INTRODUCTION

Halogens are the elements of VII – A group of the periodic table. They include fluorine (F), Chlorine (Cl), Bromine (Br), Iodine (I) and Astatine (At). A name derived from Greek word meaning "Salt Producing" (Halo means salt; gene means producing), because these elements combine readily with metals to form salts. These are strong oxidizing agents. The last member of the family is Astatine, which is radioactive, shows different behavior and is rather unstable. They exhibit variable oxidation states in their compounds except fluorine which shows an oxidation state -1 always. Halogens exist as diatomic molecule; F_2, Cl_2, Br_2 and I_2. Fluorine and chlorine are gases. F_2 is pale yellow in color; chlorine is of greenish yellow gas or pale green in color. Bromine (Br_2) is volatile reddish brown liquid. Iodine (I_2) is shiny black solid that sublimes readily.

PREPARATION OF CHLORINE GAS (Cl_2)

a. Laboratory Method For Preparation Of Cl_2 Gas

Chlorine is usually prepared in the laboratory from hydrochloric acid. When conc: HCl is gently heated with MnO_2 or $KMnO_4$, chlorine gas is produces.

i. $MnO_2 + HCl \xrightarrow{\Delta} MnCl_2 + 2H_2O + Cl_2$

ii. $2KMnO_4 + 16HCl \xrightarrow{\Delta} 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$

Procedure:

In this method MnO_2 is taken in round bottomed flask with conc: HCl, fitted with a cork greenish yellow chlorine gas comes out which is collected by the upward displacement of air in a gas jar through the delivery tube.

Since it is a poisonous gas so efficient ventilation in the laboratory is necessary.

(fig)

b. Industrial Preparation Of Cl_2 Gas:

On large scale chlorine gas is manufactured by the electrolysis of sodium chloride solution in two types of cells.

a. Nelsone's Cell
b. Castner Kellner's Cell

NELSON'S CELL

Construction:

i. Nelson's cell consists of a U – shaped perforated steel vessel, which acts as cathode.
ii. The graphite anode is dipped in the salt solution, taken in the U – shaped vessel.
iii. The U – tube is separated from anode by a diaphragm, deposited on inner wall of the perforated U – tube.
iv. The U – tube is known as anode compartment and this U – tube is fixed in an outer compartment, known as cathode compartment.

Working:

On passing electric current through the solution, chlorine gas is produced at anode, which rises into the dome at the top of the anode and is drawn away. Na metal is produced at cathode which interacts with water of the solution seeping through the diaphragm to release hydrogen (H_2) gas

with the formation of sodium hydroxide solution, which is collected at the bottom of the cathode compartment in a catch basin.

(Figure)

Cell Reaction:

Ionization: $2NaCl \longrightarrow 2Na^+ + 2Cl^-$

At Cathode: $2Na^+ + 2e^- \longrightarrow 2Na$

$2Na + 2H_2O \longrightarrow 2NaOH + H_2$

At Anode: $2Cl \longrightarrow Cl_2 + 2e^-$

Over all reaction: $2NaCl + 2H_2O \longrightarrow 2NaOH + H_2 + Cl_2$

CASTNER – KELLNER'S CELL

Construction:

i. Castner Kellner's cell consists of two compartments. First cell is called electrolgyzer and second cell is called soda cell or denuder.
ii. First cell consists of a steel tank. A number of graphite or titanium blocks acts as anode and a stream of mercury flowing across the bottom of the cell acts as cathode. (It is called moving mercury cathode).

Working:

On passing electric current, chlorine is discharged at the anode and sodium at cathode, where it is dissolved in the Hg to form sodium amalgam. The sodium amalgam is removed from the cell. The following reactions take place.

Ionization: $2NaCl \longrightarrow 2Na^+ + 2Cl^-$

At Anode: $2Cl \longrightarrow Cl_2 + 2e^-$

At Cathode: $2Na^+ + 2e^- \longrightarrow 2Na$

$Na + Hg \longrightarrow Na/Hg$ (Amalgam)

Reaction In Soda Cell:

The sodium amalgam flows into a separate chamber called soda cell. In this cell the amalgam mixed with water, producing sodium hydroxide and releases H_2 gas. Pure mercury is regenerated and recycled through mercury pump.

$2Na/Hg + 2H_2O \longrightarrow 2NaOH + H_2 + 2Hg$

(fig)

Advantages Of The Process:

1. The process is very efficient.
2. The process gives product of high purity.
3. The possible reaction between NaOH and Cl_2 gas is avoided by obtaining NaOH and Cl_2 gas in the separate chambers.

Disadvantages Of The Process:

1. The process consumes large amount of current.

2. Inspite of s strict control, some mercury vapors escape from the factory. This mercury contaminates sea water. As a result mercury becomes part of tissues of marine animals and plants resulting in pollution of food chain.

PHYSICAL PROPERTIES OF CHLORINE GAS:

1. Chlorine is greenish yellow gas.
2. It has sharp, pungent disagreeable and irritating chocking smell.
3. It produces inflammation in the nose and throat, if inhaled in considerable quanity and cause congestion in the lung tissues.
4. It is fairly soluble in water and its solution is called chlorine water.
5. Its density is 3.214g/cm^3 at S.T.P.
6. It is 2.5 times heavier than air.
7. It shows variable oxidation states in its compounds such as –1(the most common oxidation state), +1, +3, +5 and +7.
8. Its boiling point is –34.5°C.
9. Its freezing point is –102°C.

CHEMICAL PROPERTIES OF CHLORINE GAS:

1. Reaction With Halogens:

Chlorine undergoes addition reaction with Hydrogen gas quickly in the presence of Hydrogen chloride gas

$H_2 + Cl_2 \xrightarrow{\text{sunlight}} 2HCl$

2. Reactions With Metals:

Practically all metals (except noble metals) combines with chlorine gas on heating to form their chlorides

For Example:

i. $2Na + Cl_2 \xrightarrow{\Delta} 2NaCl$

ii. $Zn + Cl_2 \xrightarrow{\Delta} ZnCl_2$

iii. $2Sb + 3Cl_2 \xrightarrow{\Delta} 2SbCl_3$

iv. $2Fe + 3Cl_2 \xrightarrow{\Delta} 2FeCl_3$

v. $Sn + 2Cl_2 \xrightarrow{\Delta} SnCl_4$

3. Reactions With Nonmetals:

a. With Phosphorous:

i. $2P + 3Cl_2 \xrightarrow{\Delta} 2PCl_3$

ii. $2P + 5Cl_2 \xrightarrow{\Delta} 2PCl_5$

b. With Sulphur:

$2S + Cl_2 \xrightarrow{\Delta} S_2Cl_2$

4. Addition Reaction:

i. $CH_2{=}CH_2 + Cl_2 \longrightarrow \underset{Cl\quad Cl}{CH_2{-}CH_2}$

ii. $CO + Cl_2 \longrightarrow COCl_2$

$COCl_2$ is a poisonous gas and is used as a chemical weapon in wars.

5. Substitution Reaction:
   Chlorine undergoes addition reaction with a lot of compounds.
   For Example

6. Reaction With Alkali:
7. Reaction With Ammonia:
8. Reaction With Lime Water:
9. Reaction With Water (Bleaching Action):

USES OF CHLORINE GAS:

The production and consumption of Cl_2 on large scale make it one of the most important chemical.

1. It is used in the
2. It is used in the
3. It is used
4. It is used
5. It is used
6. It is used
7. Chlorine is used extensively in the
8. It is also used in the layer test for the identification of bromide and iodide ions.

HYDROCHLORIC ACID (HCL)

1. Laboratory preparation:
2. Industrial preparation:

a. By direct combination of H_2 and Cl_2:
b. By Hydrolysis of PCl_3:
c. By action Cl_2 on H_2S and H_2O

PHYSICAL PROPERTIES:

1. Hydrogen chloride
2. It is highly
3. It is slightly

CHEMICAL PROPERTIES:

i. Reaction With Water:
ii. Reaction With Alkalis
iii. Reaction With Ammonia
iv. Reaction With Less Electropositive Metals:
v. Reaction With Metal Carbonates And Bicarbonates:
vi. Reaction With $Agno_3$ And $Pb(NO_3)_2$ (Pprecipitation)

USES:

1. Hydrochloric acid is used
2. It is used in the manufacture
3. It is used as chemical reagent in the laboratory.

4. It is used to remove $CaCO_3$ deposits from sanitary wares and floors.

BLEACHING POWDER

INTRODUCTION:

Bleaching powder is a mixed salt

PREPARATION:

a. Laboratory Preparation:
b. Commercial Preparation:

PHYSICAL PROPERTIES:

1. Bleaching powder
2. It is soft powder.
3. It gives a strong smell of chlorine.

CHEMICAL PROPERTIES:

i. Reaction With Water:
ii. Reaction With Strong Acids:
iii. Reaction With CO_2 In The Presence Of Moisture
iv. Reaction With Ammonia:

USES:

1. Bleaching powder is used for sterilization of drinking water and disinfecting drainages and sewers.
2. It is used for bleaching of cotton, linen and paper pulp.
3. It is used for the quick preparation of Cl_2 gas which is a powerful oxidizing agent.
4. It is also used to prepare hypochlorous acid (HClO)