Impulse Turbine

Quite a number of impulse turbine are produced. The mains are:

- Pelton turbine/Peltric set
- Cross-flow turbine

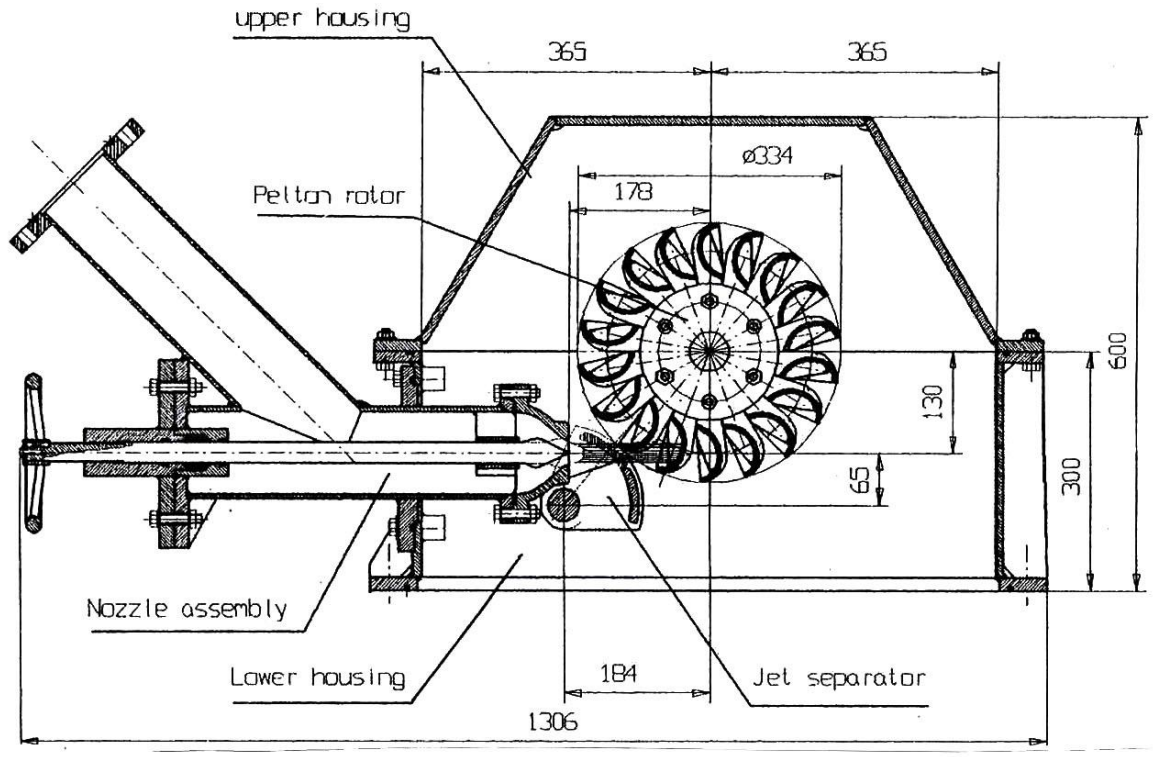


Fig. 4.1.1 Pelton Turbine (n_s = 8 to 72) (Single jet with horizontal shaft)

4.1.2.1.1 (Pelton Turbine)

A Pelton turbine is mostly suitable for the sites having relatively high head and low discharge. It is fully free jet turbine. The water jet hits the rotor bucket and the bucket are made in such a way that the middle ridge (splitter edge) divides the free jet into two equal parts and the jet are reversed by almost 165 degree to obtain maximum possible efficiency. The turbine must be placed above the tailrace canal as cross-flow to avoid the watering of the runner. Needle valve is placed at the nozzle to control flow system of this turbine. In this turbine a device called jet separator or jet deflector is used to divert the water jet to tail race pit instead of runner. The device is actuated quickly first in the cases of emergency shut down and then slowly needle valve is

operated so that water hammer (pressure waves) is minimized to the safe limit in the pressure pipe.

- One of the example of Pelton Turbine is "Peltric Set" which being manufactured in Nepal by Nepalese manufacturer and produced in quite a number is used for a lower output

- Range of 0.5 kW - 5 kW. Where as it is well known that Pelton is almost first priority, if site permits for Mega plants as well.

- The other example of Impulse being "Turgo" is also used commonly.

- The main advantage of the pelton turbine is that it can be installed with horizontal shaft as well as with vertical shaft and it can be managed with multi-jet system, which is better for installation where flow varies in different seasons. However, the efficiency of the turbine remains same whether it operates with single jet or multiple jets. The turbine is recommended up to three jets with horizontal shaft and six jets with vertical shaft. Generally pelton turbine shaft is coupled directly to the generator shaft.

- Pelton turbine rotor diameter can vary from 150 mm to 600 mm for MHP. Commonly available standard rotor diameter is 150, 175, 200, 250, 300, 400 mm.

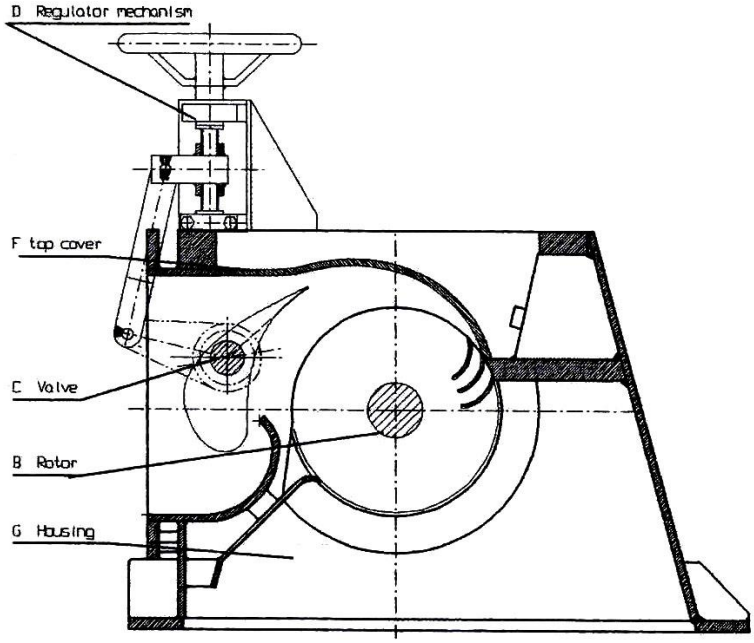
- In case, the speed of the rotor shaft becomes undesirable then the turbine can be selected with bigger or smaller rotor diameter from standard series. A custom designed turbine is required to get the desired speed.

- Cavitations problem is less than compared to reaction turbines.

Cross flow turbine

The third example of Impulse being "Crossflow" commonly manufacture and used in Nepal have the field of application within output range 15 kW - 250 kW.

The following is the model of BYS SKAT T- 12 crossflow turbine. This turbine is partially free jet type. The main feature of the crossflow is rectangular cross-section of water jet.



Crossflow Turbine (Specific speed n_s = 42 to 170)

- Cross flow is designed such that the streamline of the flow enters the rotor with the correct velocity and entrance angle. The curves of the blades are arranged at the periphery of the cylindrical rotor in such a way that the flow passes twice through rotor blades. First successive entry of water through cascade (first stage) of the blades, the flow still possesses a considerable amount of energy. That water inside the rotor (in a centrifugal flow) strike one more time to the blades while it comes out from cascade (second stage) of the blades of the rotor gives up around one third of energy.

- Crossflow are always installed horizontally only.

- Crossflow can be installed at sites where head ranges from 4m to 100m, with the flow ranges from 50 l/s to 800 l/s. Same model of turbine can be installed without varying the rotor diameter for the different head and flow rates. But inlet width known as "bo" varies for different flow rates.

- Cross-flow turbine rotor diameter varies from 200mm to 800mm for MHP. Commonly available standard rotor diameter is 200, 250, 300, 360, 400 mm.

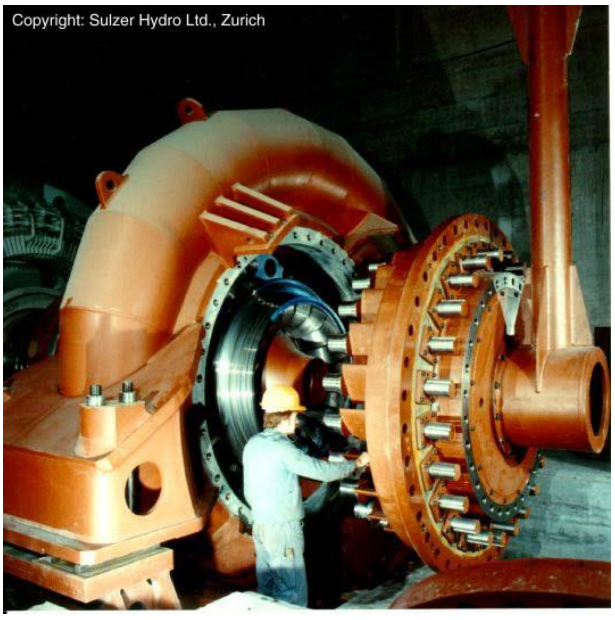
- In general, the cross flow turbine is used in low range of power plant. Basically, it is used for sites where the head is low and flow is medium whereas for low head site, the turbine needs larger rotor diameter resulting the lower rotor speed. So, the required speed is to be adjusted by adding suitable transmission system (gearbox, belts, chains etc.).

- In case of shaft speed of the standard turbine becomes unsuitable or unmatched with generator speed, it is customary to design the turbine particularly to that site (custom design) to match the speed of the generator.

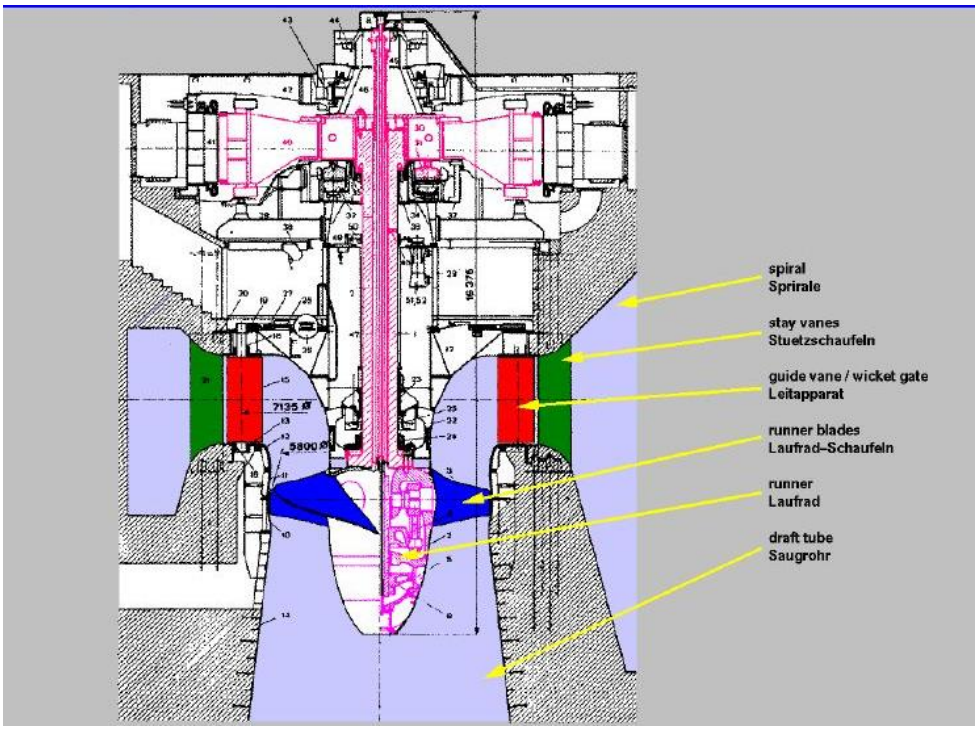
- The rotor should always be above the tailrace water level to rotate freely at atmospheric pressure.

Reaction Turbine

In reaction turbine, rotor completely submerged in water and the rotor rotates under the pressure. Draft tube is an integral part of the reaction turbine fitted at outlet.



Francis Turbine (Specific speed n_s = 60 to 350)



Kaplan / Propeller Turbine (Specific speed n_s = 270 to 1000)

Selection of turbine

Turbine should be selected according to the site condition. Selected turbine should be appropriate to the available head and flow. In Micro Hydro Project (MHP) mainly Cross flow is widely used. This turbine is feasible where head will be available from 4m to 100m and discharge available from 50 l/s to above 800 l/s.

Production of the various types of turbine depends upon the manufacturer capability and workshop facility. There are many turbine manufacturers, and produce different models with different efficiency and characters.

Particular speed of turbine rotor at which it performs best is called its optimum speed. The turbine needs to be operated at this speed at all loading conditions to get the maximum output.

Selection of the turbine depends upon the different factors such as:

- Power plant size

- Required efficiency of the turbine
- Cost of the turbine/ equipment or project
- Turbine locally manufactured or imported

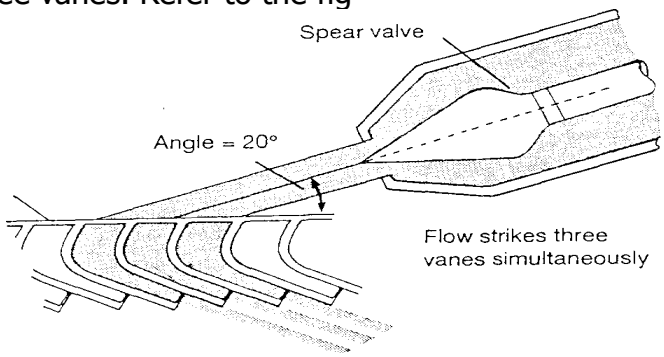
Characteristics (Reaction):

- ????? (Self Searching) Homework

22

Turgo Turbines

- It is an impulse turbine whose components are similar to the Pelton turbine.
- The only difference is that the jet strikes the plane of the runner on one side (usually at 20 degree) and exists on the other.
- In turgo turbine, water jet strikes simultaneously three vanes. Refer to the fig



Syllabus

Micro/Mini Hydropower System

Site Investigation

Determation of Flow

Construction and operation of different types of water turbines within the range of micro and small hydro power systems

Characteristics of turbine uses for micro and small hydro power plant (detail in Hydro Machine/ Fluid Machine)