TOPICS TO BE COVERED….

- Hydraulic Turbine
- classification & examples of Hydraulic Turbine
- some important terms used in Hydraulic Turbines.
- Working and construction of Pelton turbine,
- Working and construction of Francis turbine.
- Working of Kaplan turbine, Selection of turbines.
- Specific speed of turbine
- Working of water pumps
- Working and construction of centrifugal pump,
- cavitation process
- draft tube and its function.

INTRODUCTION

Hydraulic turbines uses the potential and kinetic energy of water and converts it into usable mechanical energy as efficiently as possible. The mechanical energy made available at the turbine shaft is used to run an electric motor to generate the electricity.

Classification of turbines

- Based on head and quantity of water

According to head and quantity of water available, the turbines can be classified into

a) High head turbines

b) Medium head turbines

c) Low head turbines

a) High head turbines

High head turbines are the turbines which work under heads more than 250m. The quantity of water needed in case of high head turbines is usually small. The Pelton turbines are the usual choice for high heads.

Classification of turbines

b) Medium head turbines

The turbines that work under a head of 45m to 250m are called medium head turbines. It requires medium flow of water. Francis turbines are used for medium heads.

c) Low head turbines

Turbines which work under a head of less than 45m are called low head turbines. Owing to low head, large quantity of water is required. Kaplan turbines are used for low heads.

Classification of turbines

- Based on hydraulic action of water

According to hydraulic action of water, turbines can be classified into

a) Impulse turbines

b) Reaction turbines

a) Impulse turbines

If the runner of a turbine rotates by the impact or impulse action of water, it is an impulse turbine.

b) Reaction turbines

These turbines work due to reaction of the pressure difference between the inlet and the outlet of the runner.

Classification of turbines

- Based on direction of flow of water in the runner

Depending upon the direction of flow through the runner, following types of turbines are there

a) Tangential flow turbines

b) Radial flow turbines

c) Axial flow turbines

d) Mixed flow turbines

a) Tangential flow turbines

When the flow is tangential to the wheel circle, it is a tangential flow turbine. A Pelton turbine is a Tangential flow turbine.

Classification of turbines

- Based on direction of flow of water in the runner

b) Radial flow turbines

In a radial flow, the path of the flow of water remains in the radial direction and in a plane normal to the runner shaft. No pure radial flow turbine is in use these days.

c) Axial flow turbines

When the path of flow water remains parallel to the axis of the shaft, it is an axial flow turbine. The Kaplan turbine is axial flow turbine

d) Mixed flow turbines

When there is gradual change of flow from radial to axial in the runner, the flow is called mixed flow. The Francis turbine is a mixed flow turbine.

Classification of turbines

- Based on specific speed of turbines

  Specific speed of a turbine is defined as the speed of a geometrically similar turbine which produces a unit power when working under a unit head.

  The specific speed of Pelton turbine ranges between 8-30, Francis turbines have specific speed between 50-250, Specific speed of Kaplan lies between 250-850.

- Based on disposition of shaft of runner

  Usually, Pelton turbines are setup with horizontal shafts, where as other types have vertical shafts.

Efficiencies of Hydraulic Turbines

- Efficiencies

Various types of efficiencies are defined as under:

(a) Hydraulic efficiency: It is the ratio of the power developed by the runner to the actual power supplied by water to the runner. It takes into account the hydraulic losses occurring in the turbine

η_h = Runner output / Actual power supplied to runner

= Runner output / (ρQgH)

Where, Q = Quantity of water actually striking the runner blades

H = Net head available at the turbine inlet

Efficiencies of Hydraulic Turbines

- Efficiencies

(b) Volumetric efficiency: It is the ratio of the actual quantity of water striking the runner blades to the quantity supplied to the turbine. It takes into account the volumetric losses.

Let ΔQ = Quantity of water leaking or not striking the runner blades

$$\eta_v = Q / (Q + \Delta Q)$$

(c) Mechanical efficiency: The ratio of the shaft output to the runner output is called the mechanical efficiency and it accounts for the mechanical losses.

$$\eta_m = \text{Shaft output} / \text{Runner output}$$

Efficiencies of Hydraulic Turbines

- Efficiencies

(d) Overall efficiency: Ratio of shaft output to the net power available at the turbine inlet gives overall efficiency of the turbine

η_m = Shaft output / Net power available

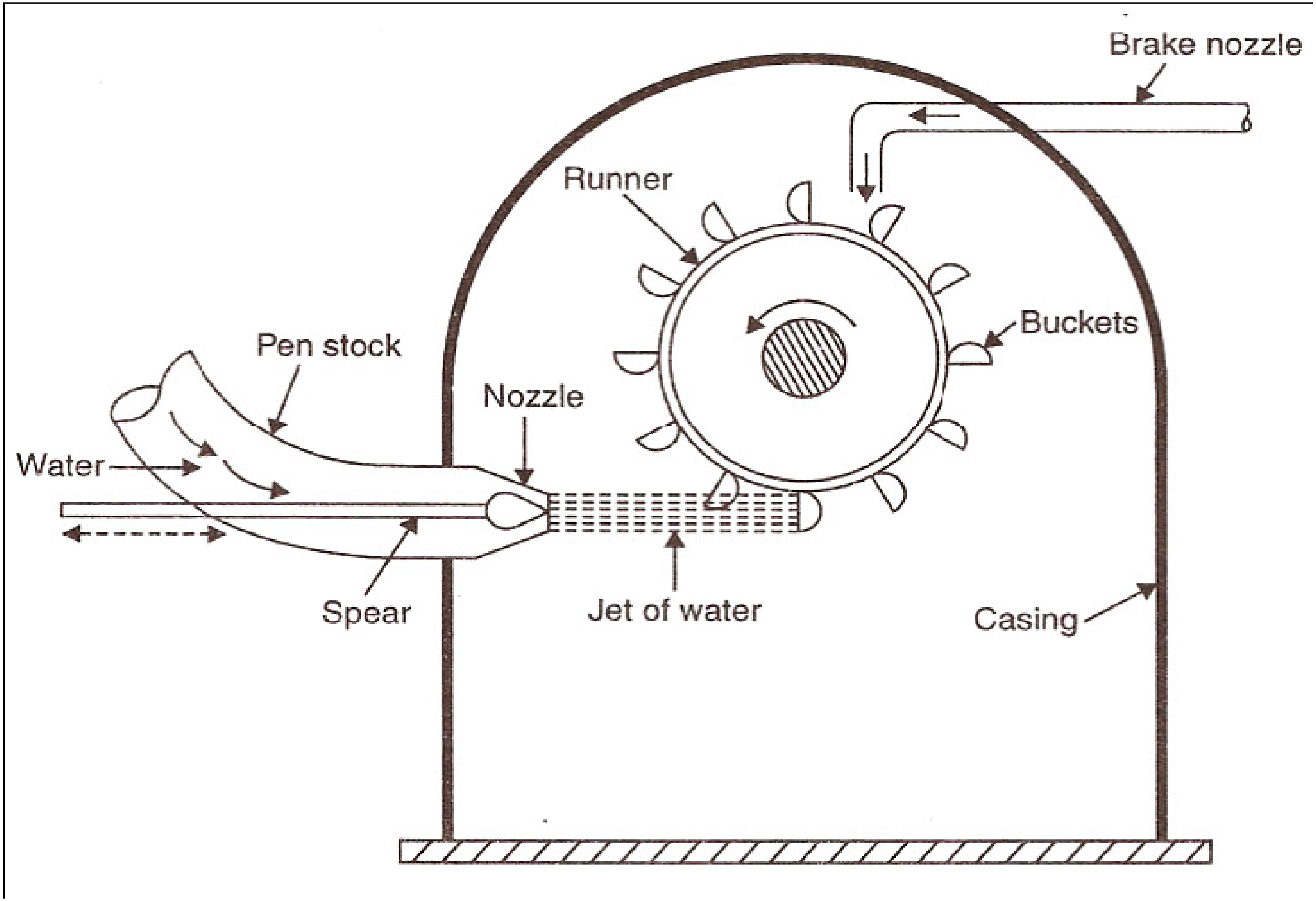
$$\eta_o = \frac{Shaft.output}{\rho(Q + \Delta Q)gH}$$

$$\eta_o = \frac{Shaft.output}{Runner.output} \times \frac{Runner.output}{\rho QgH} \times \frac{Q}{(Q + \Delta Q)}$$

$$\eta_o = \eta_m \times \eta_h \times \eta_v$$

Thus all the three types of losses, mechanical, hydraulic and volumetric have been taken into account.

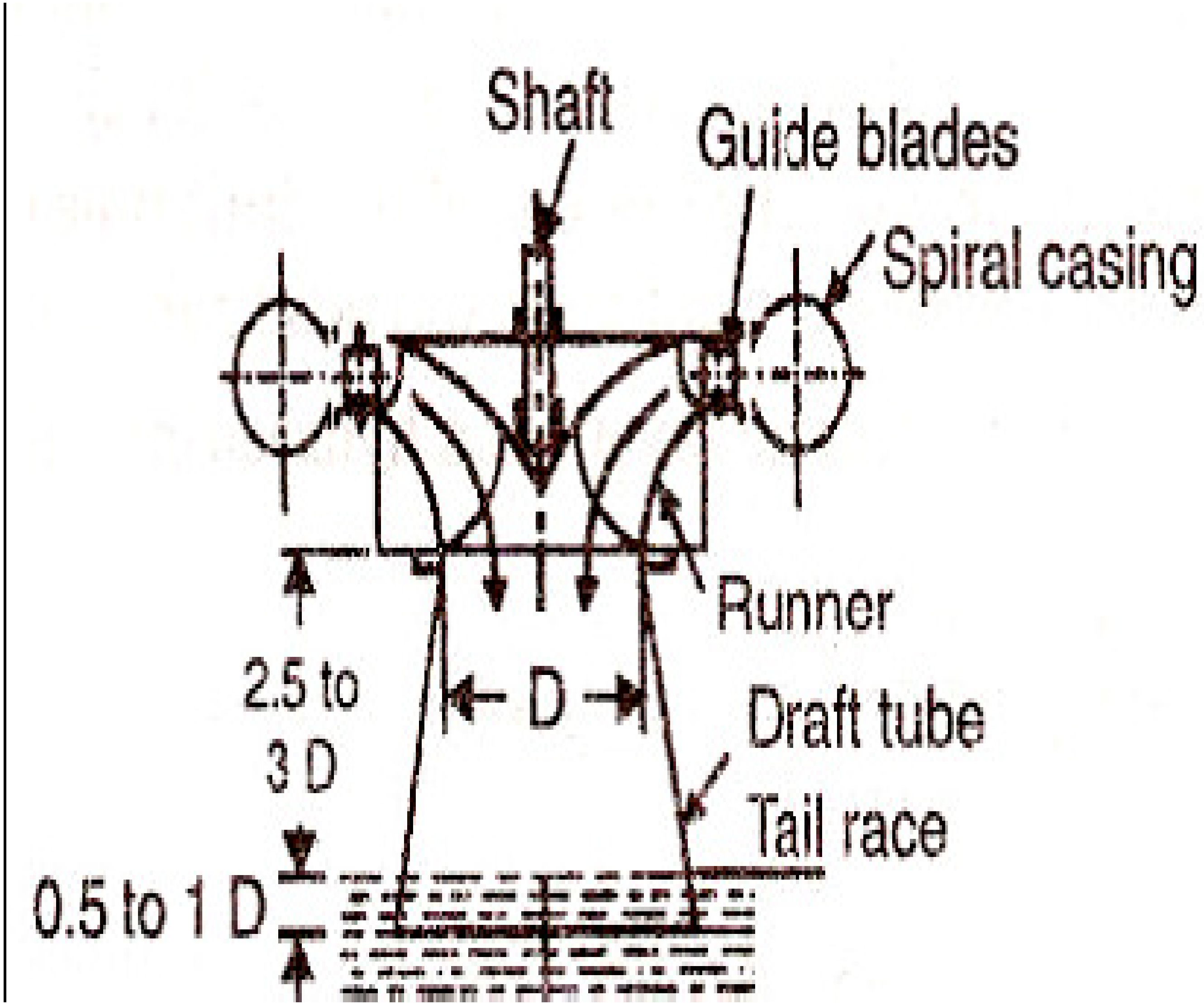
PELTON TURBINE



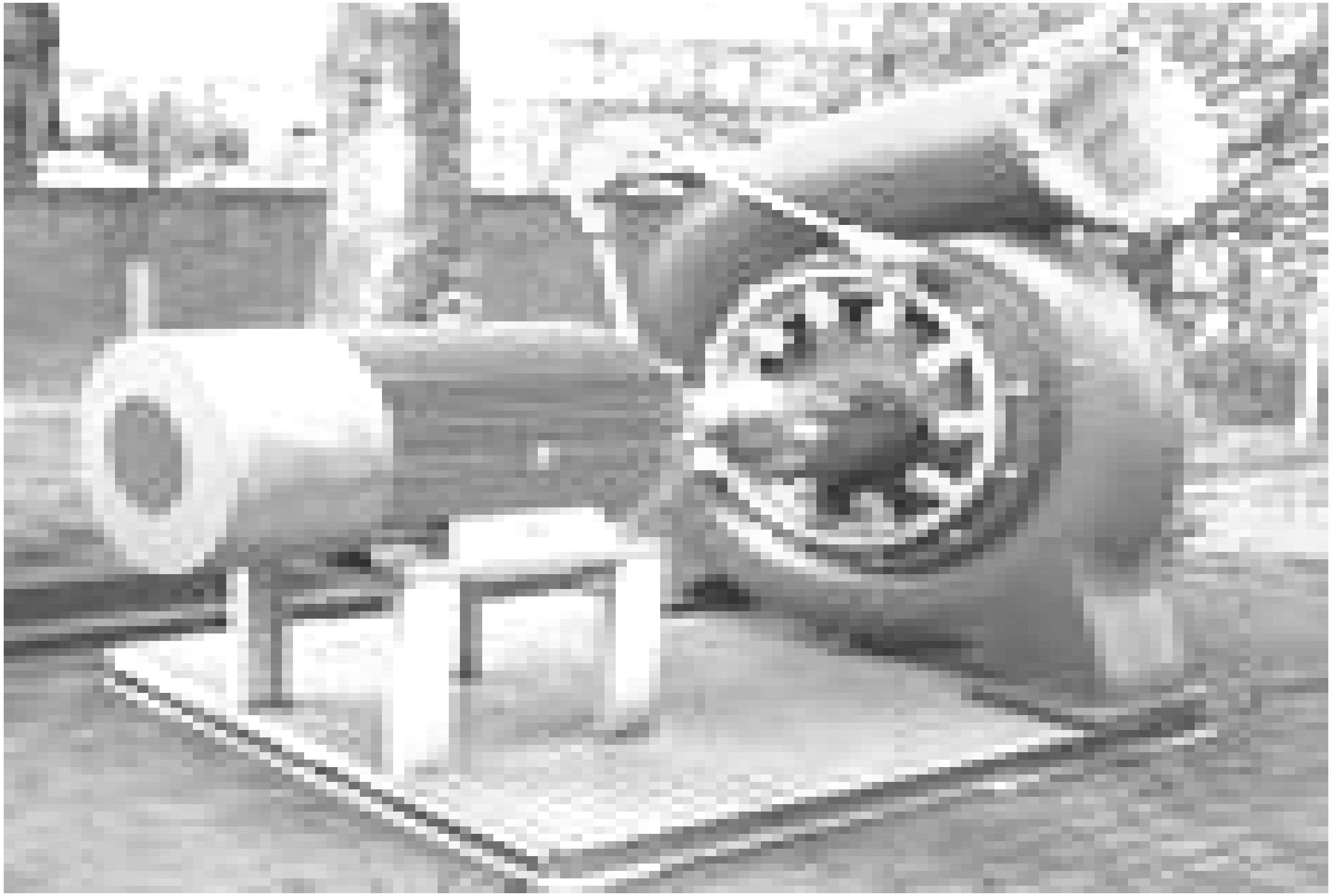
EFFICIENCIES OF PELTON TURBINE

- Mechanical efficiencies: - It is ratio of the shaft power to the water power.
- Hydraulic efficiencies: - It is ratio of the power developed at the turbine runner to the power supplied by the water jet at entrance to the turbine.
- Volumetric efficiencies: - It is ratio of the theoretical to the actual discharge.
- Overall efficiencies: - It is ratio of the shaft power to the water power.

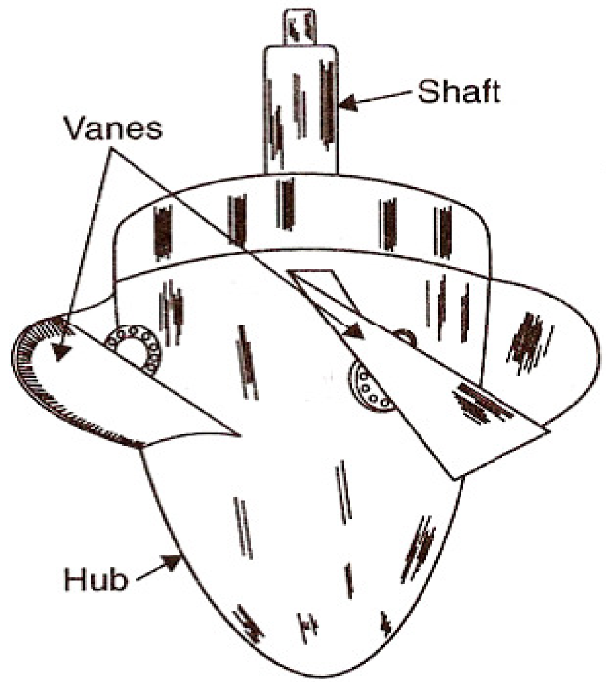
FRANCIS TURBINE

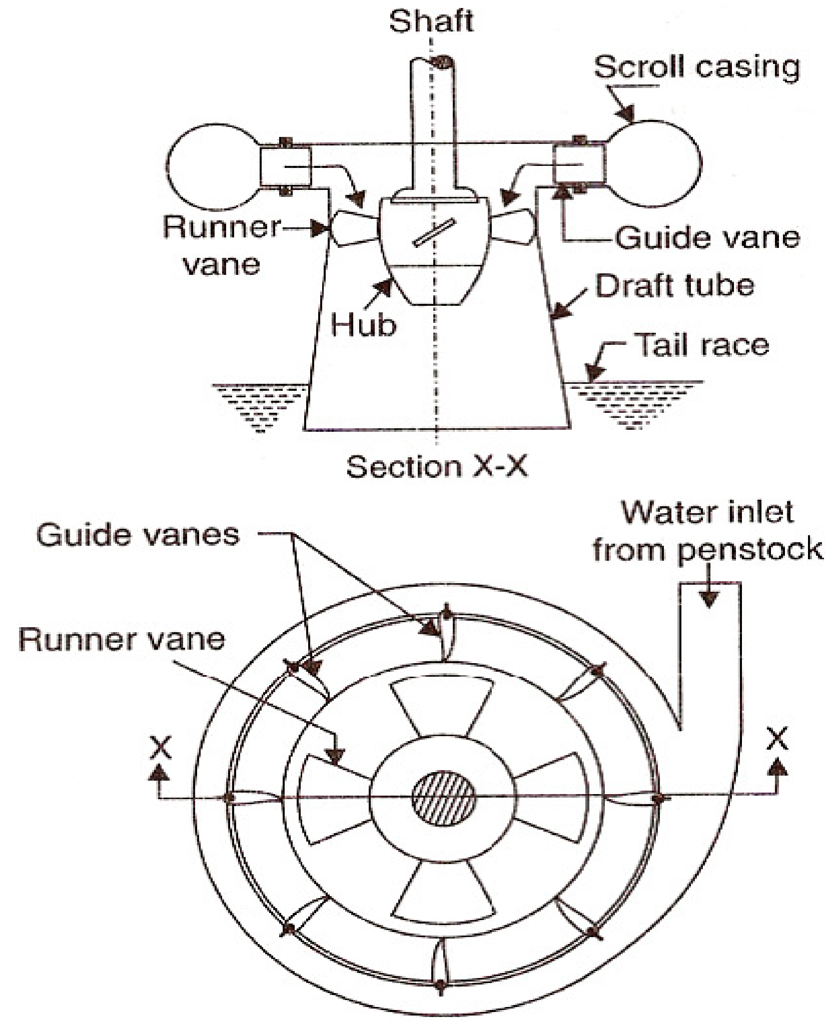


Francis Turbine and generator

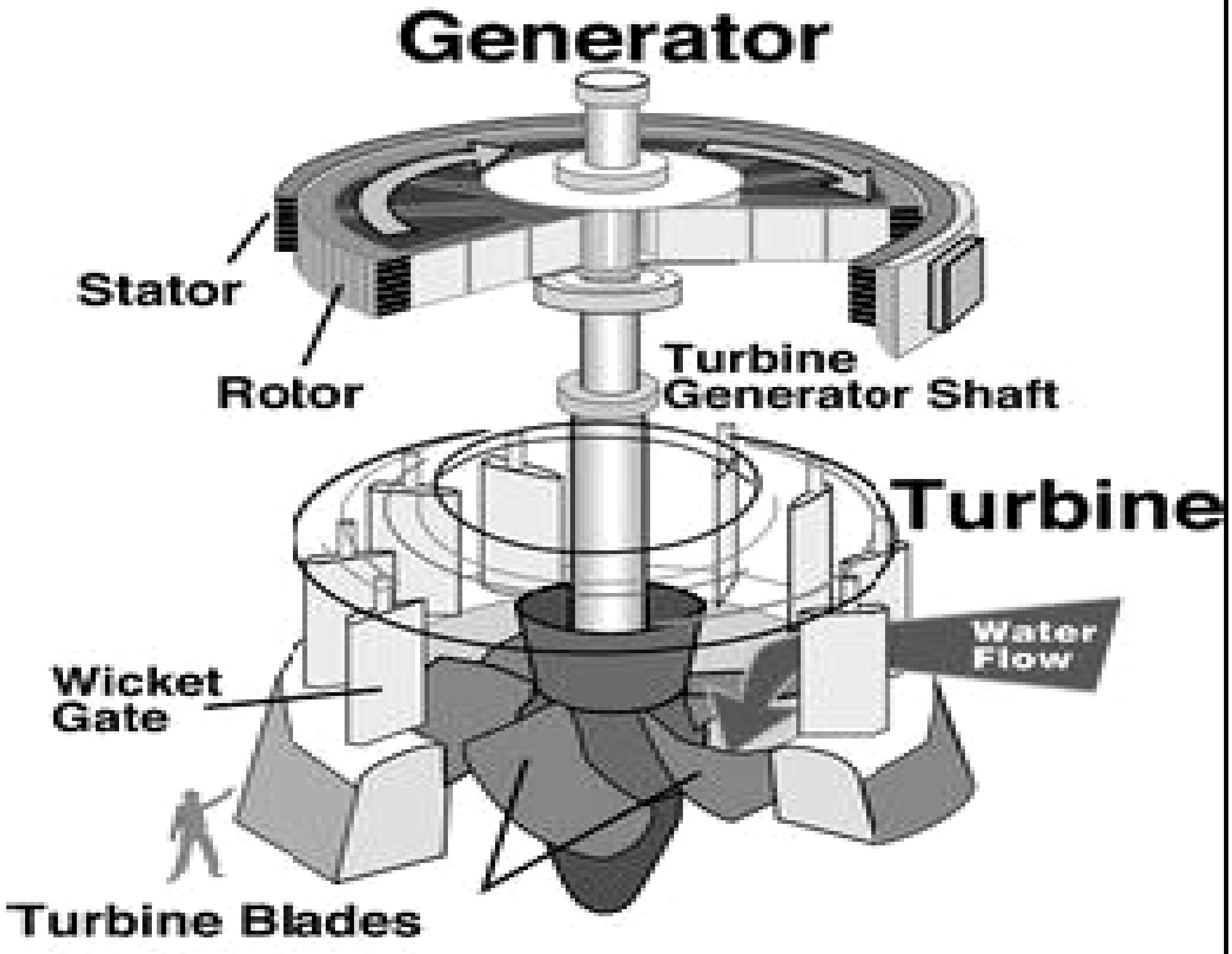


KAPLAN TURBINE

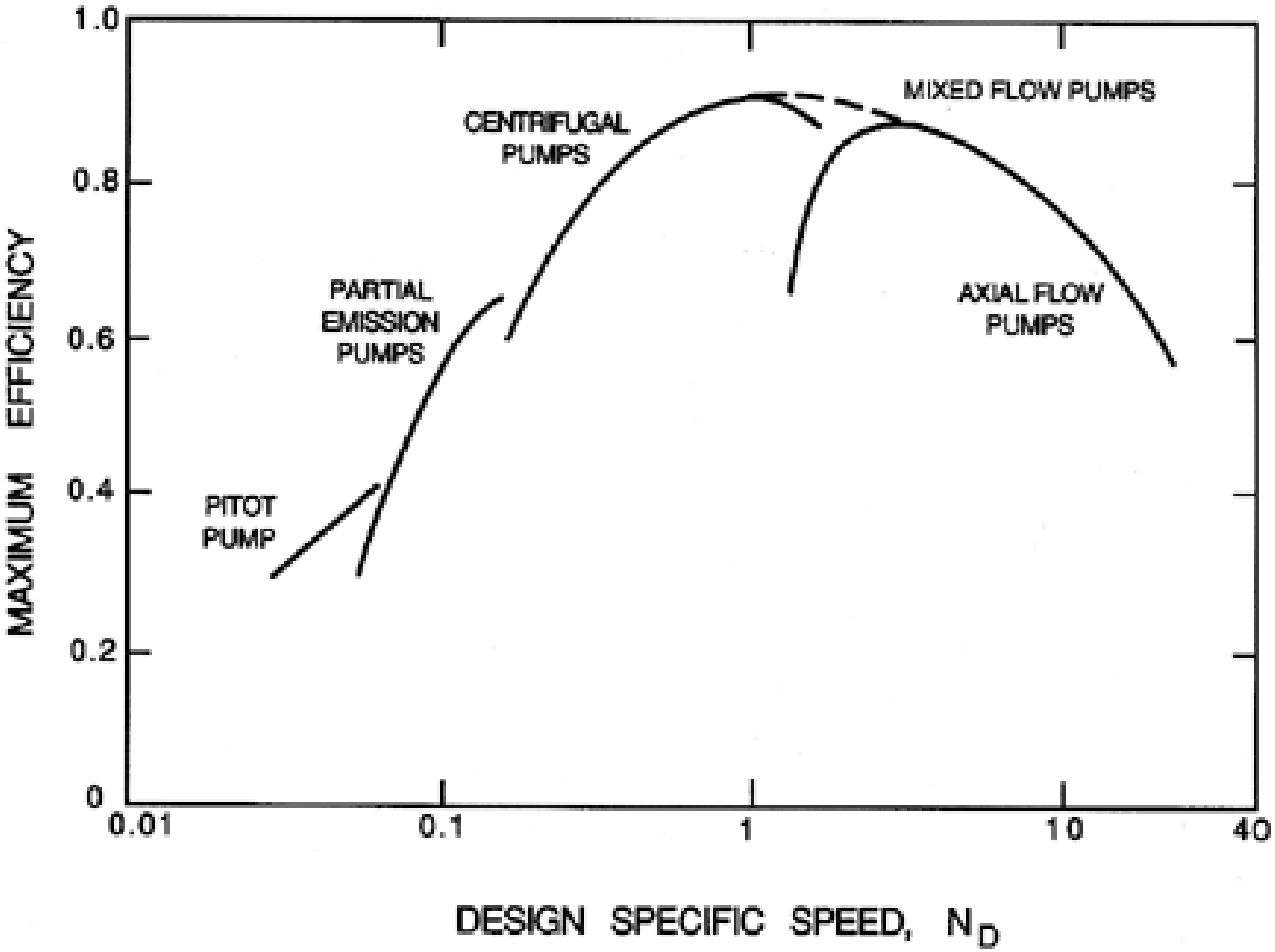




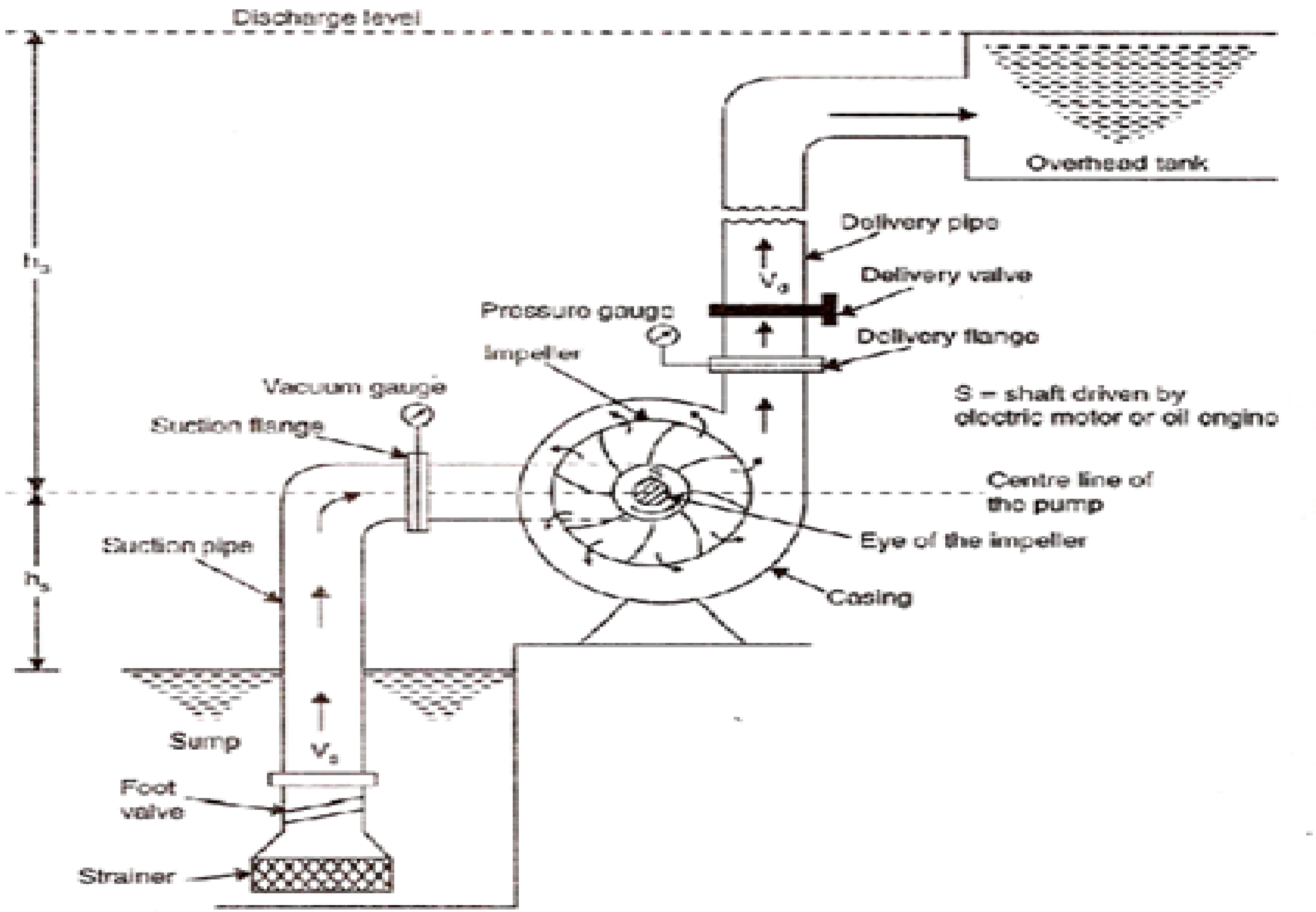
Working of Kaplan turbine



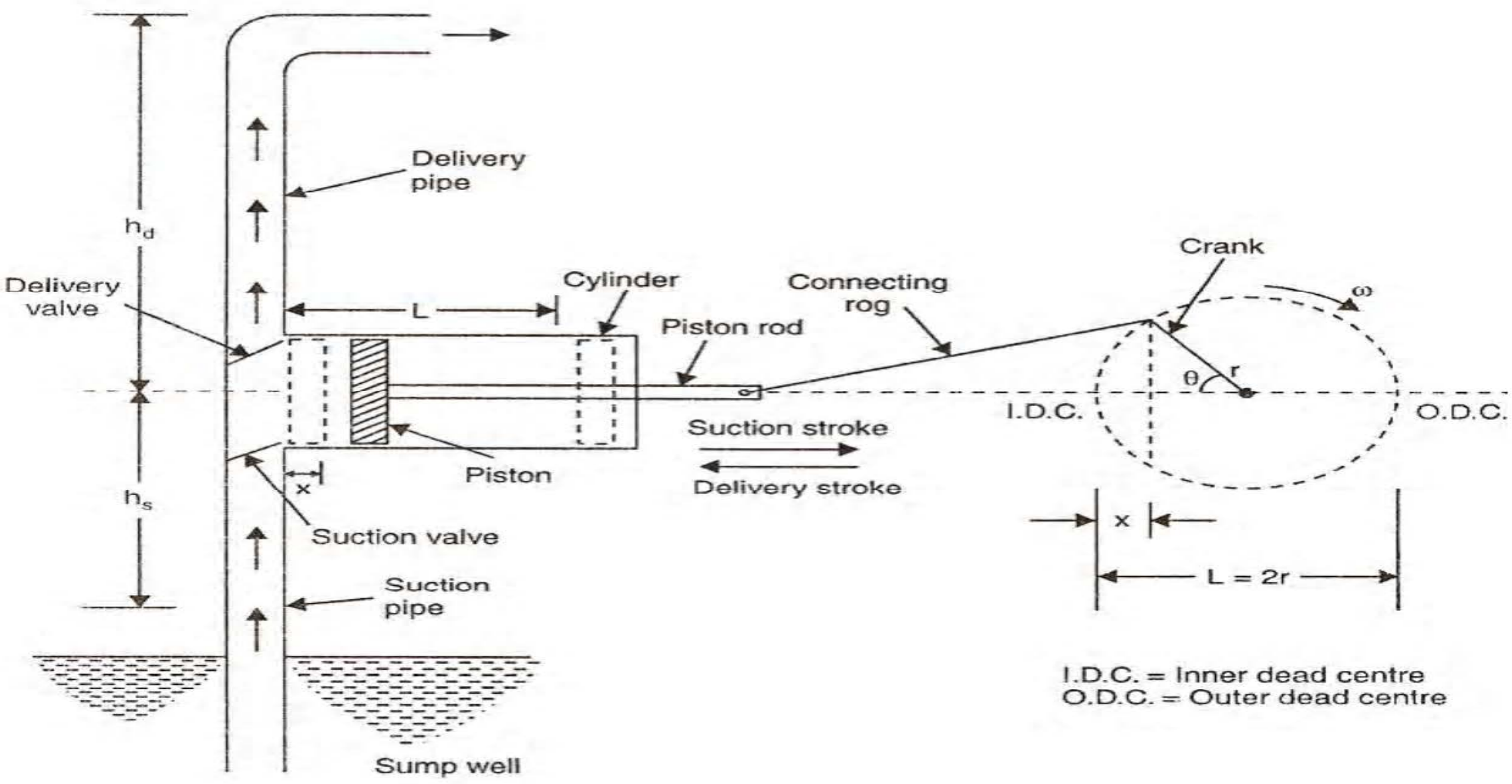
SPECIFIC SPEED OF TURBINES



CENTRIFUGAL PUMP



Reciprocating pumps



CAVITATION

- the formation of an empty space within a solid object or body.
- the formation of bubbles in a liquid, typically by the movement of a propeller through it.

DRAFT TUBE

In turbines, a diffuser tube is installed at the exit of the runner, known as **draft tube**