Micro Hydro Power

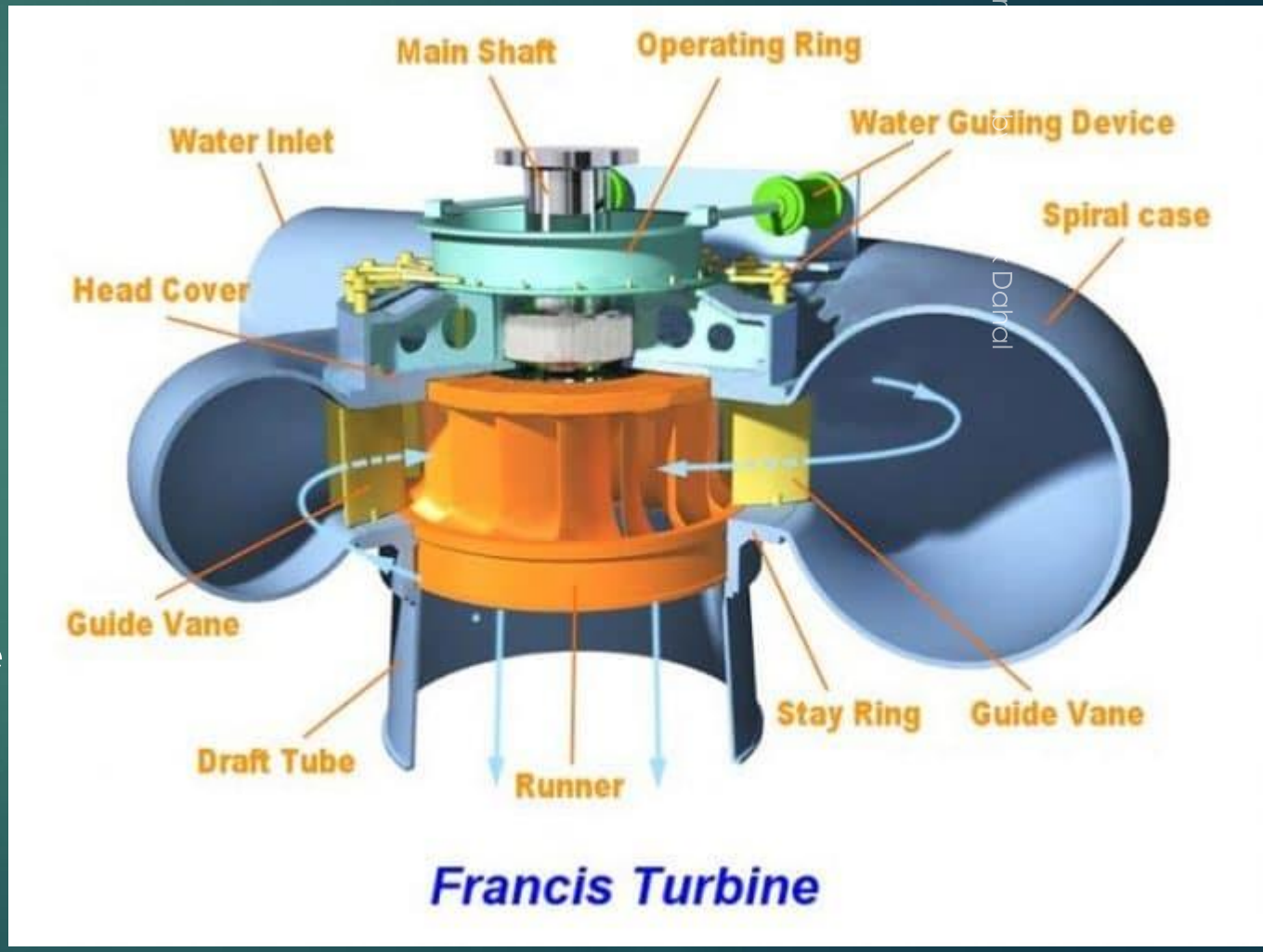
LECTURE 6:

ELECTROMECHANICAL COMPONENTS OF MICRO HYDRO

Prepared by Er. Bibek Dahal

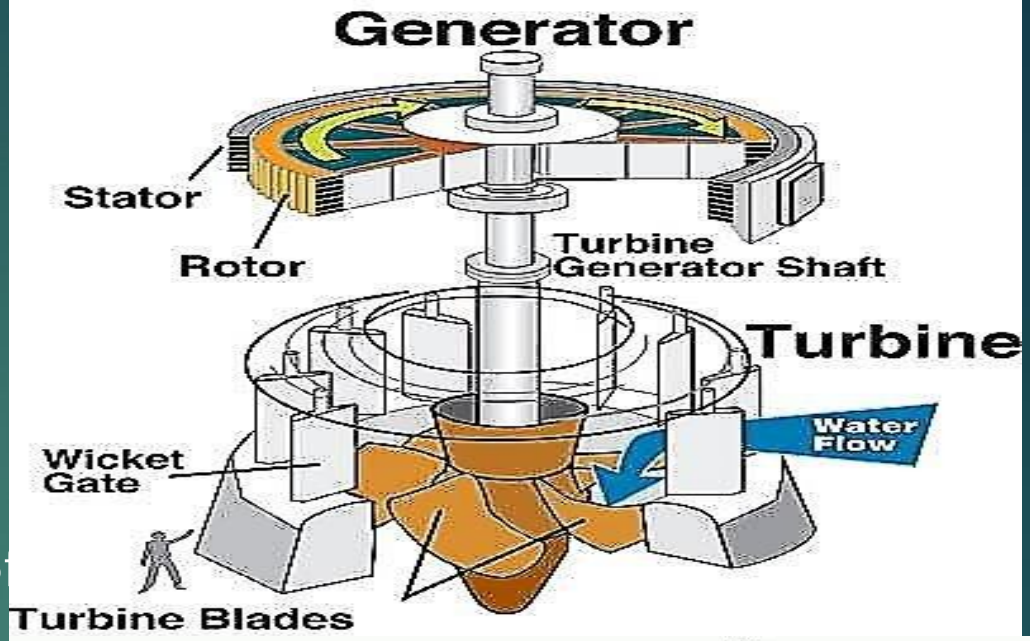
Francis Turbine

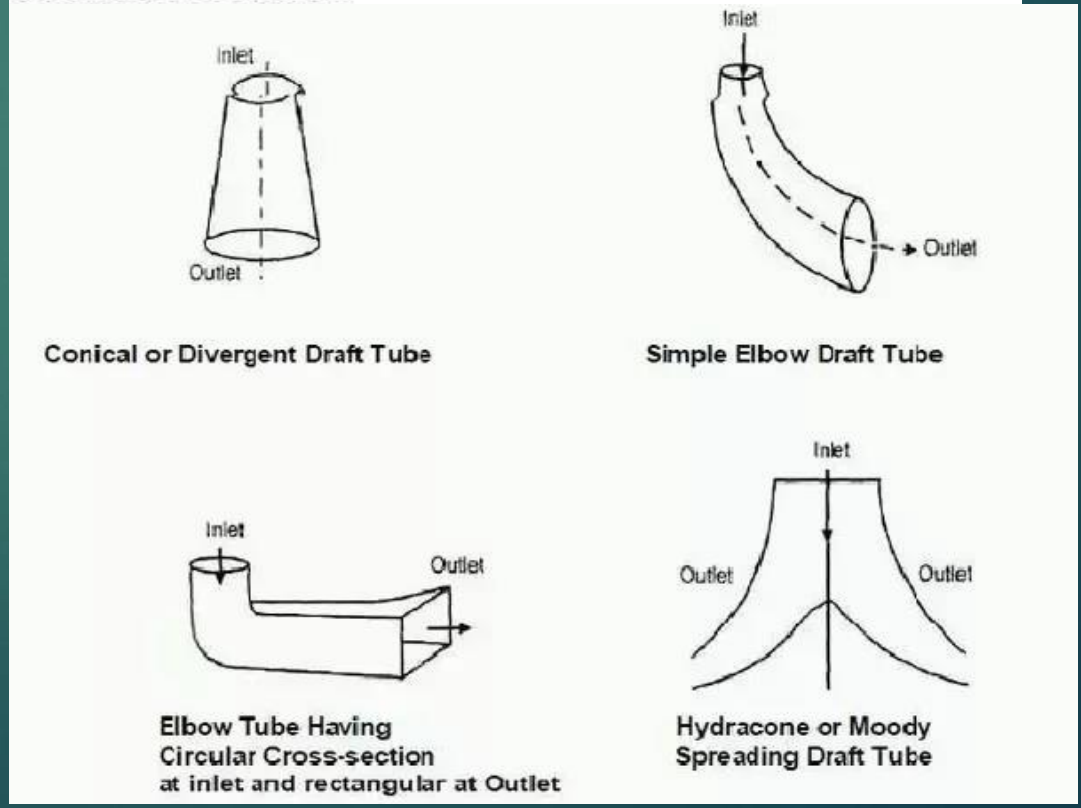
- This is a reaction type turbine in which water enters the turbine radially and leaves axially
- A spiral casing houses the turbine with guide vanes
- This is done so that water can enter the runner at constant velocity throughout the periphery and without shock at inlet
- A draft tube or pipe with gradually increasing area that serves to discharge water at the tailrace
- In Francis turbine the pressure of water at inlet is more than the pressure of water at outlet



Francis Turbine

- The pressure of water at outlet is generally less than atmospheric pressure
- If draft tube is not used reverse flow o water will take place and the runner will get damaged due to cavitation
- A draft tube therefore increasing the pressure at outlet by converting the rejected kinetic energy into pressure energy
- It also establishes negative head at the outlet which allows the turbine to be placed above tail race without appreciable loss in head

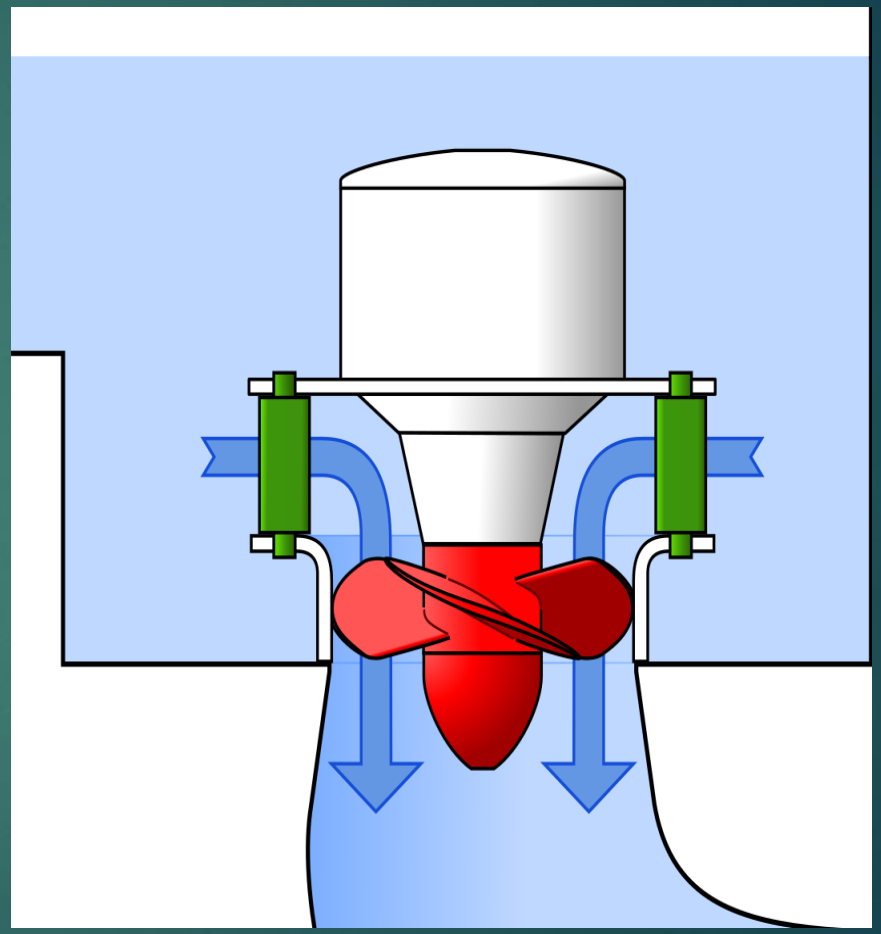




Prepared by Er. Bibek Dahal

Propeller and Kaplan

- These turbines are similar in construction to Francis turbine
- The casing, stay rings and draft tube are also present which perform the same function
- But the water flows in axial direction
- The runners of these turbines resemble a screw or a propeller
- The lower end of the shaft is made large which is known as ‘hub’ or ‘boss’



Propeller and Kaplan

- In propeller turbines the vanes are fixed to the hub whereas in Kaplan turbines, they are adjustable
- These turbines are employed when large quantity of water is available with low head
- Kaplan turbines have high efficiency of 50% underload to 50% overload
- The number of blades range from 3 to 8 (12 to 22 in Francis)
- So friction loss is lesser than that of Francis turbine

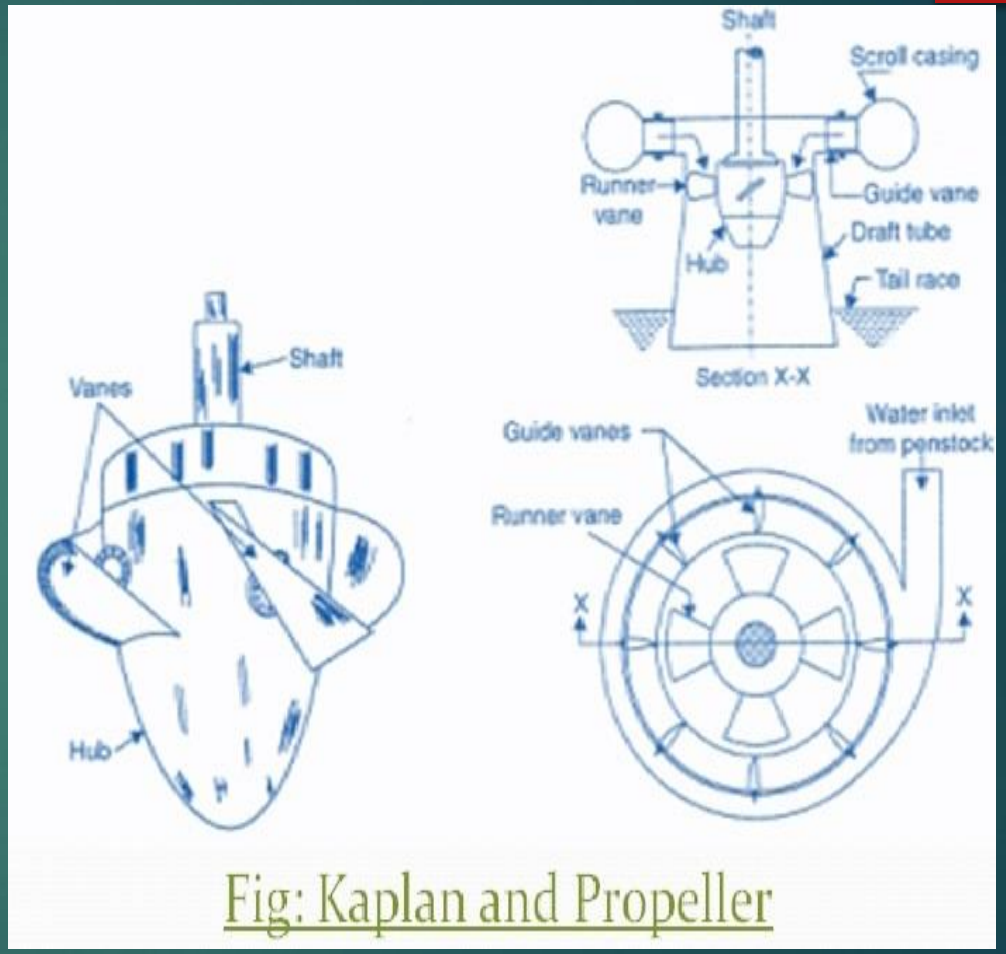
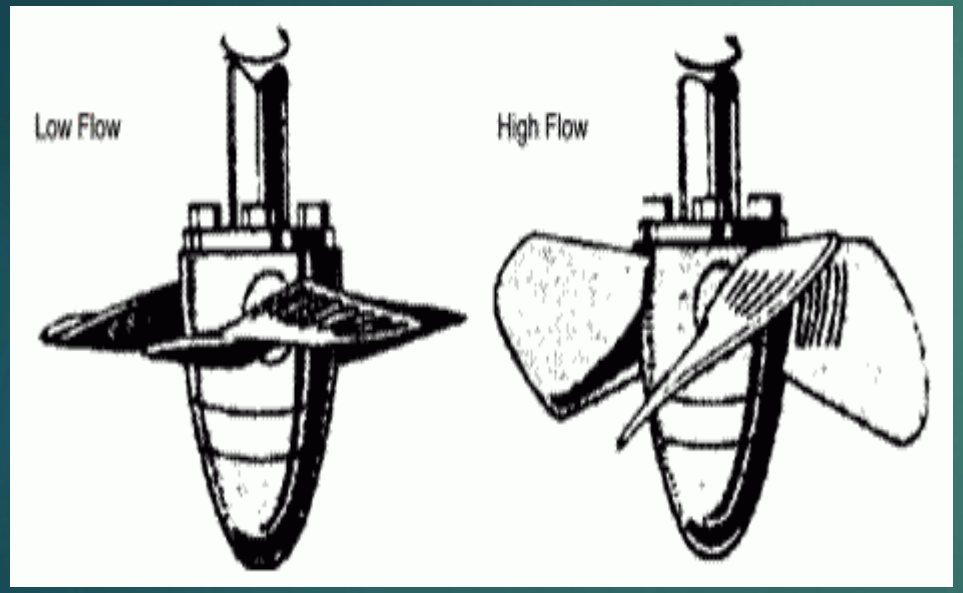


Fig: Kaplan and Propeller

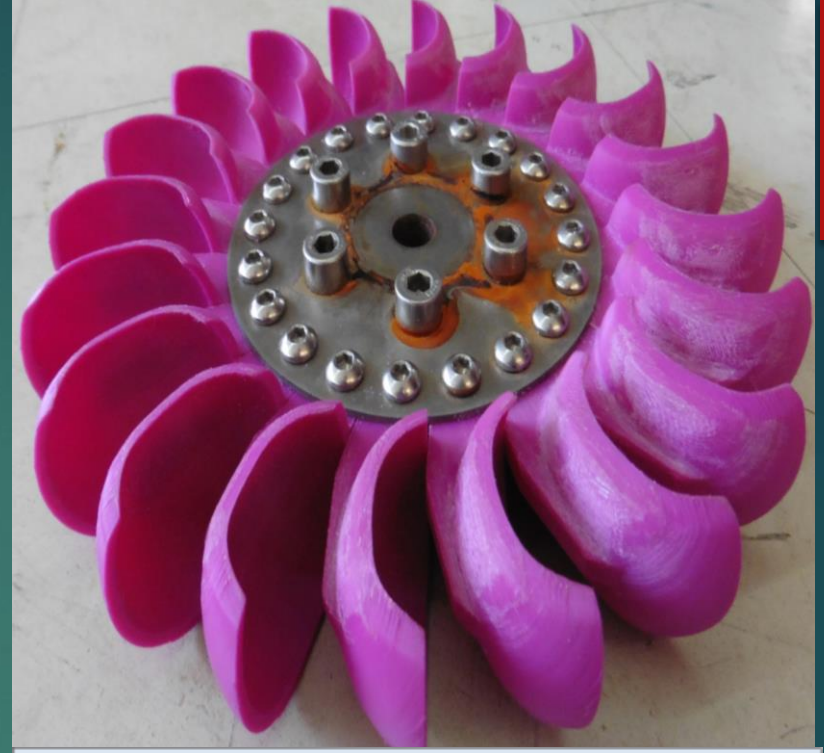
Propeller and Kaplan

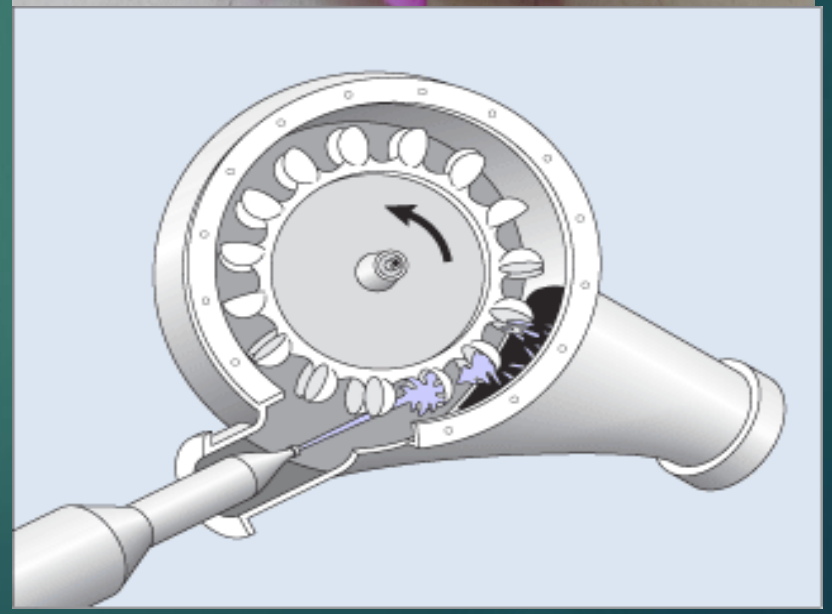


Prepared by Er. Bibek Dahal

Turgo Turbines

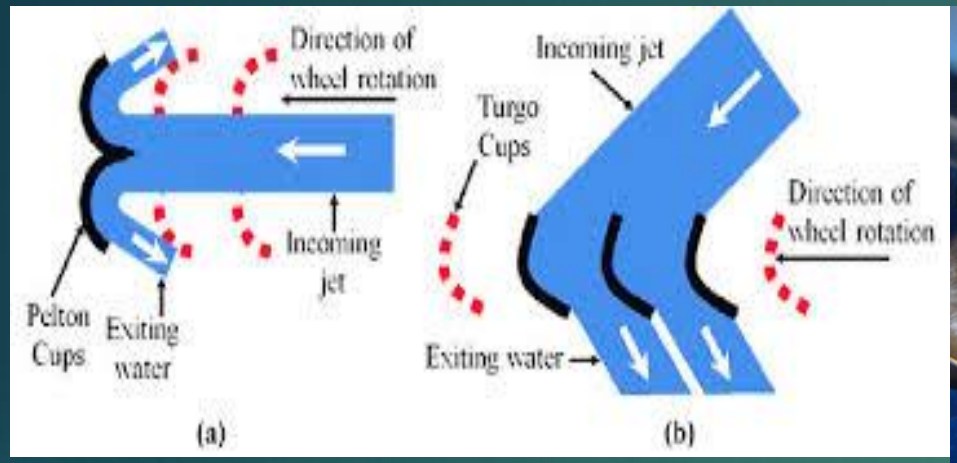
- The Turgo turbine is similar to the Pelton Turbine
- but the jet strikes the plane of the runner at an angle (typically 20 to 25 degree)
- The lead to water entering runner on the one side and exits on the other
- Therefore the flow rate is not limited by the discharged fluid interfering with the incoming jet (as in the case with Pelton)
- As a consequence, a Turgo turbine can have a smaller diameter runner and rotate faster than a Pelton turbine for equivalent flow rate
- The Turgo Turbine is an impulse water turbine designed for medium head application
- In factory and lab tests, Turgo Turbines perform with efficiencies of up to 90%
- These turbines have complex blade design but greater flow possibilities

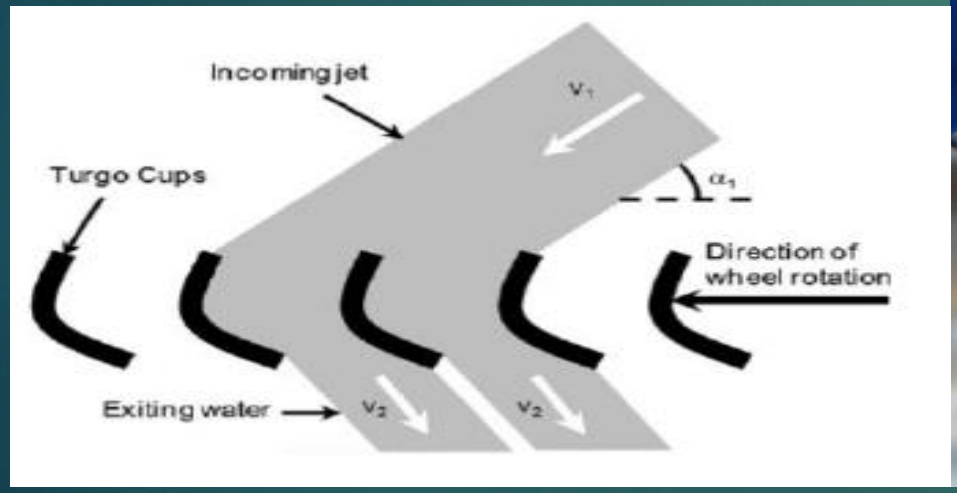


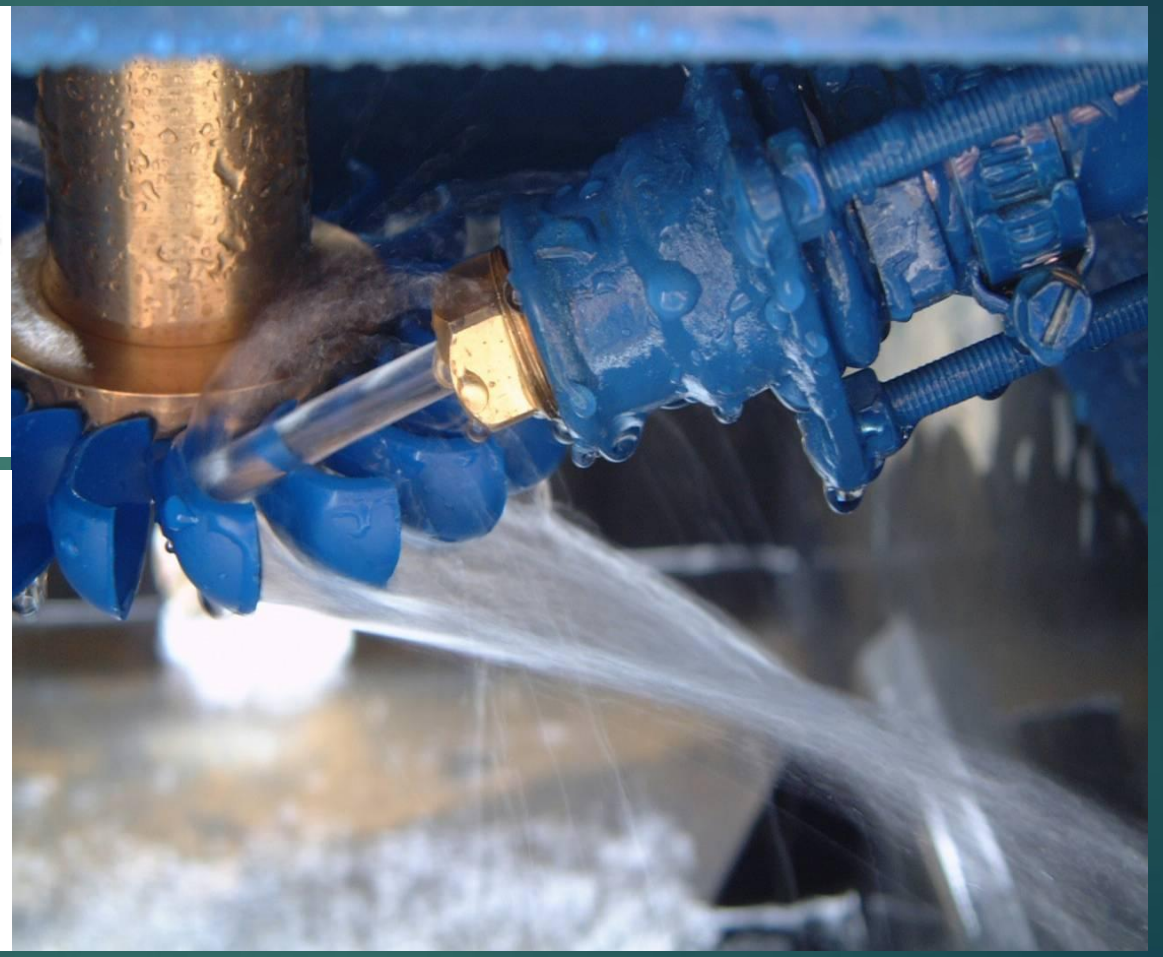


Prepared by Er. Bibek Dahal

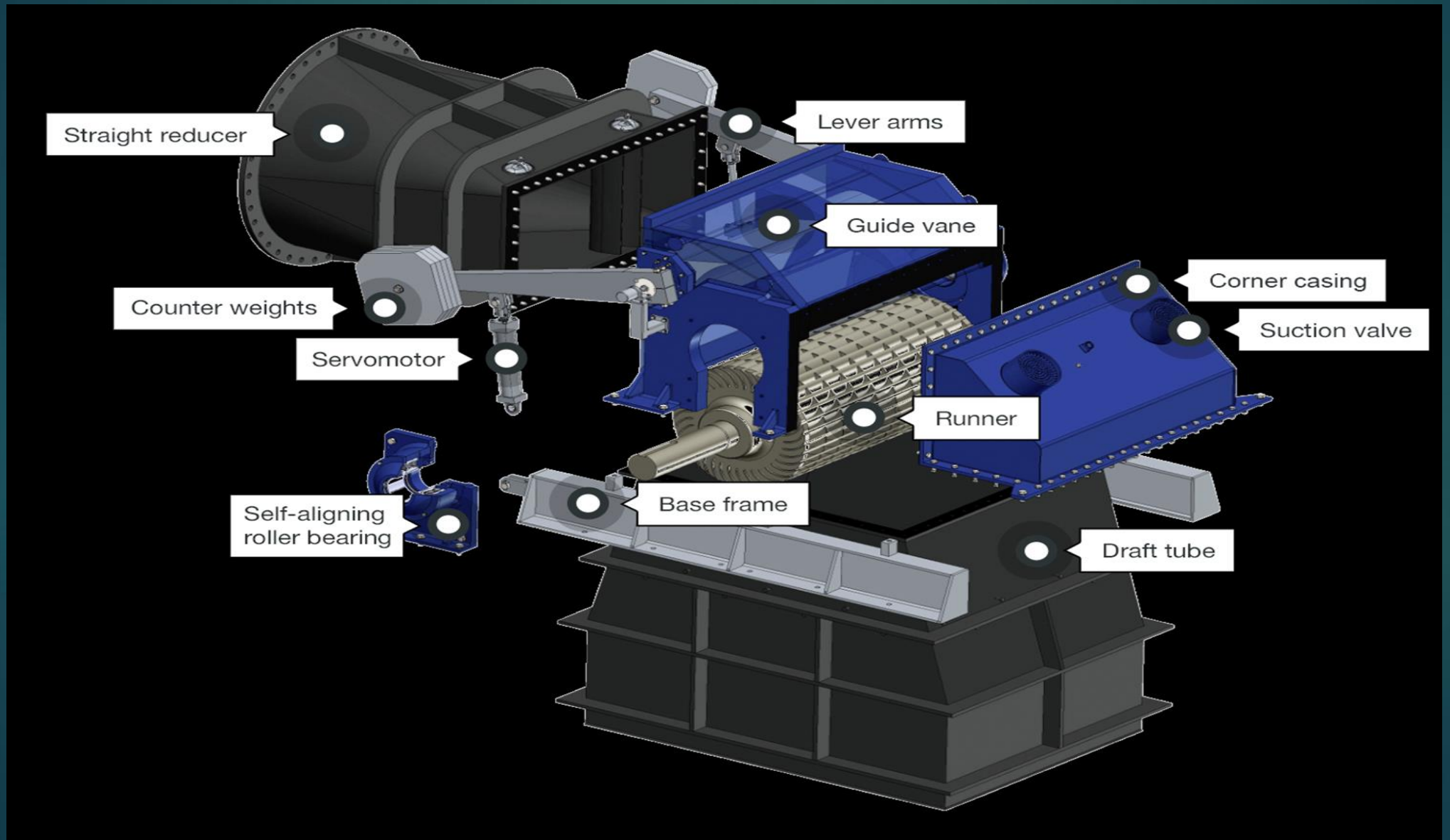
Turgo Turbine







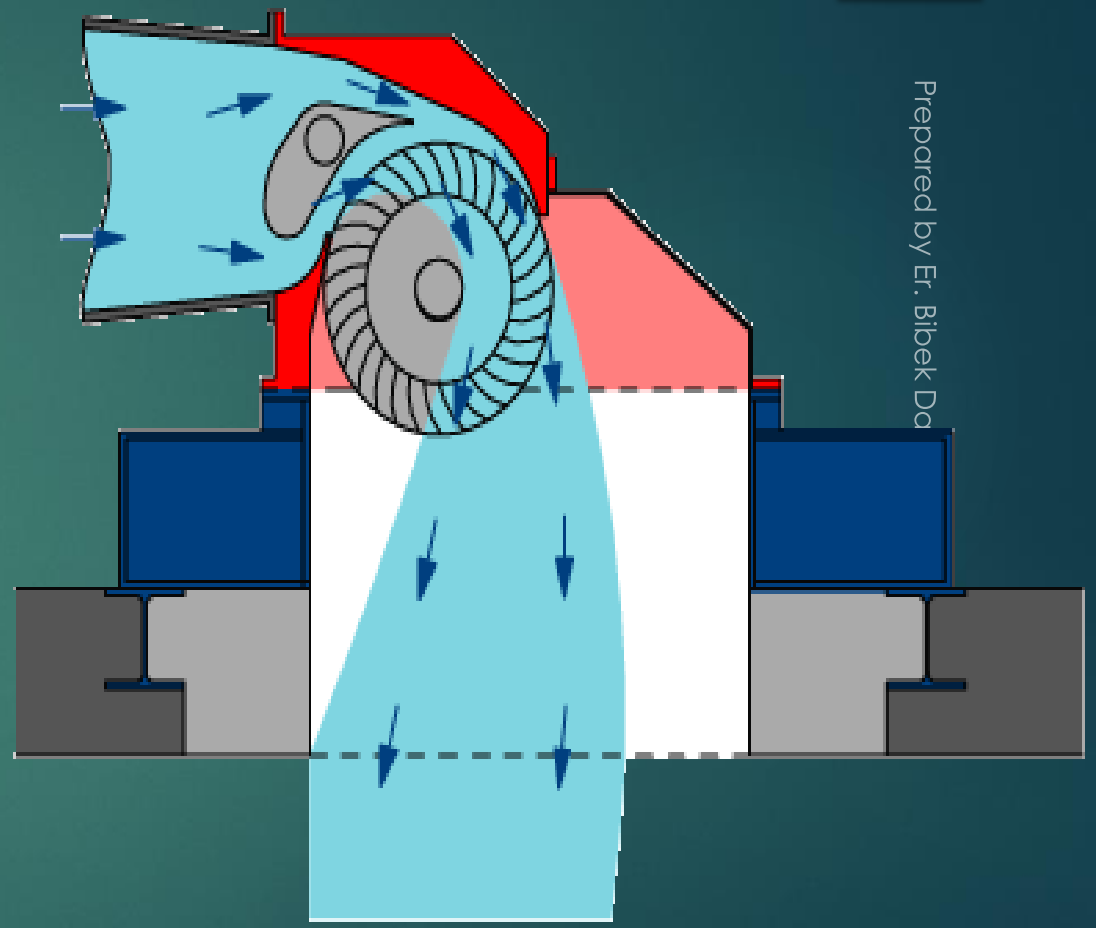
Crossflow Turbine



Prepared by Er. Bibek Dahal

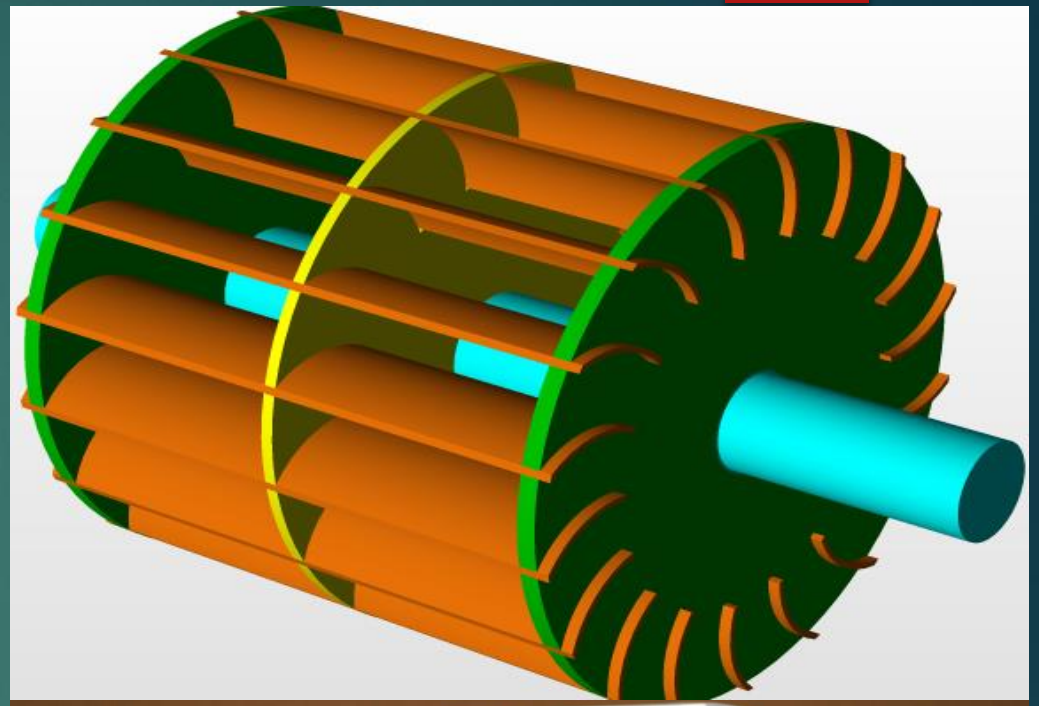
Crossflow Turbine

- Crossflow turbines are also known as Banki/ Mitchell/ Ossberger Turbine
- A crossflow turbine is drum shaped and uses a rectangular section nozzle directed against curved vanes on a cylindrically shaped runner
- The crossflow turbine allows the water to flow through the blades twice
- In the first pass, the water flows from the outside of the blades to the inside and the second pass is from the inside to the outside
- A guide vane at the entrance to the turbine directs the flow to a limited portion of the runner

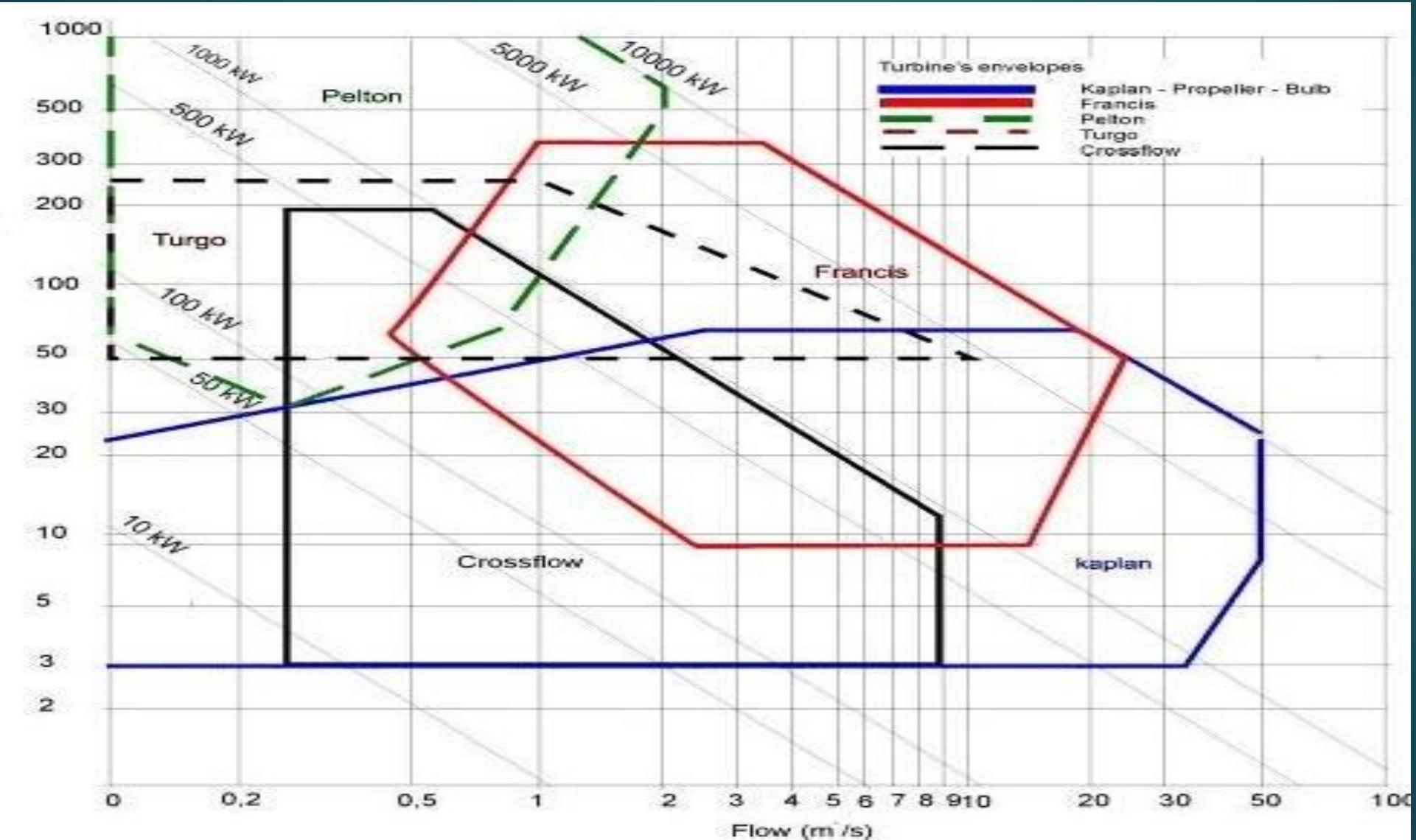


Crossflow Turbine

- Crossflow turbines gets their name from the way the water flows through or more correctly across the rotor as shown in figure (hence across flow or crossflow)
- The water flows over and under the inlet guide vane which directs flow to ensure that the water hits the runner blades at the correct angle for maximum efficiency
- The water then flows over the upper runner blades producing more torque on the runner
- Most of the power is extracted by the upper blades (roughly 75%) and the remaining 25% by the lower blades
- Obviously the runner is rotating, so what are the upper blades one moment will be the lower blades the next

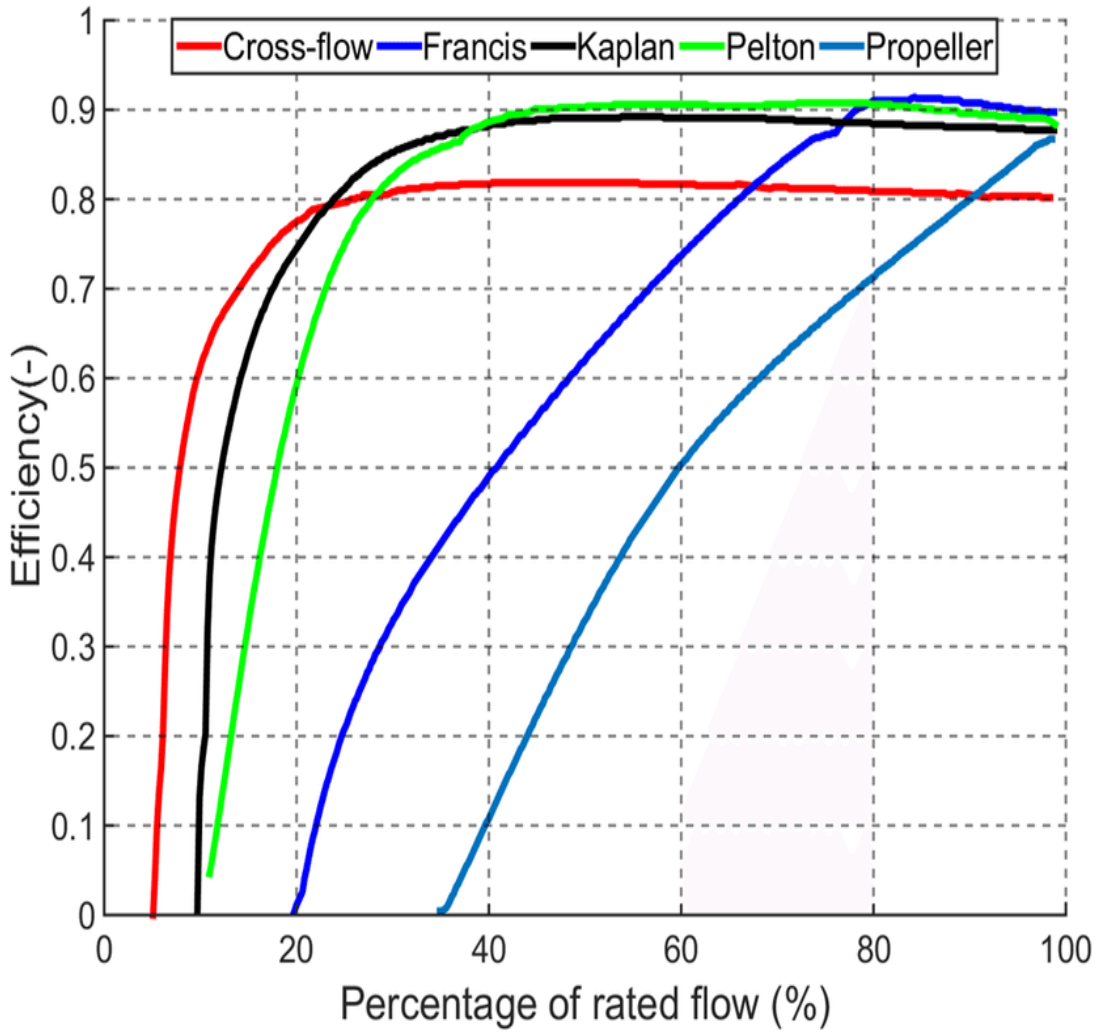


Turbine Selection Chart

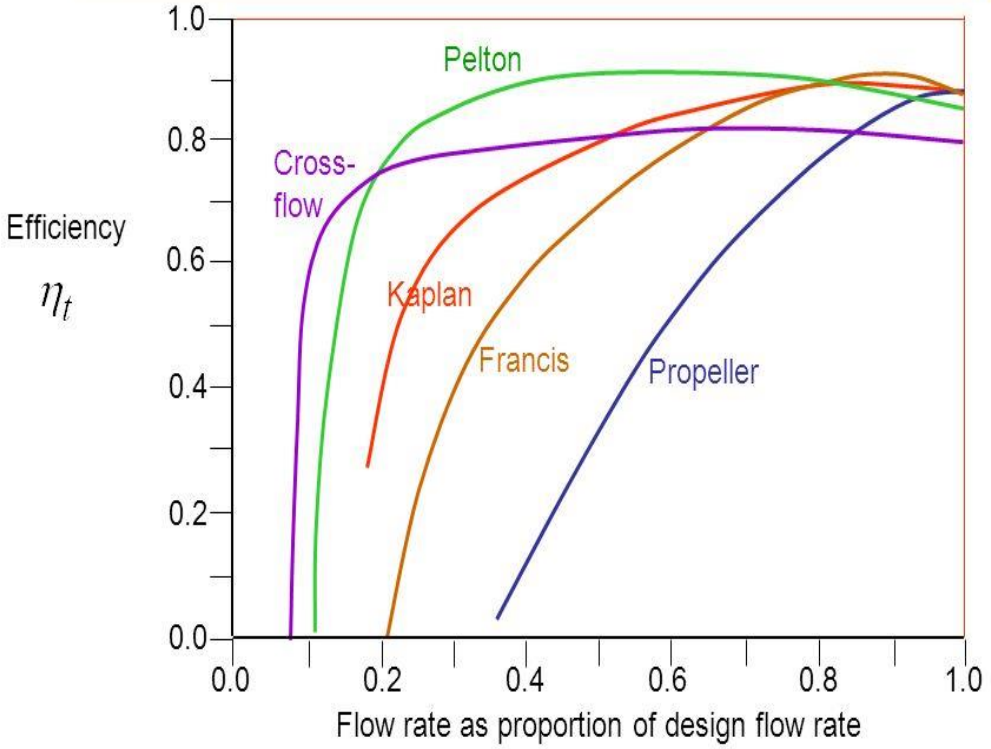


Prepared by Er. Bibek Dahal

Turbine Efficiency Curve



Maximum and minimum turbine flow rates to be decided based on turbine size and efficiency curve.



Part-flow efficiency of small hydraulic turbines

Prepared by Er. Bibek Dahal

Turbine Selection Based on Head

Turbine	High Head (>200m)	Medium Head (30-40m)	Low Head (<30m)
Impulse Turbine	Pelton (sp. Speed (0-50) Turgo	Cross flow, Turgo, Multijet Pelton	Cross flow
Reaction turbine		Francis (sp. Speed 60-300)	Propeller, Kaplan sp. Speed (300-1000)

Prepared by Er. Bibek Dahal

Turbines for MHP

- Normally impulse turbine are used for micro hydro due to following advantages
  - They are more tolerant of sand and other particles in the water
  - Provides better access to working parts
  - They are easier to fabricate and maintain
  - They are less subject to cavitation (although high head cause high velocity which can cause cavitation at the nozzle or the blades or the buckets)
  - They have flattery efficiency curves if a flow control device is built in

Thank You