

# **Electro-hydraulic power stations**

**Water head created by dams built across rivers or similar running water paths is utilized by water turbines to turn hydraulic energy into mechanical energy suitable for driving the synchronous alternator.**

# Classification

## Storage plants

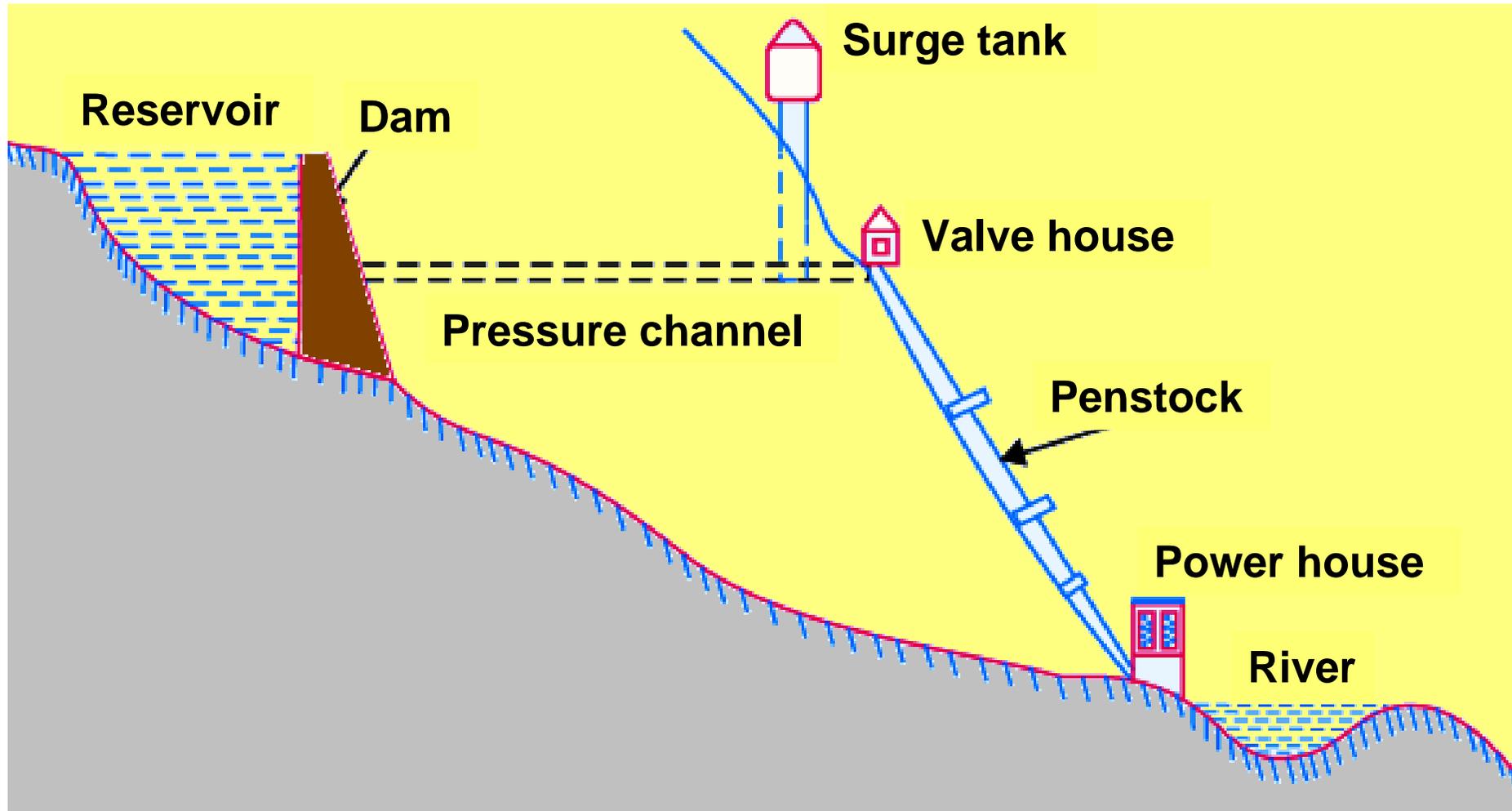
- **Low head plants** (Head < 60m), uses Propeller or Kaplan turbines, large diameter and short length pipes, low speed large diameter generators.
- **Medium head plants** (60 m < Head < 300 m), uses horizontal shafts Francis turbines
- **High head plants** (Head > 300 m), uses jet impulse turbines and high speed small diameter generators.

## Run of river Plants

- **Without pondage**: Doesn't store water; no water flow control, consequently, water is wasted during high flood or low load, and capacity is reduced at low runoff. Used to supply peak load.
- **With pondage**: Could supply base load at high water flow, and peak load at dry seasons

**Pumped storage plants** Peak load plant in which all or part of water supply is pumped back during low load periods by surplus base load plant generation. (Unit acts as turbine and pump alternatively)

# High-Head Plant schematic arrangement



**Dam: A concrete, stone masonry, earth or rock fill made water barrier**

## Spill ways:

- Discharges surplus water from reservoir to river on the downstream side of the dam when river flow exceeds reservoir's storage capacity.
- Constructed from concrete piers with gates on top of the dam.

## Head works:

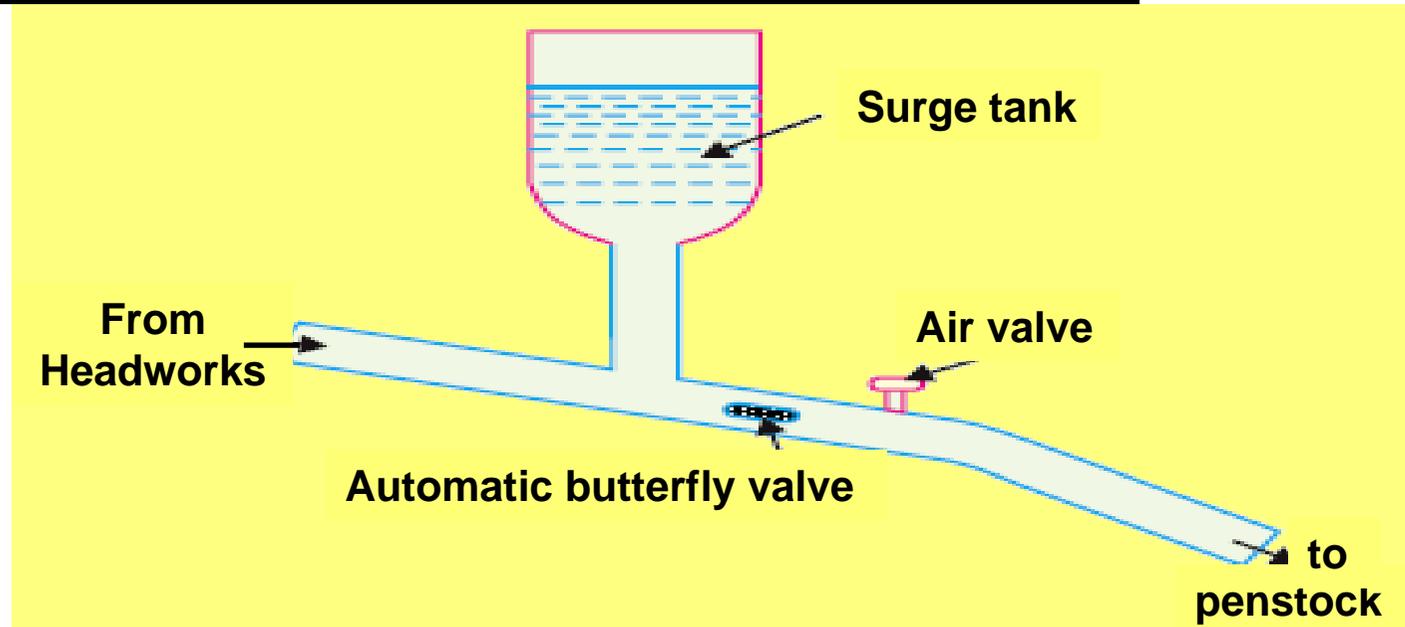
Constructed from:

1. Diversion structures at the head of an intake, equipped with booms and racks for diverting floating debris.
2. Sluices for by-passing debris.
3. Sediments and valves for controlling water flow to turbine.

Valve house: Contains *flow control sluice valves*, & *automatic isolating valves* to cut water supply when penstock bursts.

Penstock: Huge *steel* or *reinforced concrete*, open or closed large length, small cross-section conduit leading to the power house

## Closed conduit penstock protective devices:



**Surge tank:** An open from top tank, built before valve house to protect penstock from bursting due to abnormal pressure at sudden close of turbine gates. Serves as reservoir utilized at sudden demand increase.

**Automatic butterfly valve:** Rapidly shuts off water flow through the penstock in case of rupture of the penstock's conduit.

**Air valve:** Maintains air pressure inside penstock's closed conduit equal to atmospheric pressure; to avoid possible conduit collapse due to vacuum created by water running out faster than water running in.

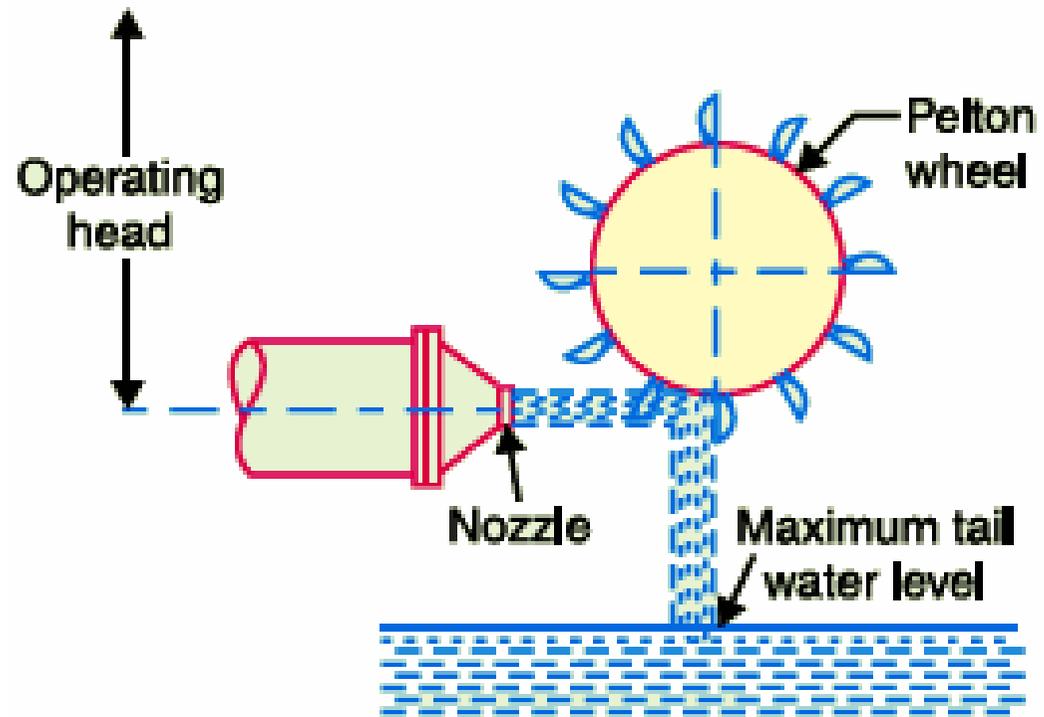


# Water turbines

- Impulse turbines:  
    PELTON wheel
- Reaction turbines  
    Francis turbines  
    Kaplan turbines

# Impulse turbines

Used for high heads



**PELTON wheel:** Consists of a wheel fitted with elliptical buckets along its periphery. The water jet is controlled by a needle or spear located in the nozzle's tip and controlled by the governor. The entire water pressure is converted to kinetic energy in a nozzle; the velocity of the resulting jet drives a wheel.

# Reaction turbines

## Francis turbine:

Used for low to medium heads and water flow plants. It consists of an outer ring of stationary guide blades fixed to the turbine casing and an inner ring of rotating blades forming the runner. The guide blades control the flow of water to the turbine. Water flows radial inwards and changes to a downward direction while passing through the runner. As the water passes over the “rotating blades” of the runner, both pressure and velocity of water are reduced. This causes a reaction force which drives the turbine.

## Kaplan turbine:

Kaplan turbine is used for low heads and large quantities of water. It is similar to Francis turbine except that the runner of Kaplan turbine receives water axially. Water flows radial inwards through regulating gates all around the sides, changing direction in the runner to axial flow. This causes a reaction force which drives the turbine.

## **Advantages of hydroelectric plants:**

- Requires no fuel as water is used for generation of electrical energy.**
- Quite neat and clean as no smoke or ash is produced.**
- Comparatively simple in construction and requires less maintenance.**
- Does not require a long starting time like a steam power plant.**
- Robust and has a longer life.**
- Helps in irrigation and controlling floods.**
- Needs only few experienced personnel for operation.**

## **Disadvantages of hydroelectric plants :**

- Involves high capital cost due to construction of dam.**
- Uncertainty due to dependence on weather conditions.**
- Skilled and experienced Personnel are required to build the plant.**
- Requires high cost of transmission lines as the plant is usually located in areas which are quite away from the consumers.**