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Subject: Power generation

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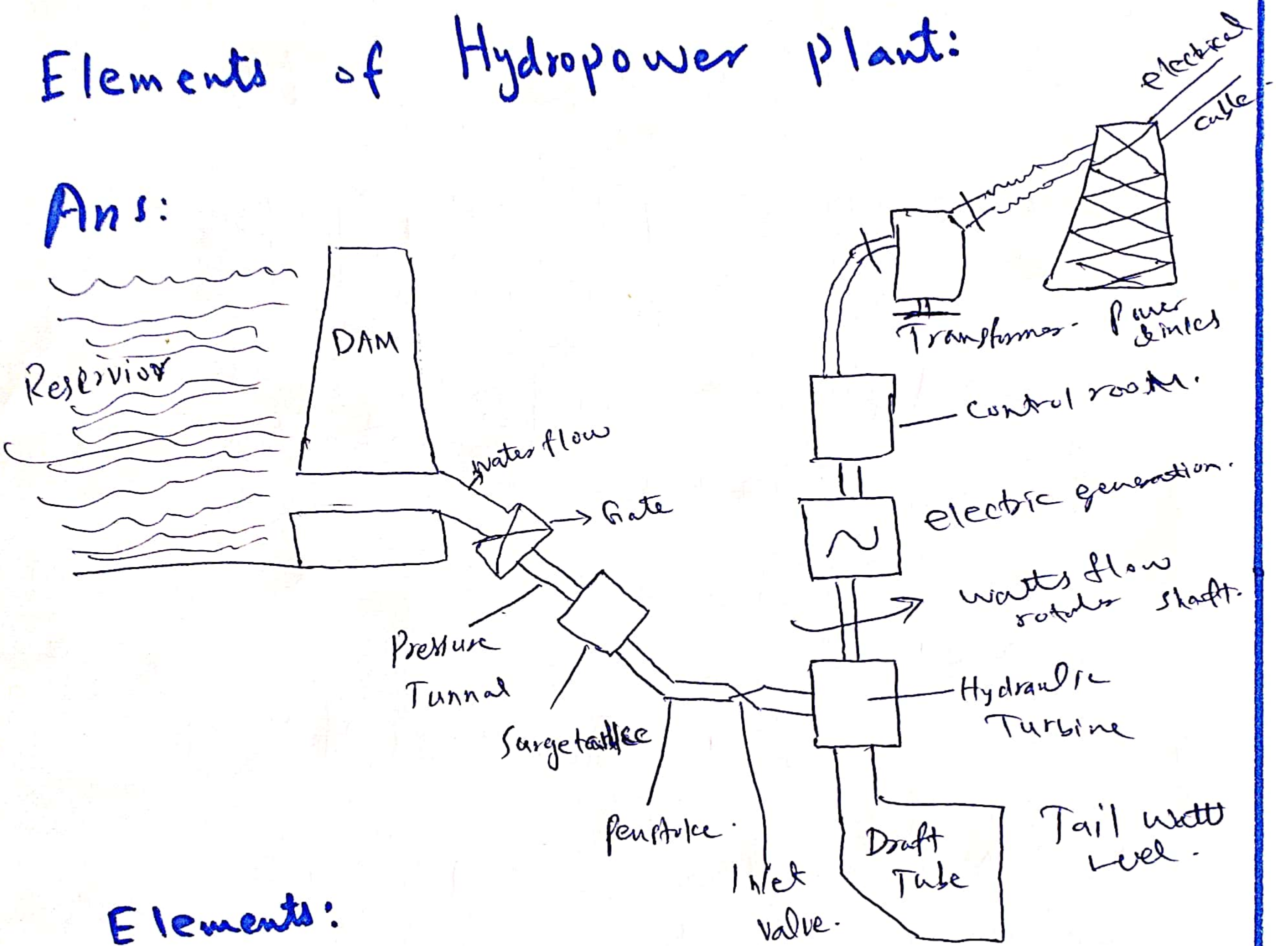
Q No:1 (A)

Elements of Hydropower plant:

Ans:



Elements:

1. Avrage Resorvior.
2. DAM.
3. Forebay.
4. Spill way
5. Intake
6. Surge tank.
7. Penstokk.
8. Valves and Gates.
9. Trash Rakes.
10. Tail race.
11. DrafT Tubes
12. Prime movers or water Turbines.

α ———— α

Q No: 1 (b)

Water for a small hydroelectric station is made available - - - - - - .

Solution: Given That.

Available Volume at Pondage: $V = 5 \times 10^5 \, m^3$

Available head $h = 100$ m.

Hydraulic efficiency $= 85\%$ or 0.85

Electrical E effeciency $= 0.94$

Therefore, overall effeciency $= 0.85 \times 0.94 = 0.80$

Using: $E = \eta \rho g h V = 0.8 \times 1000 \times 9.81 \times 100 \times 5 \times 10^5$

$E = 3.92 \times 10^{11}$ W-s.

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Q No: 2 (A)

Hydropower Turbines and Parameters..?

Ans: Turbine:

Is a Rotary Mechanical device that extracts energy from a "fluid flow" and Converts it into Useful work.

Types:

1: Impulse Turbine

2: Reaction Turbine.

1: Impulse Turbine:

The Impulse Turbine generally uses the Velocity of The water To Move The runner. The water stream hits each bucket on The runner.

* An Impulse Turbine is generally suitable for high head, low flow applications.
* An Impulse Turbine, at Inlet, only kinetic energy available. But in reaction Turbine at Inlet kinetic energy as well as Pressure energy both are available.

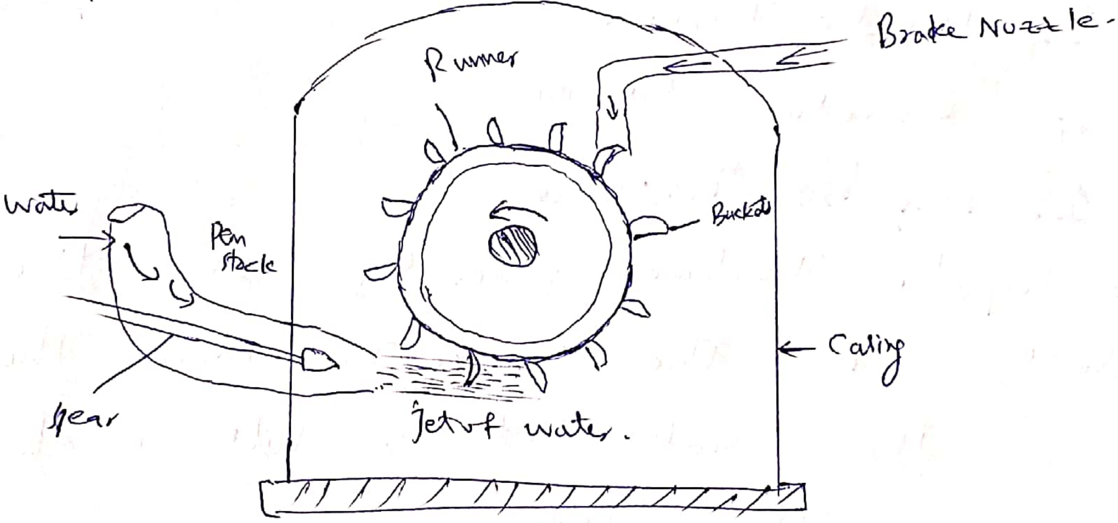
Types of Impulse Turbines:

i) Pelton Turbine

ii) Cross flow Turbine

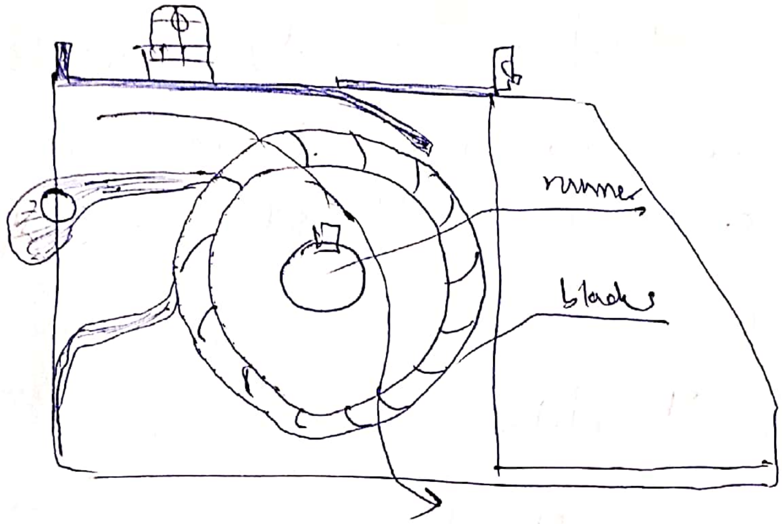
1 Pelton Turbine:

A Pelton wheel has one or More free jets, discharging water on The buckets of a runner.



(ii) Cross flow Turbine:

Its resemble a "Squirrel cage" blower. The cross-flow Turbines allows The water To flow Through the blades twice. The first Pass when the water flows from The outside of the blade to the Inside The second Pass is from the Inside back out.



2: Reaction Turbine:

A Reaction Turbine develops power from The combined action of Pressure and Moving water. The runner is Placed directly in the water stream flowing over the blades rather than Striking each Individually.

Types:

1: Propeller Turbine
2: Francis Turbine
3: Kinetic Turbine.

1: Propeller Turbine:

A Propeller Turbine generally has a runner with Three To six Blades in which The water contacts all of the blades constantly.

A Propper Turbine generally has, a runner with Three To six blades in which the water contacts all of the blades Constantly -

(1) Bulb Turbine

(2) Starflo Turbine

(3) Tube Turbine

(4) Kaplan Turbine -

(2) Francis Turbines:

A Francis Turbine has a runner with fixed buckets (vanes) Usually nine or More -

(3) Kinetic Turbines:

Kinetic Turbines also called free-flow Turbines, generate electicity from kinetic energy present in flowing water -

Parameters:

Types of Turbine	Specific speed (rpm)	Reference
Pelton wheel single jet	$n_s = \frac{85.49}{(h)^{0.243}}$	Siervo and Lugaresi, 1978.
Francis	$n_s = \frac{3763}{(h)^{0.854}}$	Schweger and Gregory 1989.
Cross flow	$n_s = \frac{513.25}{(h)^{0.505}}$	Kpordze and Warnick 1983
Kaplan	$n_s = \frac{2283}{(h)^{0.486}}$	Schweiger and Gregory 1989.
Bulb	$n_s = \frac{1520.6}{(h)^{0.2837}}$	Kpordze and Warnick 1983.

Q No: 2(b)

Given That:

Head = h = 190m.

Discharge Q = 2.2 m^3/s

overall effeciency η = 85% or 0.85

At a head of 190m a Single jet Pelton wheel Turbine seems most suitable Therefore from Table 11.7. The specific Speed can be determined by Using.

$$n_s = \frac{8.549}{(h)^{0.243}} = \frac{85.49}{(190)^{0.243}}$$

$$n_s = 23.88 \text{ rpm}.$$

The output power can be obtained by:

$$P = \eta \rho Q g h \text{ watts}.$$

$$P = 0.85 \times 1000 \times 2.2 \times 9.81 \times 190$$

$$P = 3485.5 \text{ KW}$$

$$n = \frac{n_s h^{3/4}}{\sqrt{P}} = 23.88 \times \frac{(190)^{3/4}}{\sqrt{3485.5}}$$

$$= 285.32 \text{ rpm.}$$

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.

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

$$= 21.02 \text{ Poles.}$$

Selecting 24 Poles alternator will rotate at 250 r.p.m at 50 Hz seems just righ. The Turbine will have a diameter which can be determined By Using equation.

$$D = 38.567 \frac{\sqrt{h}}{n} = 38.567 \times \frac{\sqrt{190}}{250} = 2.12 \text{m}$$

The jet diameter can be calculated as:

$$Q = (\pi d_j^2) V_j / 4$$

The jet Velocity $V_j = \sqrt{2gh}$

$V_j = \sqrt{2 \times 9.81 \times 190} = 61.05\ m/s$

Therefore The jet diameter is:

$$d_j = \sqrt{\frac{4P}{\pi V_j}}$$

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

$$= 0.24\ m \text{ or } 21.4\ cm$$

Thus Turbine will have a standard diameter of 2 meters defined as the diammeter of the cicle describing the buckets centrs line and The diameter of the jet 20 cm.

X ——— X

Q NO: 3 Explain Different stages of Nuclear Fuel cycle: ?

Ans: The Nuclear fuel cycle represents the progression of Nuclear fuel from creation to disposal.

Mixed oxide is another type of Nuclear ~~fuile~~ fuel.

Nuclear fuel cycle includes following stages.

Uranium recovery: To extract (Mine) Uranium ore and concentrate (Mill) the ore to produce a Uranium ore concentrate called U_3O_8.

Conversion: of Uranium are concentrate into Uranium hexaflouride (UF_6)

Enrichment: To increase the concentration of Uranium - 235 (U^{235}) in UF_6.

Deconversion:

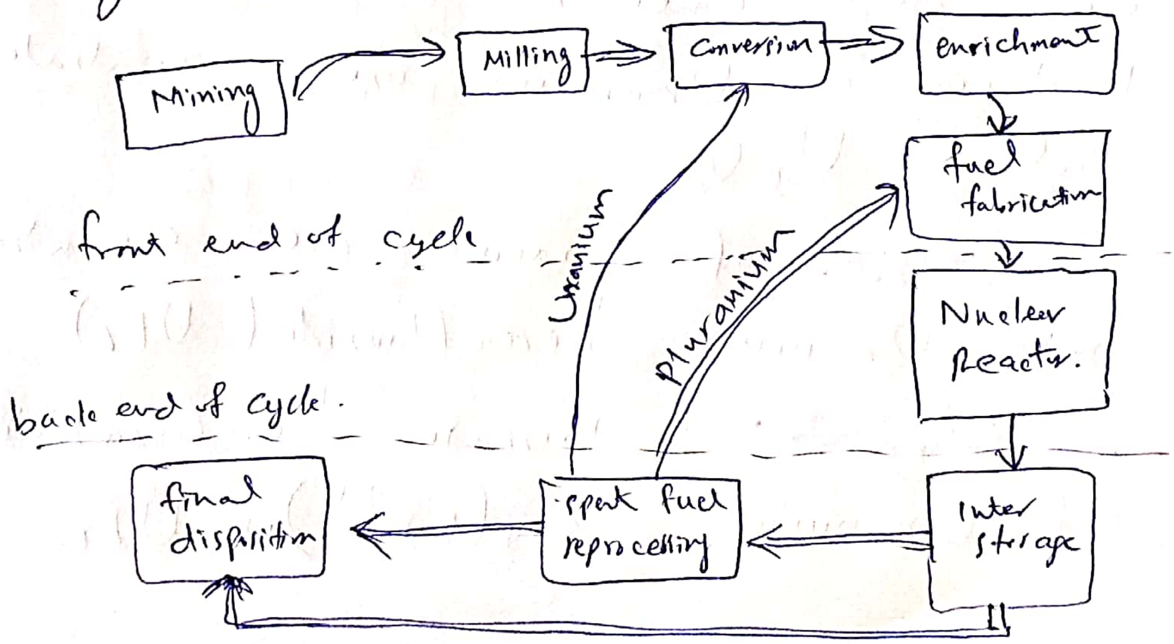
To reduce the hazards associated with the deleted Uranium hexaflowride (DUF_6).

Fuel Fabrication:

To convert natural and enriched UF_6 into UO_2 or Uranium metal alloys for use as fuel for Nuclear Reactors.

Reprocessing:

of high level waste. Final disposition of used fuel for high level of waste.



X ——— X