CONTENTS

AIM

To study of the effect of metal coupling on the rate of corrosions.

Materials required:

Apparatus:

Beakers-15, Iron sheets of 2# size-6, Aluminium rods of 2# size-6, Brass rods of 2# size-6, Zinc sheets of 2# size-6, Measuring cylinders, Chemical Balance, Weight Box.

Chemicals: Hydrochloric acid and Sodium hydroxide.

Theory:

1. Corrosion is a serious problem of some metals like iron, zinc, aluminium and alloys like brass which are commonly used in day to day life.
2. Apart from reducing the life of articles made up of these metals or alloys the chemical substances formed out of corrosion have serious public health problems.
3. Replacement of machines or their parts and many other articles in industrial and public dealing lead to huge expenditure.
4. Hence, how to reduce or avoid corrosion of articles made up of metals or alloys has been a major subject of study in the field of chemistry and electro-chemistry.

Procedure:

1. Mix 9 ml. of conc. HCl with 241 ml. of water to form 250 ml. of solution.
2. Take this solution in seven different beakers.
3. Mark each beaker serially from 1 to 7.
4. Take the weights of three iron sheets, three aluminium rods, three brass rods and three zinc sheets.
5. Now keep iron sheets, aluminium rods, zinc sheets and brass rod in separate beakers.
6. Then take iron + brass, iron + aluminium, iron + zinc, aluminium + zinc and brass + zinc and keep them in different beakers.
7. Allow the reactions to occur for 24 hours.
8. Note the maximum and minimum temperatures.
9. Now at the end of reaction take out the metals and keep them in sun for sometime so that they get dried up quickly
10. Take the weights of each specimen and note the difference.
11. Similarly repeat 1,2,3,4,5,6,7 and 8 steps in a basic solution.

Observations:

S. No.	Specimen (with acid)	Initial Weight (in gm)	Final Weight (in gm)
1.	Brass	8	5
2.	Iron	8	6
3.	Zinc	8	6.50

4.	Aluminium	8	7.10
5.	Iron + Aluminium	15	12.30
6.	Brass +Zinc	15	13.00
7.	Iron +Zinc	15	14.10
	Specimen (with Base)		
8.	Brass	8	5.80
9.	Zinc	8	6.20
10.	Iron	8	7.10
11.	Aluminium	8	7.60
12.	Brass + Aluminium	15	12.90
13.	Brass + Zinc	15	13.60
14	Iron + Aluminium	15	14.40

Results:

1. The rate of corrosion observed in acidic medium or the mass consumed during the corrosion is in the decreasing order from brass to aluminum. Brass has the highest corrosion rate while aluminium has the least corrosion rate. Brass > Iron > Zinc > Aluminium
2. When coupling of these metals was done each couple showed some difference in their corrosion with respect to each metal kept alone. Iron + Aluminium couple has the highest rate of corrosion while iron +Zinc couple has the lowest rate of corrosion. Rate of corrosion of each couple is in the order of Iron + Aluminium> Brass + Zinc> Iron + Zinc
3. Rate of corrosion in basic medium is in the decreasing order from Brass to Aluminium. The order of rate of corrosion is as below: Brass > Zinc >Iron > Aluminium
4. When these metals were coupled the rate of corrosion was in the decreasing order from Brass+ Aluminium> Brass + Zinc > Iron + Aluminium
5. Temperature and time of reaction were constant i.e., temperature was 21° C and time of reaction was 24 hours.

Conclusions:

1. Corrosion is a serious problem of some metals like iron, zinc, aluminium and alloys like brass which are commonly used in day to day life.
2. Apart from reducing the life of articles made up of these metals or alloys the chemical substances formed out of corrosion have serious public health problems.
3. Replacement of machines or their parts and many other articles in industrial and public dealing lead to huge expenditure.
4. Hence, how to reduce or avoid corrosion of articles made up of metals or alloys has been a major subject of study in the field of chemistry and electro-chemistry.
5. The study of the rate of corrosion of different metals or alloys showed gradual decrease in their masses in acidic medium. The decrease is in the order of brass, iron, zinc, aluminium.
6. The present experiments are in full agreement with the well known electro-chemical reaction. Some of the typical reactions as occur with iron are illustrated.

(a) The reactions at respective electrodes are:

At cathode:

Fe . Fe^{2+} + 2e. in acid the equilibrium is

HCl .H^{+} + Cl . At anode:

The water which is in equilibrium

H_2O .H^+ + OH.

Here the Fe^{2+} cation will readily take Cl- and form $FeCl_3$. While H+ of acid will be reacting with another H^+ of water and will form H_2 gas. While OH. anion will also react with some of the iron and will form $Fe(OH)_3$ which is observed in the form of rust.

(b) The e.m.f of these metals are in the order of Al : Zn : Fe. The values are

e.m.f

Al .Al_3++3^{e-}

Zn .Zn^{2+}+2^{e-}

Fe .Fe $^{2+}$+ 2^{e-}

1.66V

0.76V

0.44V

Brass which is an alloy of zinc and copper has the e.m.f. 0.42V during the forward reaction or oxidation reaction. While in backward reaction the e.m.f. value is .0.42. This is because during oxidation reaction the e.m.f values of zinc and copper are .0.76 and + 0.34, respectively. That is why the value differs.

(c) In acid there are replaceable H^+ ions which react with metals and H_2 gas is evolved. This is because all the metals are highly electronegative in nature. When these two come in contact they react very easily and form stable compounds. Thus the rate of corrosion is very high.

The rate of corrosion in basic medium is very less as compared to acidic medium. This is shown because of following factors:

(i) Ex: sodium hydroxide .NaOH which is in equilibrium with Na^+ and OH. ions.

NaOH .Na^+ + OH When

NaOH comes in contact with water the two ions immediately dissociate. The hydrates Na^+ ions will take the H+ ion.

The electropositive characters here will be the main factor in the slow rate of corrosion. Na being more electropositive than the metal mentioned above, most of OH- ions will be taken by Na+ when compared to the other metals i.e., the rate of corrosion is slow with

Na^+ \ Fe^{2+} | | OH\OH- While H^+ + electron = H H^+ H = H_2 gas.

(ii) The availability of e- is very less for the conversion of H^+ to H_2 gas state. That is why there will not be replaceable 'H' ion. If there is no replaceable H^+ ion then the corrosion will be possible. Hence the rate of corrosion is very slow.