Simulation Hydropower Plant (HTML)

Content Outline:

A. Formula for power generated by hydropower plant

The power generated by a hydropower station mainly depends on three factors:

- **Head height of water (h)**
- **Flow rate of the water (Q)**
- **Efficiency of the plant (η)**

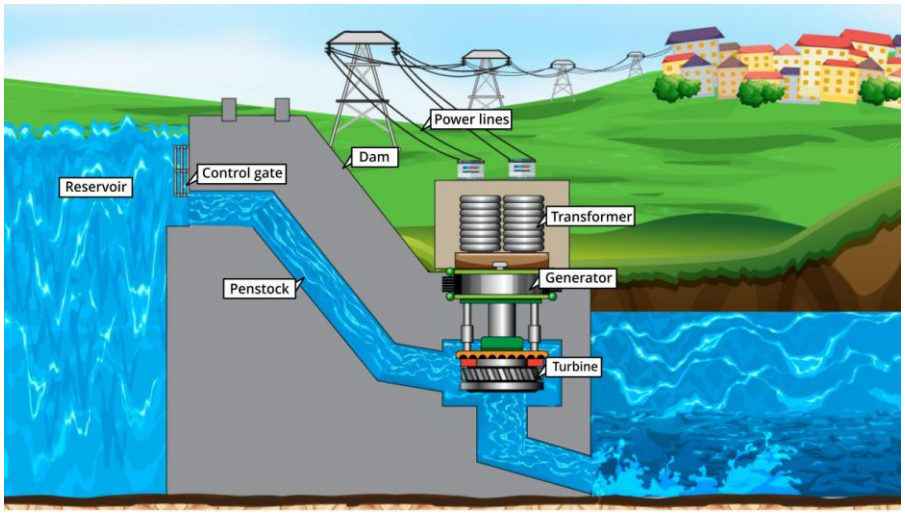
The formula for the power generated from the hydropower station is given below.

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

Where, P = electrical power produced (W)
ρ = density of water (kg/m3)
g = acceleration due to gravity (m/s2)
H = elevation head of water (m)
Q = flow rate of water (m3/s)
η = overall efficiency of hydroelectric power station

Unit of electric energy consumed (1 unit = 1 kWh)
1 kWh is the electric energy consumed by an electric device of power 1000 watt in one hour.

B. Components of Hydropower Plant



1. **Reservoir:** It is built behind the dam as a storage area for water. Here, the water is stored at a height and it possesses **potential energy**.

2. **Dam:** It is a structure that is built to **obstruct the flow** of water which gets stored in the reservoir up to a greater height.

3. **Control Gate:** It is a gate which is used to **regulate the amount of water** going out of the reservoir to the power generation unit through penstock.

4. **Penstock:** It is a pipe made up of concrete or steel that **carries water** from the reservoir to the turbine. In the penstock, water possesses both kinetic energy and potential energy.

5. **Turbine:** It is a unit that **converts the kinetic energy of water into rotational energy** which is further converted into electrical energy through a generator. Different types of turbines are used depending upon the height of the reservoir, water quantity and amount of power to be generated.
6. **Generator:** It is the main component of the hydropower plant which is used to convert the **rotational energy of the turbine into electrical energy**.

7. **Transformer:** It is a device which is used to **increase the voltage** of electricity generated by the generator for further transmission.

8. **Tail Race:** It is the channel that **carries water away** from the hydropower plant or the turbine. The water in this channel has already been used to rotate the turbine blades.

9. **Transmission Lines**: It is the high-tension power line through which the electricity is transferred from the generator to the point of use.

C. How to calculate the demand?

Electric energy required for providing electricity to "n" houses of a town for one day.

Average units of electricity consumed by a house of 4 members = **10 units** per day
(Here 1 unit = 1 kWh)
1 kwh is the electric power consumed by an electric device of power **1000 watt** in **one hour**.

Electric energy required for one house for one day = 10 units = 10 kWh
Electric energy required for **n** house for one day = **n** x 10 kWh = **10n kWh** (This is the demand per day)

D. Variables for simulation

- Number houses to be lighted
- Head of water **(Scale 10 m - 100 m)**
- Efficiency **(80% - 100%)**
- Gate opening - Fixed

E. Instructions to operate the Simulation (HTML)

Step 1: Enter the number of houses for which electricity is needed (n).

Step 2: Select a value for the efficiency of plant by sliding the slider of "**Efficiency of plant**" scale.

Step 3: Select a value for head height by sliding the slider of "**Head height**" scale.
(This is the difference in height between where the water enters and leaves the penstock.)

Note: User can perform the steps **1**, 2, and **3** in any order.

Step 4: Then the user will click on the "**Start**", after that the simulation will start working and messages will appear on the screen according to the demand for electricity and energy generated by the hydropower plant per day.

Output:

- If the energy generated by the demo plant is **equal to or greater** than the required demand, then a message will appear on the screen: '**Specifications are met**'.
- If the energy generated by the demo plant is **less** than the required demand, then a message will appear on the screen: '**Specifications are NOT met**' '**Increase the head height or Efficiency'.**