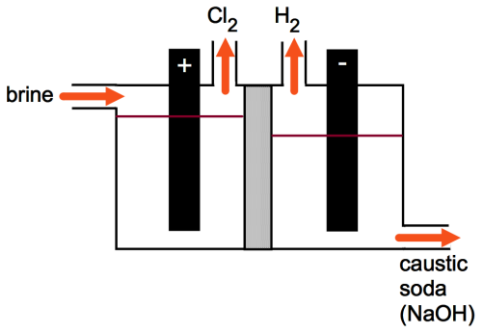
$NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$



H_2O is the best oxidising agent in place of Na^+, so hydrogen and not sodium metal is made at the cathode.

The Cl^- is more attracted to the positive electrode and oxidises in place of the water at the anode. This is the reason concentrated NaCl is used – to prevent H_2O from forming oxygen.

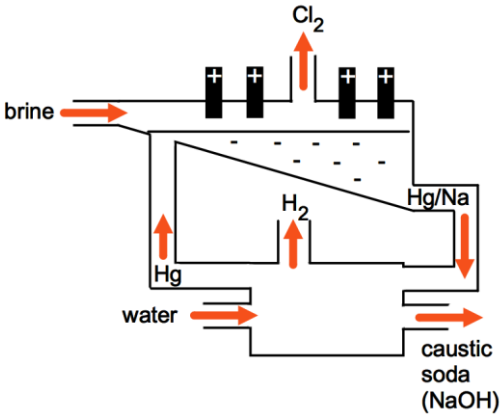
Electrolysis in a Diaphragm Cell



Cathode:$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Electrolysis in a Mercury-Cathode Cell

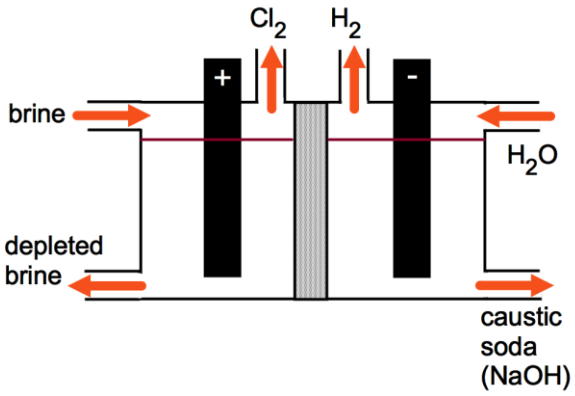


Cathode:$Na^+ + e^- \rightarrow Na$

$$Na + H_2O \rightarrow NaOH + H$$

Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Electrolysis in a Membrane Cell



Cathode:$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Terminology

Brine

Concentrated salt water.

Anode

Electrode where oxidation takes place.

Cathode

Electrode where reduction takes place.

Asbestos

Firbous material used in the diaphragm cell – lung irritant.

Electrolysis

Process using electricity to create chemicals.

Demonstration

If you try to electrolyse a solution of table salt, no metal is made at the positive electrode.

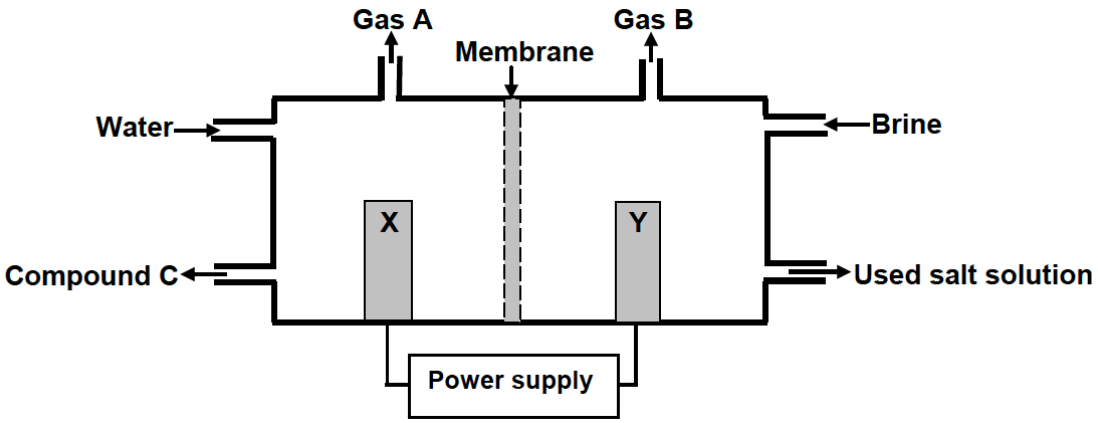
Carefully waft some of the bubble past your nose – do you smell anything familiar? The chlorine produced there smells like bleach because this is one of the ways in which bleach is produced!

Questions

Question 1

(DOE Nov 2011, Question 10)

The simplified diagram of a membrane cell used in the chlor-alkali industry is shown below. Gas A, gas B and compound C are the three major products formed during this process. X and Y represent the two electrodes.



1.1 Write down the function of the membrane in this cell. (1)

1.2 Which electrode, X or Y, is connected to the positive terminal of the power supply? Briefly explain how you arrived at the answer. (2)

1.3 Write down the NAME or FORMULA of:

1.3.1 Gas A (1)

1.3.2 Gas B (1)

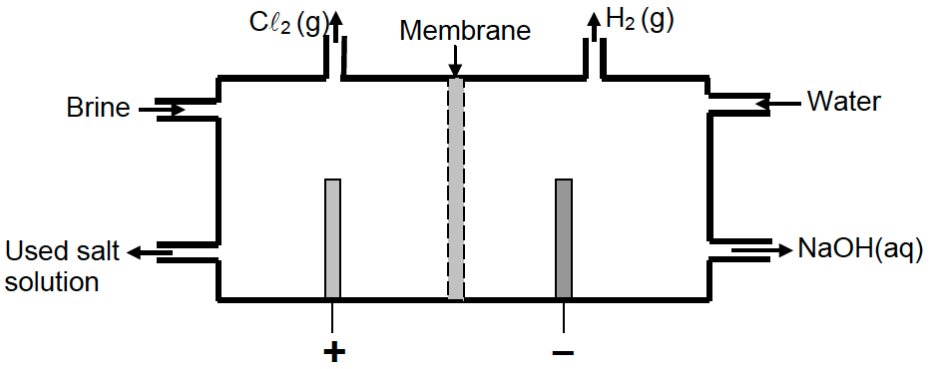
1.3.3 Compound C (1)

1.4 Write down the balanced net (overall) cell reaction taking place in this cell. (3)

Question 2

(DOE, Nov 2009, Question 11)

Industrially, chlorine gas is produced by the electrolysis of brine. In addition to chlorine gas, hydrogen gas and sodium hydroxide are also produced.



2.1 Write down the equation for the half-reaction that takes place at the cathode. (2)

2.2 Write the balanced overall (net) cell reaction, omitting spectator ions, for this cell. (3)

2.3 State TWO functions of the membrane in the above cell. (2)

2.4 Use the relative strengths of oxidising agents present in a brine solution to explain why sodium metal is NOT one of the products in this process. (2)

2.5 Chlorine is used in many useful products such as plastics, drugs and disinfectants. Environmentalists are protesting against the large-scale production of chlorine. They base their argument on the negative impact of chlorine on humans.

Name ONE negative impact of chlorine on humans. (1)

Question 3

(DOE Mar 2012 Question 2.11)

Overexposure to sunlight causes damage to skin cells.

3.1 Which type of radiation in sunlight is said to be primarily responsible for this damage? (1)

3.2 Name the property of this radiation responsible for the damage. (1)

Links

- http://www.mindset.co.za/learn/xtra
- http://www.education.gov.za/Examinations/PastExamPapers/tabid/351/Default.aspx
- http://phet.colorado.edu