PNS School of Engineering & Technology

Nishamani Vihar, Marshaghai, Kendrapara

Internal Assessment Examination-2022(5th Semester)

Subject : Th-4 -Utilization of Electrical Energy & Tranction

Branch : Electrical Engineering

Time : $1\frac{1}{2}$ Hours F.M. : 20

1. Answer all the following questions . [2 x 5]

(a) What is electrolytic process ?

(b) What is current efficiency ?

(c) If a current of 10A deposits 13.42gm of silver from silver nitrate solution in 20 minutes. Calculate the ECE of silver.

(d) What are the modes of heat transfer ?

(e) Write down the advantages of electrical heating over other methods of heating.

2. Answer the following questions. (any Two) [5 x 2]

(a) Define Faraday's Law of Electrolysis.

(b) Find the thickness of copper deposited on a plate of area 2.25cm^2 during electrolysis, if a current of 1A is passed for 100 minutes. (density of Cu is 8.9gm/cc and ECE of Cu is 0.0003295gm/Columb)

(c) Write down the working principle of direct are furnace with dig.

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ANSWER

1(a) The process of decomposition of electrolyte by the passage of electric current through them is called electrolytic process.

1(b) The Current Efficiency is the ratio of the actual mass of a substance liberated from an electrolyte by the passage of current to the theoretical mass liberated according to Faraday's law.

1(c) Strength of current,

I = 10 Amp.

Time of flow of current,

T = 20 x 60 = 1,200 sec.

Weight of silver deposited,

W = 13.42 gm.

Now E.C.E. of silver, Z = W / I*T = 13.42 / 10* 1200 = 0.001118 gm/coulomb

1(d) Modes of heat transfer are

- Concection.
- Conduction
- Rediation

1(e) Advantage of electric heating over other mode of heating are

- Neat and clean atmosphere
- Uniform heating
- Localized application
- Cheap furnaces

2(a) Faraday's First Law of Electrolysis

Faraday's first law of electrolysis states that the mass of any substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed through the electrolyte).

Thus, if W gram of the substance is deposited on passing Q coulombs of electricity, then

$W \propto Q$

$W = ZQ$ …… (1)

Where Z is a constant of proportionality and is called the electrochemical equivalent of the substance deposited.

If a current of I ampere is passed for t seconds, then, Charge=Current×time

Q=I×t .... (2))

On substituting eq (2) in eq (1)

W=Z×I×t

Thus, if Q=1 coulomb or I=1 ampere and t=1 second,

W=Z×1×1

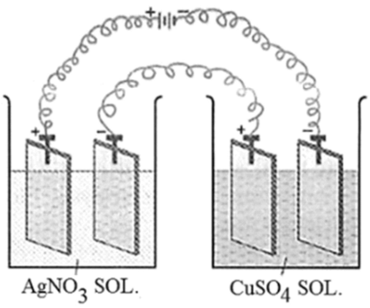
W=Z

Hence, the electrochemical equivalent of a substance may be defined as the mass of the substance deposited when a current of one ampere is passed for one second, i.e., a quantity of electricity equal to one coulomb is passed.

Faraday's Second Law of Electrolysis

Faraday's Second Law of electrolysis states that when the same quantity of electricity is passed through different electrolytes connected in series, then the masses of the substance liberated at the electrode in the ratio of their chemical equivalent masses or the ratio of their electrochemical equivalence.

The chemical equivalent mass of metal can be obtained by dividing its atomic mass by the number of electrons required to reduce its cation.



Electrolytic cells (voltameters) connected in series

For example, if the two electrolytic cells A containing silver nitrate (AgNO3) solution and BB be containing copper sulphate (CuSO4) solutions are connected in series, and the same quantity of electricity is passed through the cells. Then the ratio of the mass of copper deposited at the cathode in electrolytic cell B is x g to that of silver deposited in a cell A is y g is equal to the ratio of their chemical equivalent masses.

$$\frac{\text{Mass of Cu}(x)}{\text{Mass of Ag}(y)} = \frac{\text{Chemical Equivalent Mass of Cu}}{\text{Chemical Equivalent Mass of Ag}} = \frac{Zcu}{ZAg}$$

Each copper Cu^{2+} ion requires 2 electrons to form Cu, and each Ag^{+} needs 1 electron to form Ag.

Thus, the chemical equivalent mass of Cu= $\frac{63.5}{2}$

Chemical equivalent mass of Ag = $\frac{108}{1}$

Thus, the ratio $\frac{x}{y} = \frac{63.5*1}{108*2} = \frac{63.5}{216}$

2(b) Electro-chemical equivalent (E.C.E.) of copper = 0.0003295 gm/coulomb

Current strength, I = 1 amp.

Time for which the current is passed through the solution

T = 100 minutes = 100 x 60 = 6,000 sec.

Wt. of Copper deposited,

W =ZIT = 0.0003295 x 1 x 6000 gm. = 1.977 gm.

Density of Copper,

D = 8.9 gm/cc

Now density,

D = Mass / Volume

Volume of copper deposited,

Or V = Mass / Density = W / D = 1.977 / 8.9 = 0.222 cc

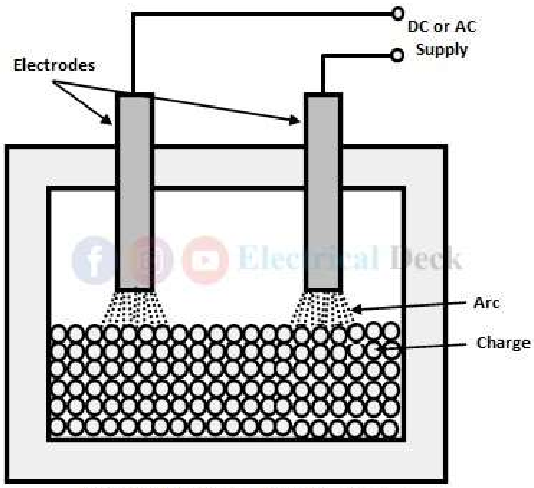
Volume = Area x Thickness

Or Thickness = Volume / Area

Or Thickness = 0.222 / 2.25 = 0.0986 cm

2(c) Direct arc furnace:

In a direct arc furnace, the arc is formed between the electrodes and the charge to be heated as shown below. In this type of furnace, the charge acts as another electrode. There are two carbon or graphite electrodes and the arc is formed between the electrode and charge at two places.



Direct Electric Arc Furnace

In this type of heating, high temperatures can be obtained since the arc is produced directly with the charge to be heated, and also there will be additional heat generation in the charge due to the flow of current through it.

In the case of a single-phase arc furnace, two electrodes are placed vertically from the top of the furnace into the charge. Whereas in the case of a three-phase arc furnace, three electrodes placed at the corners of an equivalent triangle are used which produces three arcs, the charge itself thus forms a star point.

Also, one of the important features of a direct arc furnace is that, due to the flow of current in the charge, automatic stirring action is produced in the charge by electromagnetic force set up by the current. This type of arc furnace is mostly used for the production of steel and is advantageous as compared to the cupola method for the production of steel.