SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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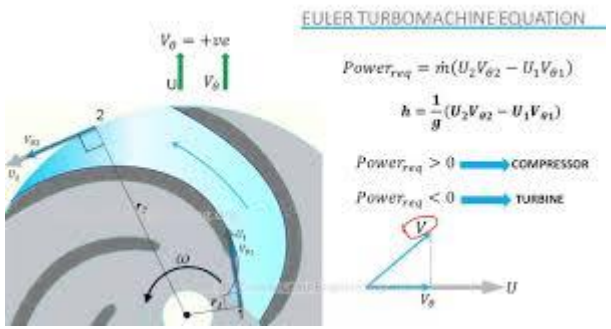
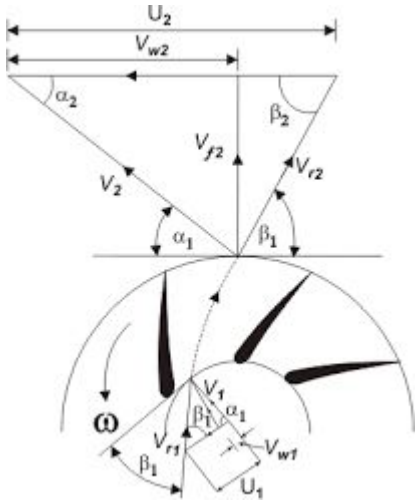
DEPARTMENT OF AGRICULTURE ENGINEERING



19MEB204 – FLUID MECHANICS AND MACHINERY

II YEAR III SEM

CASE STUDY – VELOCITY TRIANGLES OF TURBINES



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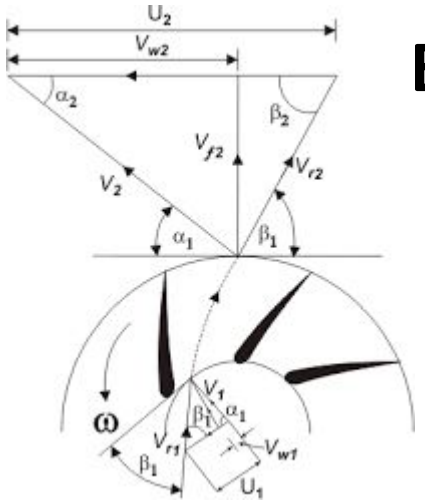
HYDRAULIC TURBINE

Definition:

The machine/device which converts hydraulic energy into mechanical energy is called as hydraulic turbine.



Examples:

1) Pelton Wheel Turbine
2) Francis Turbine
3) Kaplan Turbine

Question: Can any one recall the difference between Kaplan , Francis turbine?

CLASSIFICATION OF HYDRAULIC TURBINE

1) According to Energy at Inlet:

a) Impulse Turbine: Kinetic Energy is Maximum than Pressure Energy.

e.g. Pelton Wheel Turbine

b) Reaction Turbine: Pressure Energy is Maximum than Kinetic Energy.

e.g. Francis Turbine and Kaplan Turbine

2) According to Direction of Flow Through Runner:

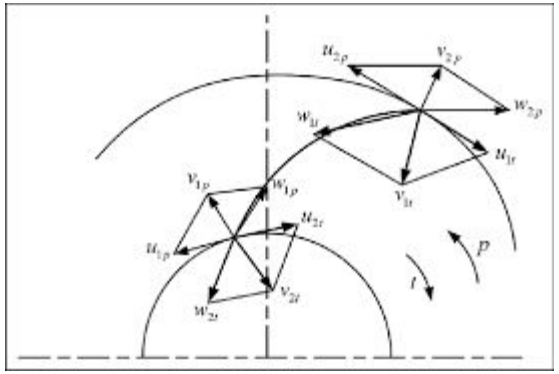
a) Tangential Flow: Water flows along the tangent of runner.

e.g. Pelton Wheel Turbine

b) Radial Flow: Water flows along the radius through runner.

c) Axial Flow: Water flows along the axis of rotation of runner.

d) Mixes Flow: Water inlet radial direction and exit in axial direction.



CLASSIFICATION OF HYDRAULIC TURBINE

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e.g. Pelton Wheel Turbine

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c) Axial Flow: Water flows along the axis of rotation of runner.

d) Mixes Flow: Water inlet radial direction and exit in axial direction.

Question: Can any one recall the difference between Kaplan , Francis turbine based on head ?

CLASSIFICATION OF HYDRAULIC TURBINE

3) According to Head Available at Inlet:

- a) Low Head: Head < 60 meters

  e.g. Kaplan Turbine
- b) Medium Head: 60 meters < Head < 250 meters

  e.g. Francis Turbine
- c) High Head: 250 meters < Head

  e.g. Pelton Wheel Turbine

4) According to Specific Speed of Turbine:

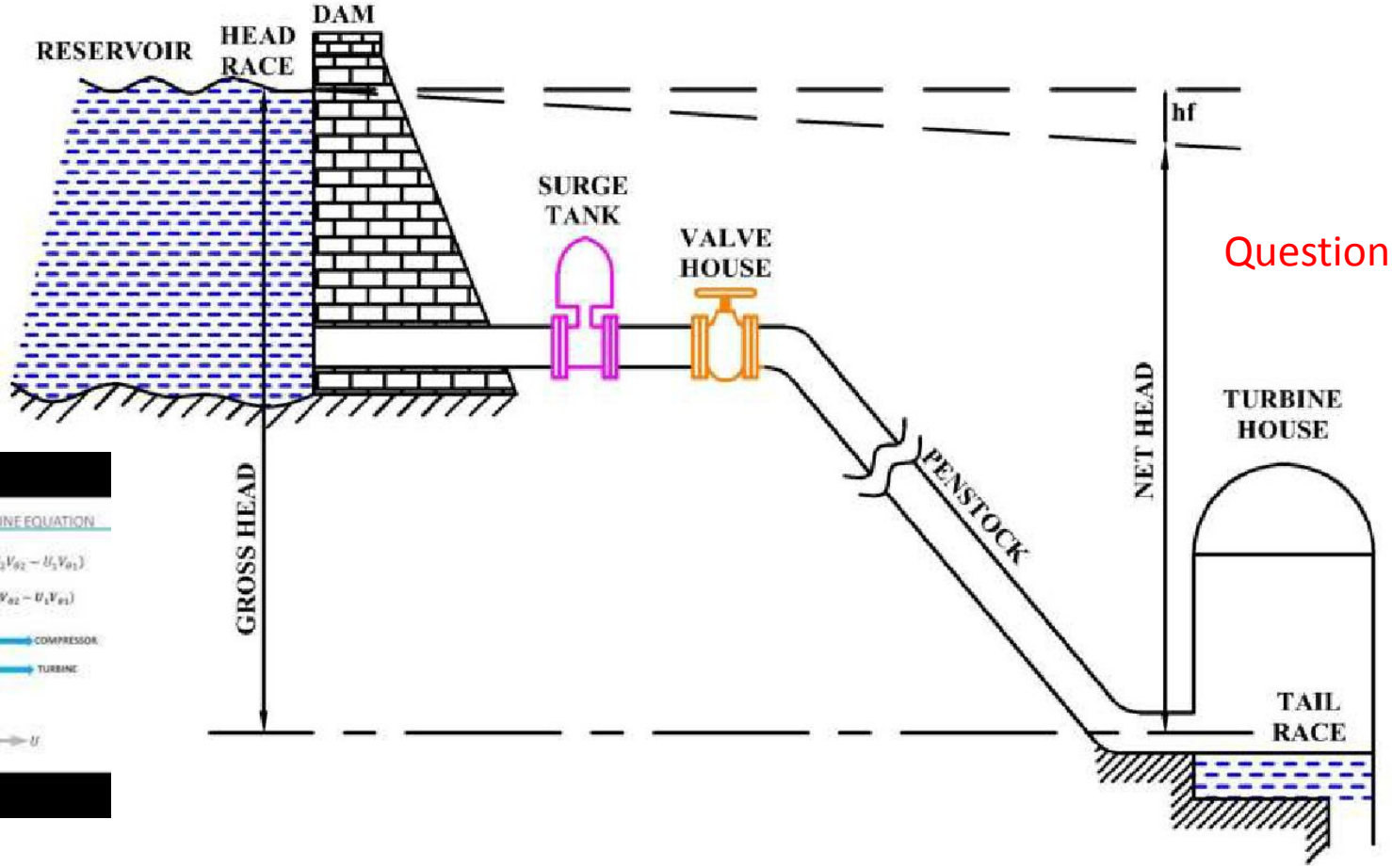
- a) Low Specific Speed: Specific Speed < 60

  e.g. Pelton Wheel Turbine
- b) Medium Specific Speed: 60 < Specific Speed < 300

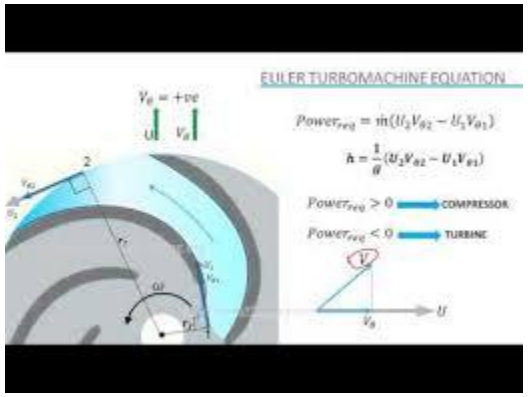
  e.g. Francis Turbine
- c) High Specific Speed: 300 < Specific Speed

  e.g. Kaplan Turbine

HYDRO-ELECTRIC POWER PLANT



Question: Need of surge tank?



HYDRO-ELECTRIC POWER PLANT

1) Dam:

A wall constructed across the flow of river

2) Penstock:

A pipe which convey the water from dam to turbine house

3) Turbine House:

Assembly of runner, shaft to convert hydro energy into mechanical energy

4) Surge Tank:

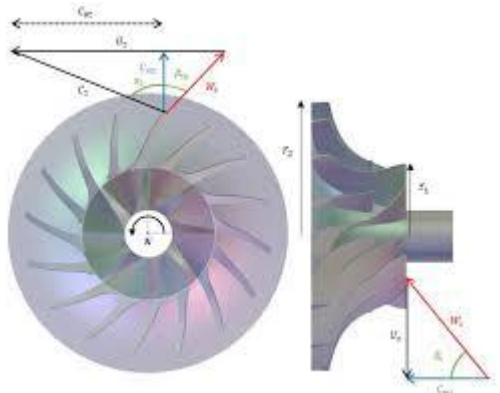
A storage tank fitted on penstock before valve to avoid water hammer

5) Valve House:

To control the rate of flow of water through penstock

VELOCITY TRIANGLE

In turbomachinery, a **velocity triangle** or a **velocity diagram** is a **triangle** representing the various components of **velocities** of the working fluid in a turbomachine. **Velocity triangles** may be drawn for both the inlet and outlet sections of any turbomachine.



VELOCITIES INVOLVED

A general velocity triangle consists of the following vectors:

V : Absolute velocity of the fluid.

U : Blade Linear velocity.

V_r: Relative velocity of the fluid after contact with rotor.

V_w: Tangential component of V (absolute velocity), called *Whirl velocity*.

V_f: Flow velocity (axial component in case of axial machines, radial component in case of radial machines).

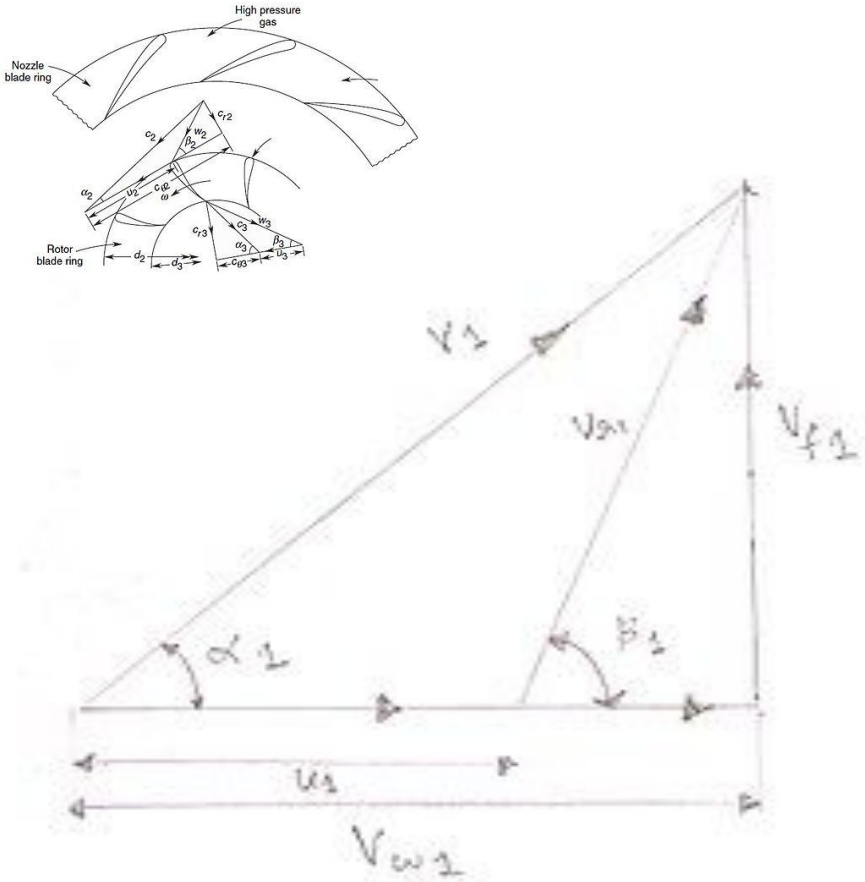
Question: What is absolute angle?

The following angles are encountered during the analysis:

α: Angle made by V with the plane of the machine (usually the nozzle angle or the guide blade angle).

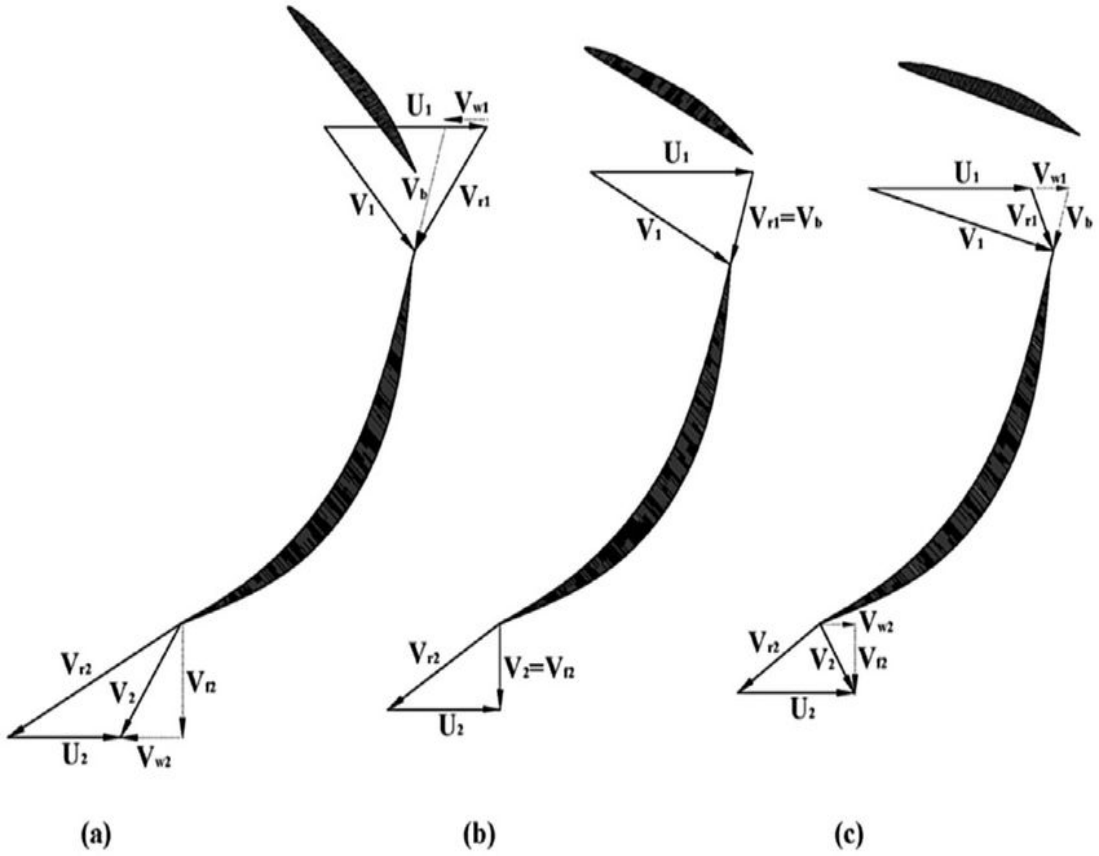
β: Angle of the rotor blade. Absolute angle

VELOCITIES INVOLVED



- An example of a velocity triangle drawn for the inlet of a turbomachine.
- The "1" subscript denotes the high pressure side (inlet in case of turbines and outlet in case of pumps/compressors).

VELOCITY TRIANGLES OF FRANCIS TURBINES



- Turbine runner blade inlet and outlet under different operation conditions:

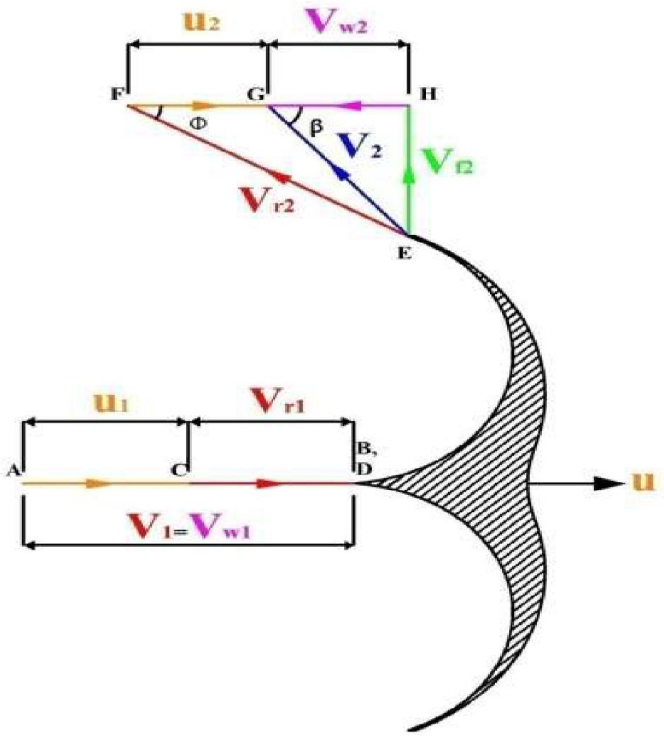
(a) maximum wicket gate opening condition;

(b) peak efficiency condition;

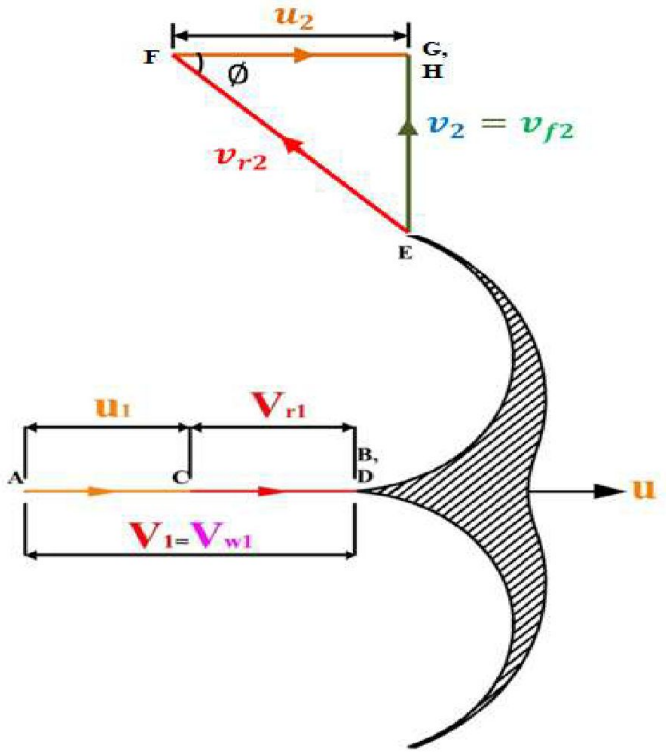
(c) minimum wicket gate opening condition

PELTON WHEEL TURBINE-VELOCITY TRIANGLE

LOW SPEED TURBINE

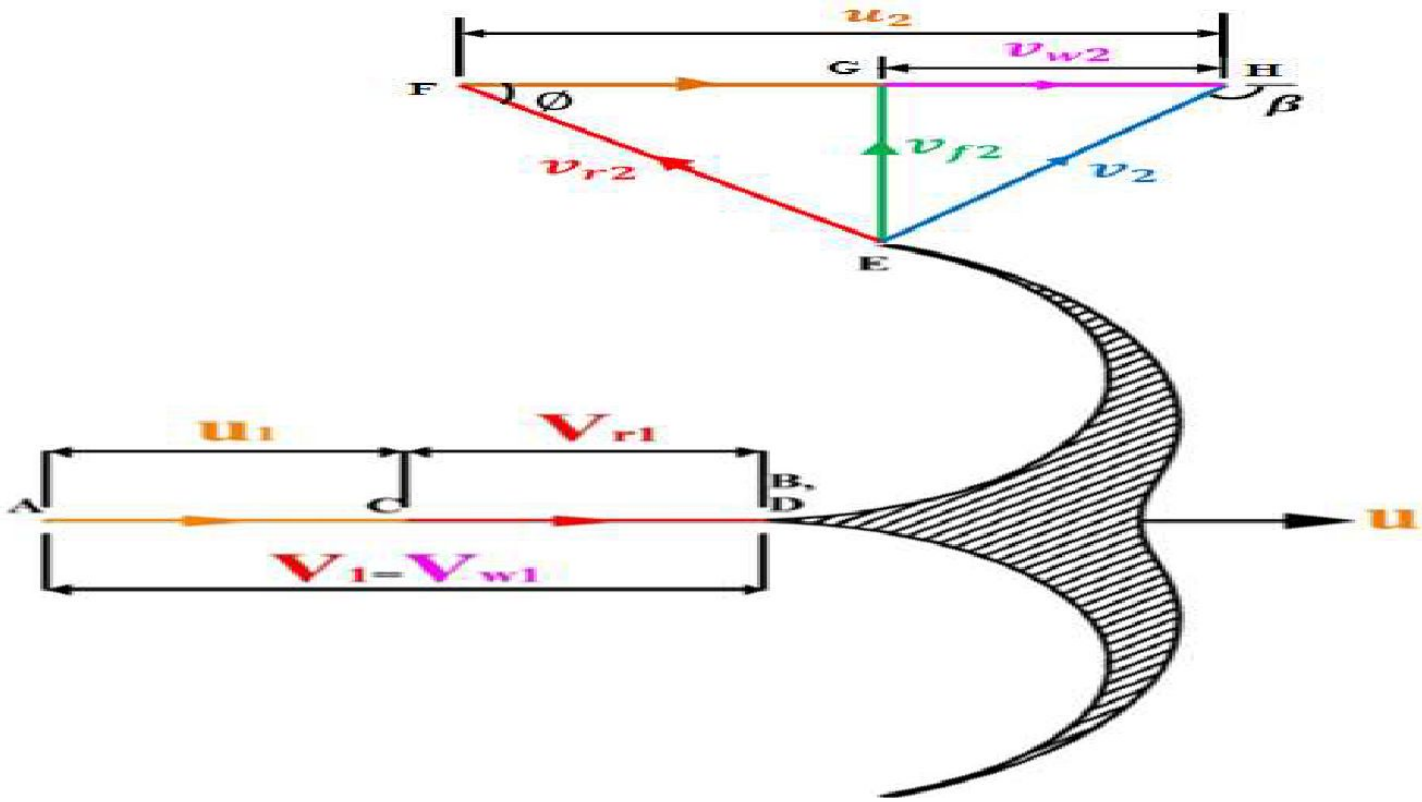


INLET VELOCITY TRIANGLE

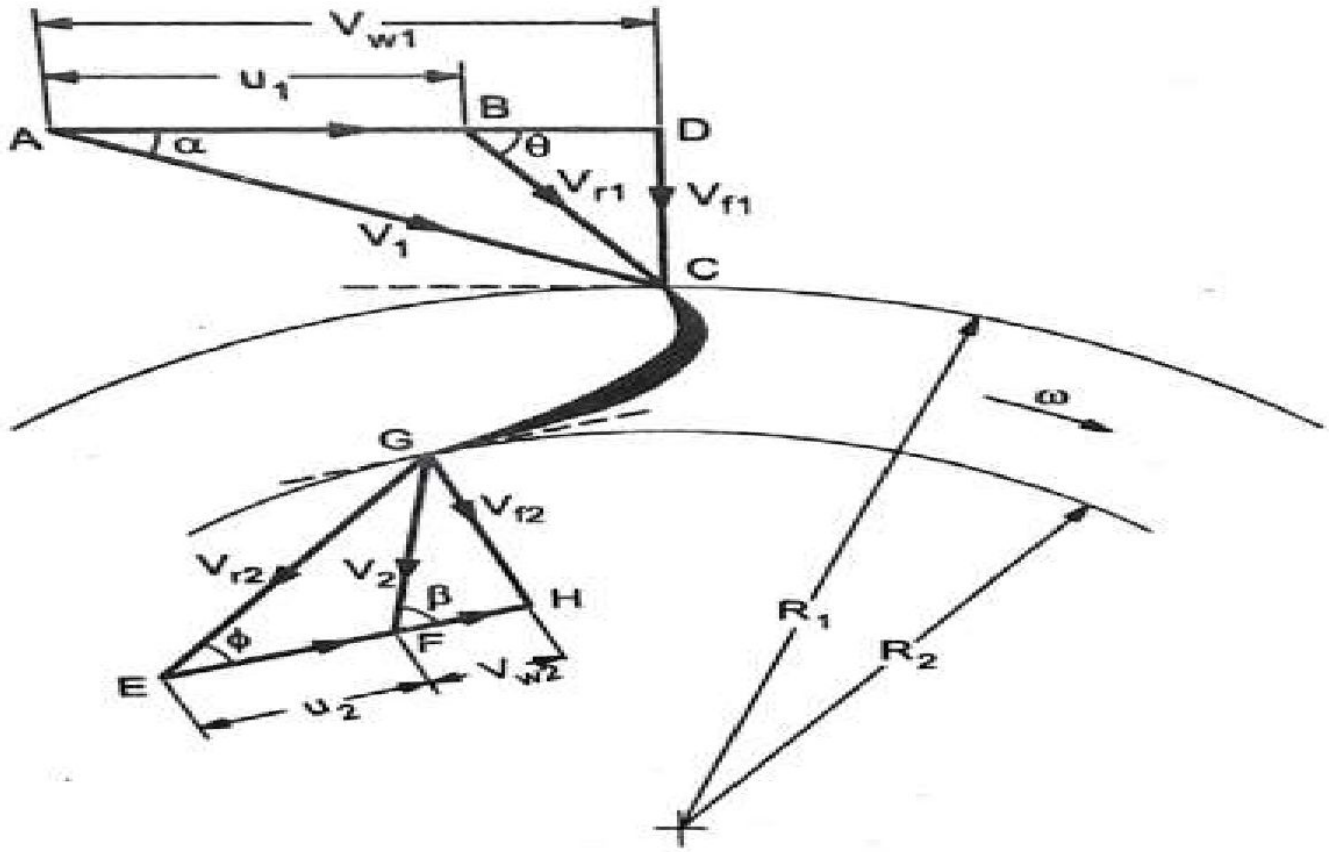


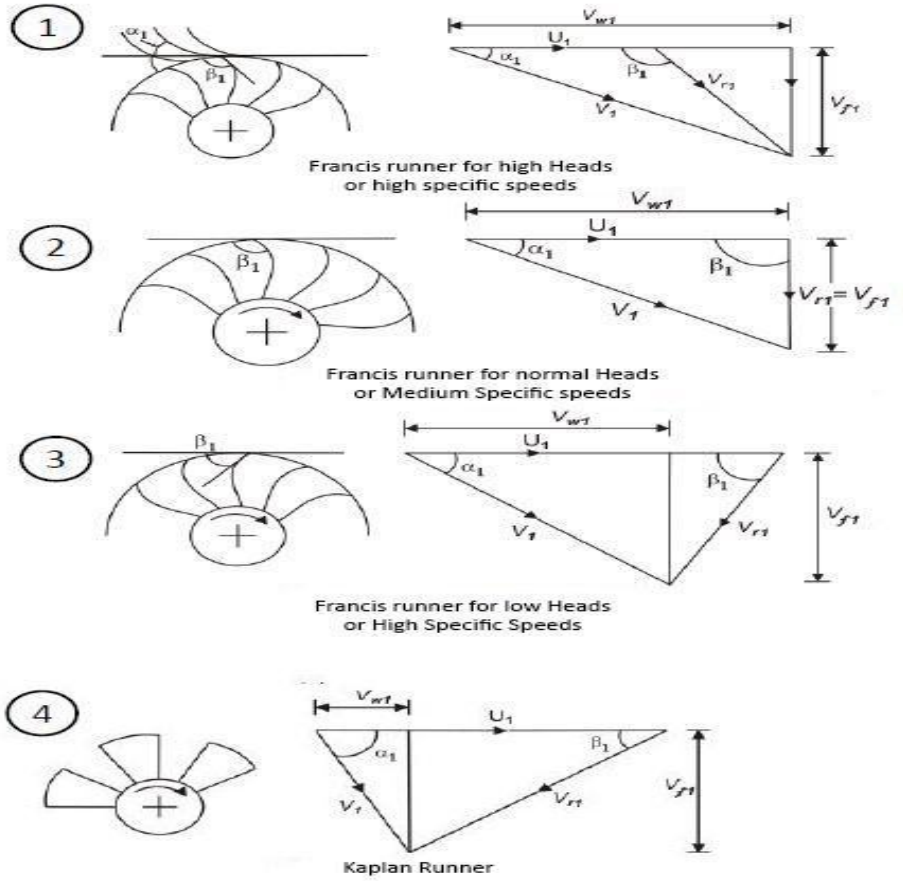
PELTON WHEEL TURBINE-VELOCITY TRIANGLE

- High Speed Turbine



FRANCIS TURBINE TURBINE-VELOCITY TRIANGLE





ASSESSMENT - KAHOOT

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