

Subject Name - Basic Mechanical Engineering

Subject Code - MEE10513

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### Experiment No - 7

\* Name of the experiment - Pelton wheel and hydro-electric power plant.

\* Aim - To study the operation of Pelton wheel for hydroelectric power generation.

\* objective - To understand the different parts and working of hydroelectric power plant.

## Advantages & Disadvantages of Hydroelectric Power Plants

### \* Overview -

In hydroelectric power plants the potential energy of water due to its high location is converted into electrical energy. The total power generation capacity of the hydroelectric power plants depends on the head of water and volume of water flowing towards the water turbine. The hydroelectric power plant, also called as dam or hydropower plant, is used for generation of electricity from water on large scale basis. The dam is built across the large river that has sufficient quantity of water throughout the river. In certain cases where the river is very large, more than one dam can be built across the river at different locations.

### \* Working Principle of Hydroelectric Power Plant -

The water flowing in the river possesses two types of energy: the kinetic energy due to flow of water and potential energy due to the height of water. In hydroelectric power plants or dams potential energy of water is utilized to generate electricity.

- The formula for total power that can be generated from water in hydroelectric power plant due to its height is given by

$$P = \rho g H n$$

where, P - electric power in KVA

$\rho$  - flow rate in the pipe ( $m^3/s$ )

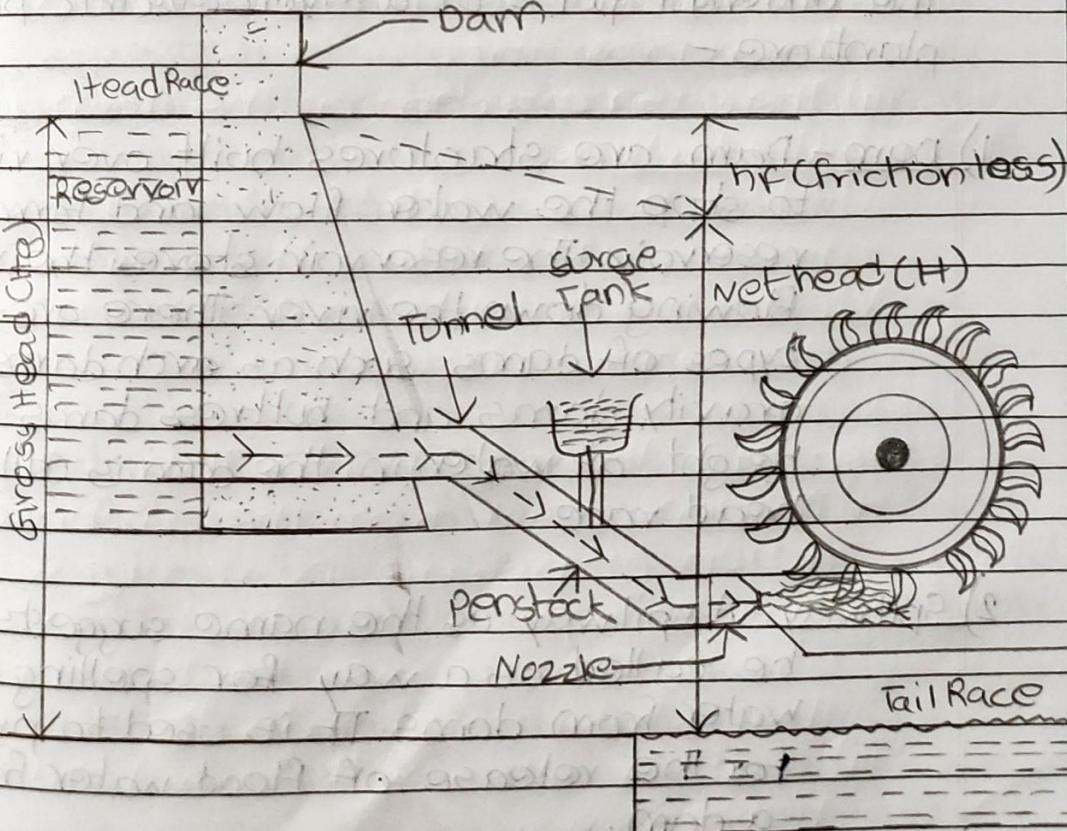
$\rho$  - density ( $kg/m^3$ )

g - Acceleration of gravity ( $m/s^2$ )

H - waterfall height (m)

n - efficiency ratio (usually between 0.7 and 0.9)

- Diagram -



Hydroelectric Power plant

### \* Pelton Turbine -

A pelton turbine or Pelton wheel is a type of hydro turbine (specifically an impulse turbine) used in hydroelectric plants. These turbines are generally used for sites with heads greater than 300 meters. As this turbine rotates due to striking action of high speed jets, the Pelton turbine is known as an impulse turbine.

### \* Layout of Hydroelectric Powerplant

Hydroelectric power plants convert the hydraulic potential energy from water into electrical energy.

The different parts of a hydroelectric power plant are -

- 1) Dam - Dam are structures built over rivers to stop the water flow and form a reservoir. The reservoir stores the water flowing down the river. There are different types of dams such as arch dams, gravity dams and buttress dams. The height of water in the dam is called head race.
- 2) Spilway - A spilway as the name suggests could be called as a way for spelling of water from dams. It is used to provide for the release of flood water from a dam.

### 3) Penstock and Tunnel

- Penstocks are pipes which carry water from the reservoir to the turbines inside power station. They are usually made of steel and are equipped with gate systems. water under high pressure flows through the penstock.
- A tunnel serves the same purpose as a penstock. It is used when an obstruction is present between the dam and power station such as a mountain.

### 4) Power house

Power house is a station for generation of electricity. It houses equipment and personnel working in a power generating station. Essential components of the power house are -

- a) Machine hall
- b) Annexes or Extensions
- c) workshop

### 5) Generating Equipment -

Estimating total capacity of plant -

- i) Head Available: Firm and Secondary Power
- ii) Load Factor: Industrial and Domestic load.
- iii) Cost Estimate: Capital charges + Depreciation + O&M
- iv) Revenue to be expected.

Estimating No. of Generating sets:-

- i) cost of Initial Installation
- ii) cost of operation
- iii) Reliability of supply
  - a) Isolated distribution system
  - b) Interconnected system
- iv) shaft arrangement
- v) Auxiliary plant

## 6) Hydro turbines

- Impulse Turbine (Pelton wheel)

- i) uses the velocity of water to move the runner & discharges to atmospheric pressure.
- ii) The water stream hits each bucket on the runner.
- iii) There is no suction on the down side of the turbine.
- iv) water flows out the bottom of the turbine housing after hitting the runner.
- v) Generally suitable for high head, low flow applications.

- Reaction Turbine: (Francis Turbine, Kaplan Turbine)

- i) Develops power from the combined action of pressure and moving water
- ii) Runner is placed directly in the water stream flowing over the blades rather than striking each individually.
- iii) used for sites with lower head and higher flows.

## \* Types of Hydro-electric Power Plant -

### • Conventional Power Plant -

Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator is called as conventional Power Plant.

### • Pumped-Storage Power Plant -

This method produces electricity to supply high peak demands by moving water between reservoirs at different elevations. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir.

### • Run-of-the-river Power Plant:

Run-of-the-river hydroelectric stations are those with comparably smaller reservoir capacities, thus making it impossible to store water.

### • Tidal Power Plant:

A tidal power plant makes use of the daily rise and fall of water due to tides; such sources are highly predictable and if conditions permit construction of reservoirs, can also be dispatchable to generate power during high demand periods.

### \* Advantages -

- 1) Renewable, non-radioactive & non-polluting source of energy.
- 2) Reliable, clean and efficient Energy Source.
- 3) Low cost of generation.
- 4) Low operation & maintenance charges.
- 5) Inherent ability for quick stopping & instantaneous load acceptance/rejection.
- 6) Meet peak load requirement.
- 7) Avoided Green House Gas (GHG) emissions from equivalent thermal and other fuel based power projects.
- 8) Increase in Agriculture Productivity through development of irrigation and multipurpose schemes.
- 9) Flood mitigation through large storage dams.

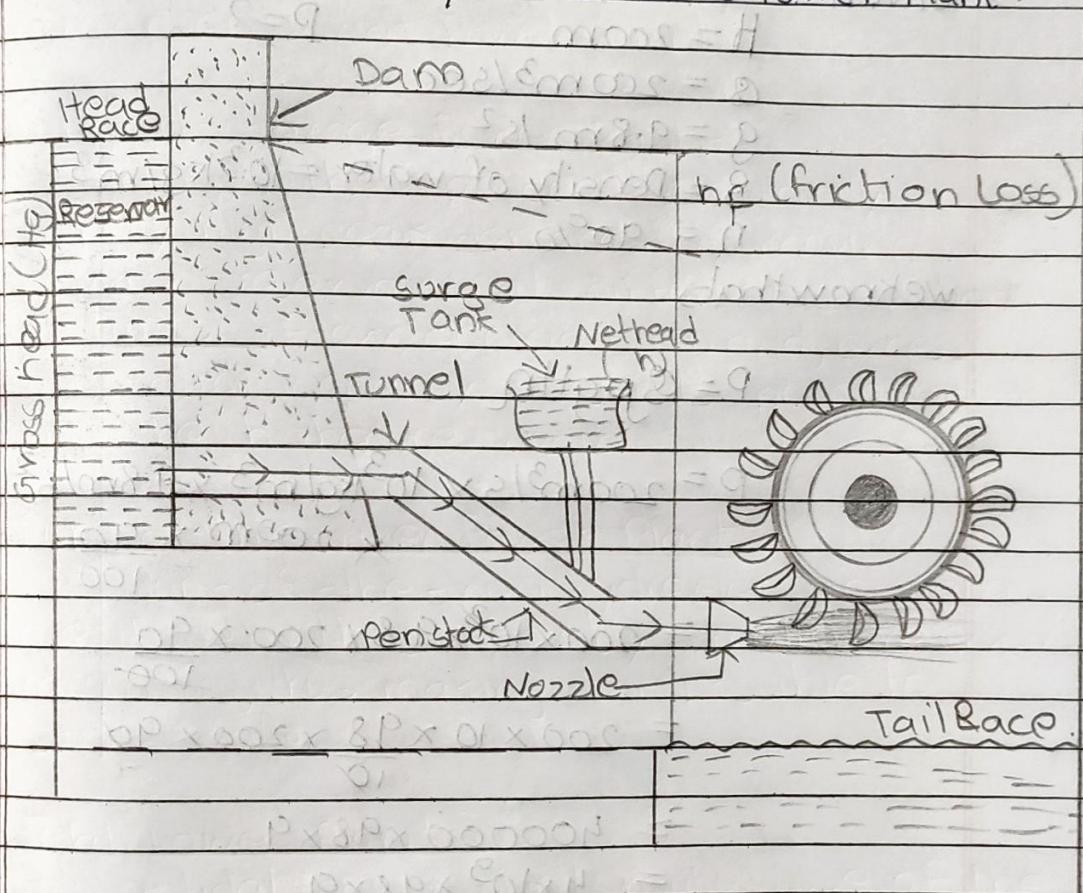
### \* Disadvantages -

- 1) Ecosystem damage and loss of land.
- 2) Siltation.
- 3) Flow shortage.
- 4) Methane emissions (from reservoirs).
- 5) Relocation.
- 6) Failure hazard.

## old biology questions

- (81) Draw the line diagram of hydroelectric Power plant.

## Hydro electric Power plant:



(Q2) For a hydroelectric power plant the available head is 200m, water flow rate is  $200 \text{ m}^3/\text{sec}$  and operating efficiency is 90%. How much power is generated?

Given - ~~Find power by H~~

$$H = 200 \text{ m} \quad P = ?$$

$$Q = 200 \text{ m}^3/\text{sec}$$

$$g = 9.8 \text{ m/s}^2$$

$$\rho = \text{Density of water} = 10^3 \text{ kg/m}^3$$

$$\eta = 90\%$$

We know that,

$$P = Q \rho g H \eta$$

$$P = 200 \text{ m}^3/\text{sec} \times 10^3 \text{ kg/m}^3 \times 9.8 \text{ m/s}^2 \\ \times 200 \text{ m} \times \frac{90}{100}$$

$$= 200 \times 10^3 \times 9.8 \times 200 \times \frac{90}{100}$$

$$= 200 \times 10 \times \frac{98}{10} \times 200 \times 9$$

$$= 400000 \times 98 \times 9$$

$$= 4 \times 10^9 \times 98 \times 9$$

$$= 3,528 \times 10^9 \text{ KVA}$$

(b3) what are the disadvantage of hydroelectric power plant?

- The disadvantages of hydroelectric power plant is -
- ① Depends upon availability of quantity of water rainfall.
  - ② Far away from needful electric power, which requires long transmission lines.
  - ③ This increases cost of transmission lines and power loss.
  - ④ Time required for development of plant is high.