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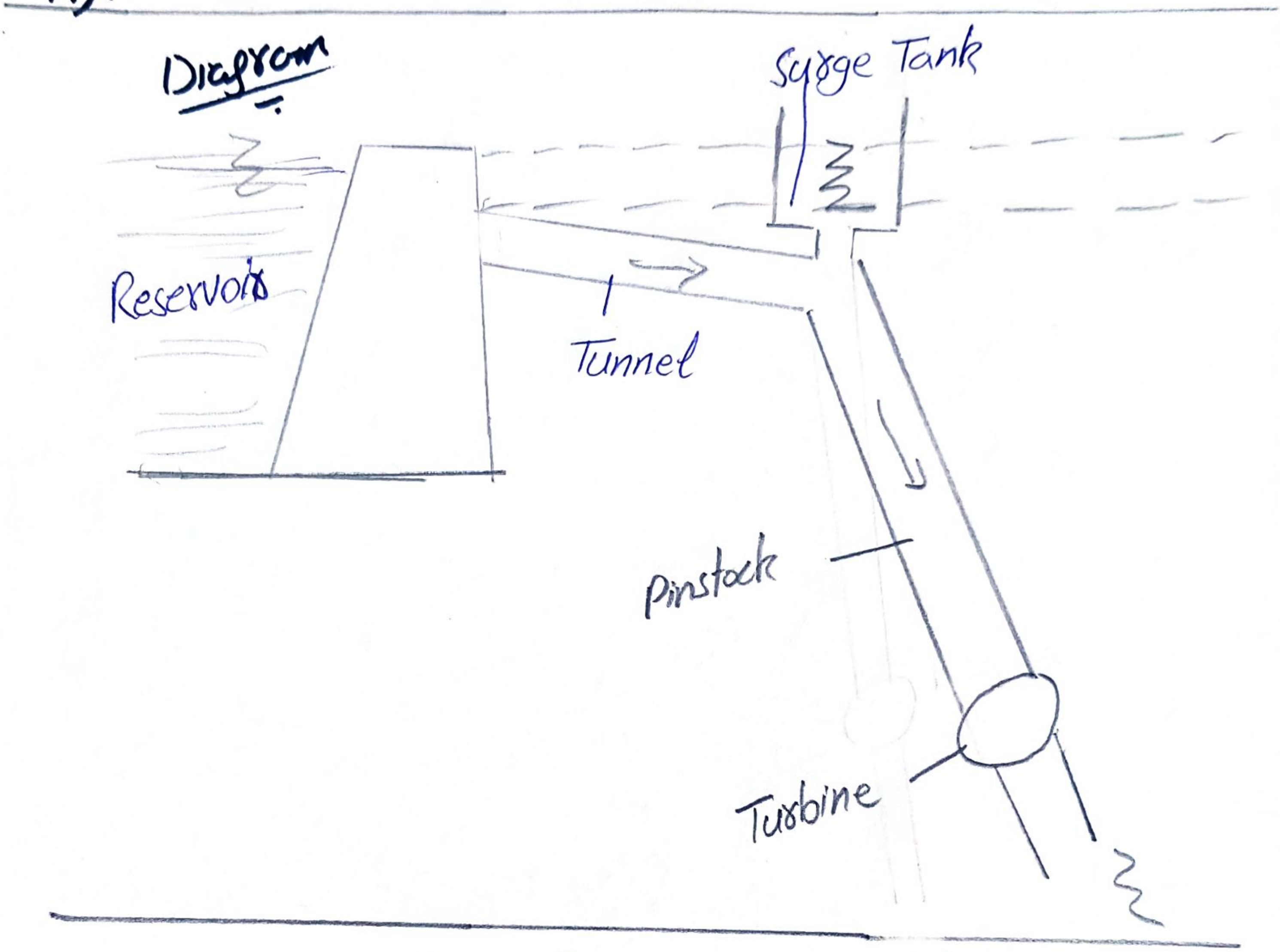
Q # 1
A):-



Component of Hydropower plant:-

1) Force-bay:

Force-bay is basin area of hydropower plant where water is temporarily stored before going intake chamber. The storage of water in force bay decided based on required water demand in that area. The water stored on the up stream side of DAM can be carried

Penstock to powerhouse. In this case reservior act as force bay

2) penstock:-

Penstock are like large pipes laid with Same slope which carries water from intake structure or reservoir to the turbines. They runs with same pressure so, suddent closing or opening of penstock gates can cause water nammer effect to the stock.

3) Surge Chamber:-

A surge chomber is a cylindrical tank which is open at the top to control the pressure in penstock. It is connected to penstock as closed as possible to the power house. There are different types of surge tank available and they are selected based on the requirment of plant length of penstock.

4) Hydralic Turbiner

Hydrical turbine a device which can convert the hydralic energy into mechanical energy which again convert into Electrical energy by coupling the shaft of turbine to generator

5) power Houser

power house is a building provided to protact the hydralic and electrical equipment.

Q#1

B/ Given data:

Volume (V) = $5 \times 10^5 m$

Hydraulic efficiency = 0.85

Electrical efficiency = 0.94

over all efficiency = $0.85 \times 0.94 \Rightarrow 0.80$

$\rho = 1000 \, Kg/m^3$

$g = 9.8 \, m/sec^2$

$h = 100 \, m$

Sol:-

$E = \rho h v g k$

$E = 1000 \times 100 \times 5 \times 10^5 \times 9.8 \times 0.80$

$$\boxed{E = 3.92 \times 10^{11} \, (W\text{-}sec)}$$

Q#02

A) **Classification of Hydropower Turbine:-**

There are two main type of turbine

① Impulse Turbine

② Reaction Turbine

1) **Classification of Impulse Turbine:**

The impulse turbine is further classified into two types

a) Pelton Turbine

b) Cross-flow Turbine

2) **Classification of Reaction Turbine:**

The reaction turbine is further classified into three types

a) Propeller Turbine

b) Francis Turbine

c) Kinetic Turbine

The propeller turbine is further classified into four types.

i) Bulb turbine
ii) Straflo turbine
iii) Tube turbine
iv) Kaplan turbine

Parameter require for Selection of Hydropower Turbine:-

1) Net Head
2) Range of discharge through turbine
3) Rotational Speed
4) Cost
5) Efficiency
6) Volume of water...

- Francis is slow runner will be used in high head scheems, where kaplan, propeller and bulb are used in low head scheems with high speeds.
- The available energy therefore depends on head of water above the turbine and volume of water flowing through it.

- Turbine can also be selected on the basis of there output power & rated disharge

Q#2

B) **Given data:-**

Head $(h) = 190$

Discharge $(q) = 2.2\ m^2/s$

efficiency $(\eta) = 85\%$ OR 0.85

Sol:-

A a head of 190 meters, a single jet pelton wheel turbine seems most suitable

The specific speed can be calculated by using equation $n_s = \frac{85.49}{(h)^{0.243}}$

$$n_s = \frac{85.49}{(190)^{0.243}}$$

$$n_s = 23.88\ rpm$$

The output power can be obtained by usine equation $P = \eta \rho q g h$

$$P = 0.85 \times 1000 \times 2.2 \times 9.8 \times 190$$

$$\boxed{P = 3481940\ W}$$

For find n:

$$n = n_s \frac{(h)^{5/4}}{\sqrt{P}}$$

$$n = 23.88 \times \frac{(190)^{5/4}}{\sqrt{3485.5}}$$

$$\boxed{n = 285.32 \text{ rpm}}$$

An alternator rated at 50Hz frequency with synchronous speed approaching 285.32 rpm but not greater is to be selected. The number of poles required are computed by using:

$$N_s = \frac{120f}{P} \quad \text{OR} \quad P = \frac{120f}{N_s}$$

$$P = \frac{120 \times 50}{285.32}$$

$$\boxed{P = 21.02 \text{ poles}}$$

Selecting 24 poles alternator will rotate at 250 rpm at 50Hz seems just right. The turbine will have a diameter, which can be determined by using equation

$$D = 38.56 \frac{\sqrt{h}}{n}$$

$$D = 38.56 \times \frac{\sqrt{190}}{250}$$

$$D = 38.56 \times \frac{13.78}{250}$$

$$D = 2.12 m$$

The jet diameter can calculated by using equation $q = \frac{(\pi dj^2) Vj}{4}$

where jet velocity $(Vj) = \sqrt{2gh}$

$$Vj = \sqrt{2(9.8)(190)}$$

$$Vj = \sqrt{3727.8}$$

$$Vj = 61.055 \ m/s$$

Therefor the jet diameter can be find by equation. $q = \frac{(\pi dj^2) Vj}{4}$

$$\frac{q}{dj^2} = \frac{(\pi) Vj}{4}$$

$$dj^2 = \frac{4q}{\pi Vj}$$

$$dj = \sqrt{\frac{4q}{(\pi)V_j}}$$

$$dj = \sqrt{\frac{4 \times 2.2}{3.14 \times 61.05}}$$

$$dj = 0.214 m$$

OR

$$\boxed{dj = 21.4 cm}$$

Thus turbine will have a standred diameter of 2 meters defined as the diameter of circle describing the bucket centre line and the diameter of the jet 20 cm.

Q.3

Stages of nuclear fuel cycle are given below

1. Uranium mines & mills
2. Conversion to UF_6
3. Enriching
4. Fuel Conversion
5. Fuel packaging in the core
6. The Reactor Core
7. Moderators

1. Mining and Milling:

- Uranium is usually mined by either surface (open cut) or or underground mining techniques, depending on the depth at which the ore body is found.
- From these, the mined uranium ore is sent to a mill which is usually located close to the mine.

- At the mill the ore is crushed and ground to a fine slurry which is leached in sulfuric acid to allow the separation of uranium from the waste rock.

- It is then recovered from solution as uranium oxide (U_3O_8) concentrate. Some time it is known as "yellow cake".

2) Conversion :-

- Because uranium needs to be in the form of a gas before it can be enriched, the U_3O_8 is converted to gas Uranium hexafluoride (UF_6) at conversion plant

3) Enriching :-

- Need to enrich uranium to at least 3% for a power plant

→ Two Methods of enriching

(i) Gaseous Diffusion Method :-

- UF_6 (Hexafluoride) gase heated
- U-238 is heavier than U-235
- Hexafluride gas can be separated into two streams
  - a. Low velocity U-238
  - b. High velocity U-235

ii) Centrifuge Method:-

- Gas spun in centrifuge
- Lighter U-235 will separate from heavier U-238

4) Fuel Conversion:-

- Enriched Uranium transported to a fuel fabrication plant where it is converted to Uranium dioxide (UO_2) powder and pressed into small pellets.
- These pellets are inserted into thin tubes, usually of zirconium alloy or stainless steel, to form fuel rods.
- The rods are then sealed and assembled in clusters to form fuel asseblies for use in the core of nuclear reactor.

5) Fuel packaging in the Core:-

- Rods contain Uranium enriched
- Need roughly 100 tons per year for a 1000 MW plant

6) The Reactor Core:-

- The reactor core consists of fuel rods & control rods
  - Fuel rods contain enriched uranium
  - Control rods are inserted between the fuel to absorb neutrons & slow the chain reaction
- Control rods are made of cadmium, which absorb neutron effectively.

7) Moderators:-

- Neutrons produced during fission in the core are moving too fast to cause a chain reaction
  → Note: This is not an issue with a bomb where fissile uranium is so tightly packed that fast moving neutrons can still do the job.
- A moderator is required to slow down the neutrons
- In Nuclear Power Plants water or graphite act as the moderator.