FLUID FACILITIES AND MACHINERY

GUIDE TO LABORATORY PRACTICALS

University of the Basque Country (UPV/EHU)

Energy Engineering Department

THEME 3: PELTON TURBINE

1. REQUIRED BACKGROUND KNOWLEDGE

Fluid Mechanics.

Hydraulic Machinery. Turbomachinery. Turbines.

2. PRE-LABORATORY

Detailed reading of the description of the practical for its completion within 1 [h]. See Video of P3.

3. OBJECTIVES

To calculate and to demonstrate the operation of an impulse turbine:

- Visual analysis of the operation of an impulse turbine.
- Experimental determination of the efficiency curves of an impulse turbine.
- Reading to gain an understanding of the parameters to take into account when selecting, designing, and optimizing the operation of an impulse turbine.

4. THEORETICAL FOUNDATION

The Pelton turbine is an impulse turbine that channels water by means of an injector towards a set of turbine blades mounted on a rotor. The injector is specifically designed to regulate the flow of water at the desired rate. In this way, the available energy at the inlet of the injector is basically pressure energy, which will be transformed entirely into kinetic energy as it passes through that component, before entering into contact with the blades of the runner. As long as the water is at atmospheric pressure when exiting the injector, the force it applies on the rotor will be due to variation in the direction of the water flow.

The features or the points of operation of a Pelton turbine can be shown by means of the following curves (Figure 10):

1. Mechanical torque in terms of the rotation speed: $C_m = C_m\,(N)$
2. Mechanical power in terms of the rotation speed: $P_m = P_m\,(N)$
3. Efficiency in terms of the rotation speed: $\eta = \eta\,(N)$

These curves will change according to the injector nozzle opening or closure setting.

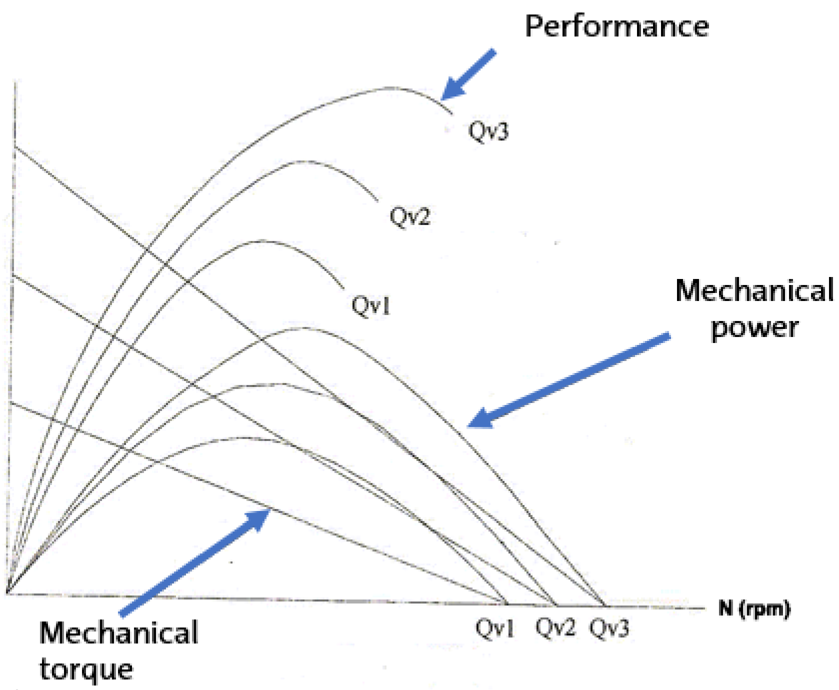

Figure 10: *Graphical representation of the characteristic curves of the Pelton turbine for a constant net head (H_n) and 3 injector closure levels (x).*

As shown in Figure 10, the mechanical power and the efficiency values reach maximums and then decrease. Turbines usually work and transform energy at constant rotation speeds. They therefore need to be carefully designed, in order to yield maximum efficiencies at those rotation speeds.

The characteristic parameters that define the operation of a turbine are as follows:

- Flow rate (Q)
- Net head (H_n)
- Hydraulic power (P_h)
- Mechanical torque (C_m)
- Mechanical power (P_m)
- Efficiency (η)

5. DESCRIPTION OF EQUIPMENT AND FACILITY

The Fluid Mechanics laboratory is equipped with a Pelton turbine mounted on a multifunctional Armfield hydraulic bench (Figure 11).

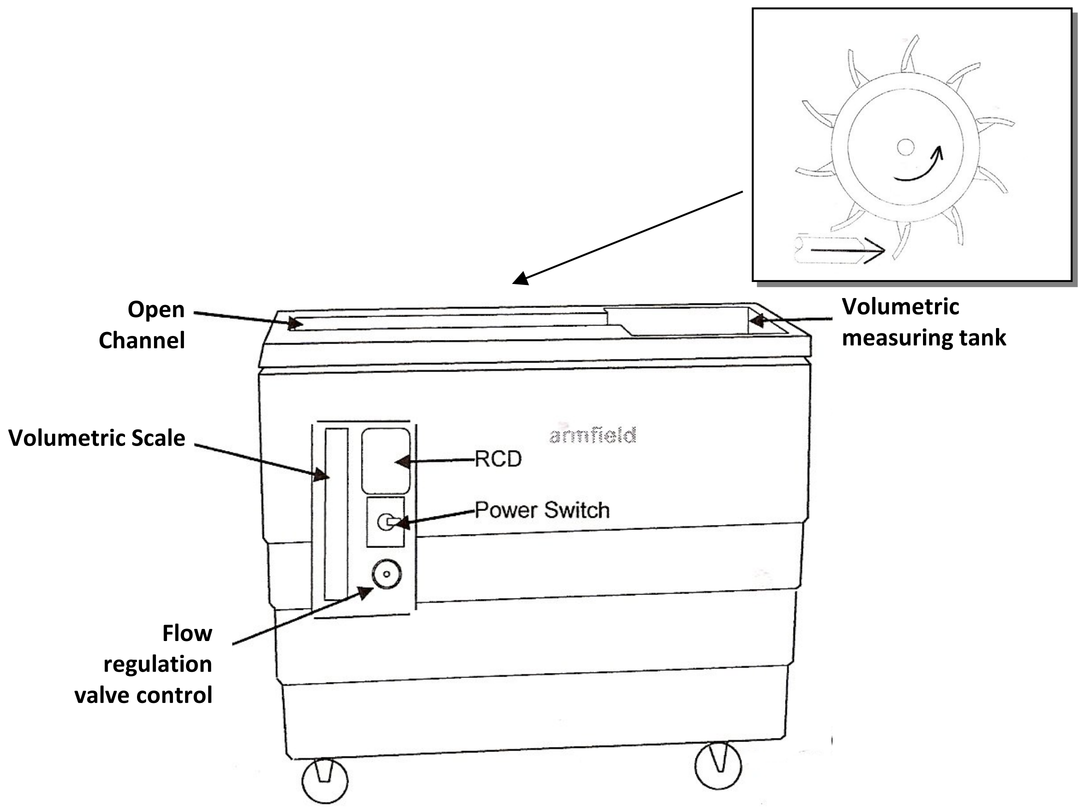

Figure 11: *Armfield hydraulic bench.*

The hydraulic bench has water in its lower part that is pumped up to the injector. A water jet leaves the injector with a preset kinetic energy and flow rate to collide on the blades of the Pelton runner (Figure 12).

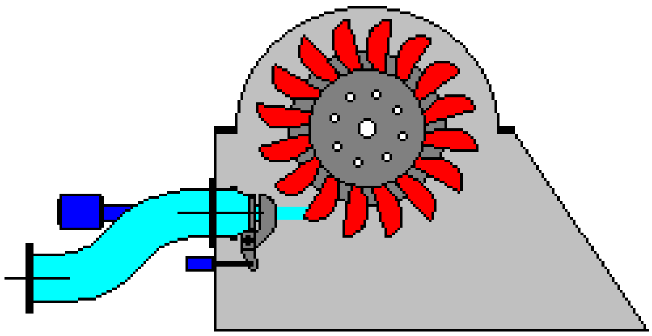

Figure 12: *Scheme of the Pelton runner and the injector.*

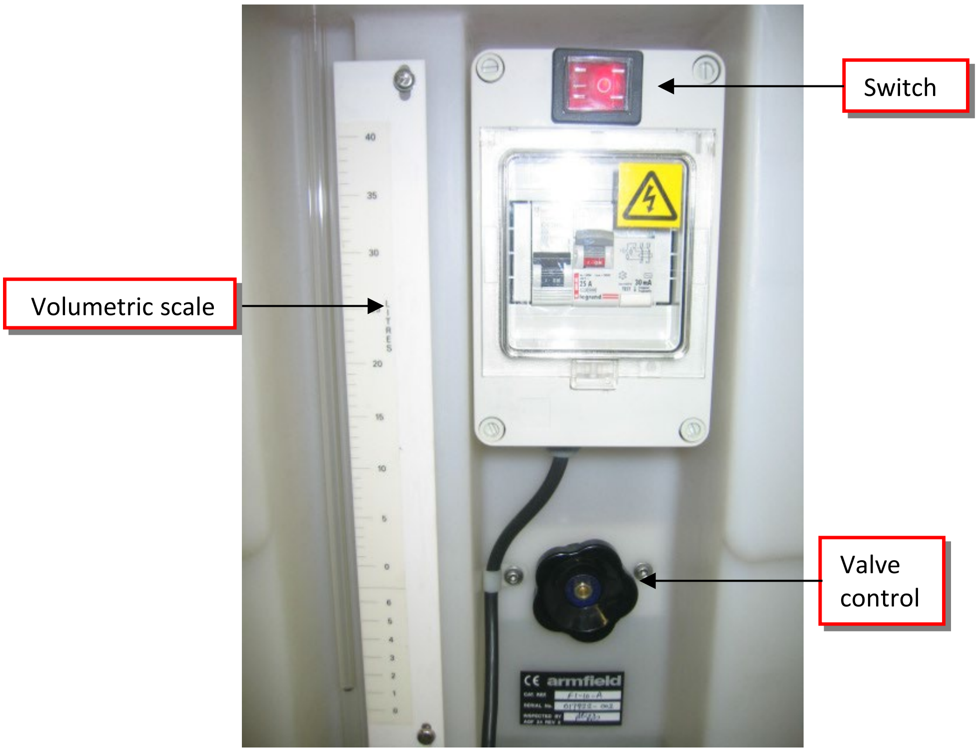

Figure 13: *Volumetric scale, water feed valve and switch.*

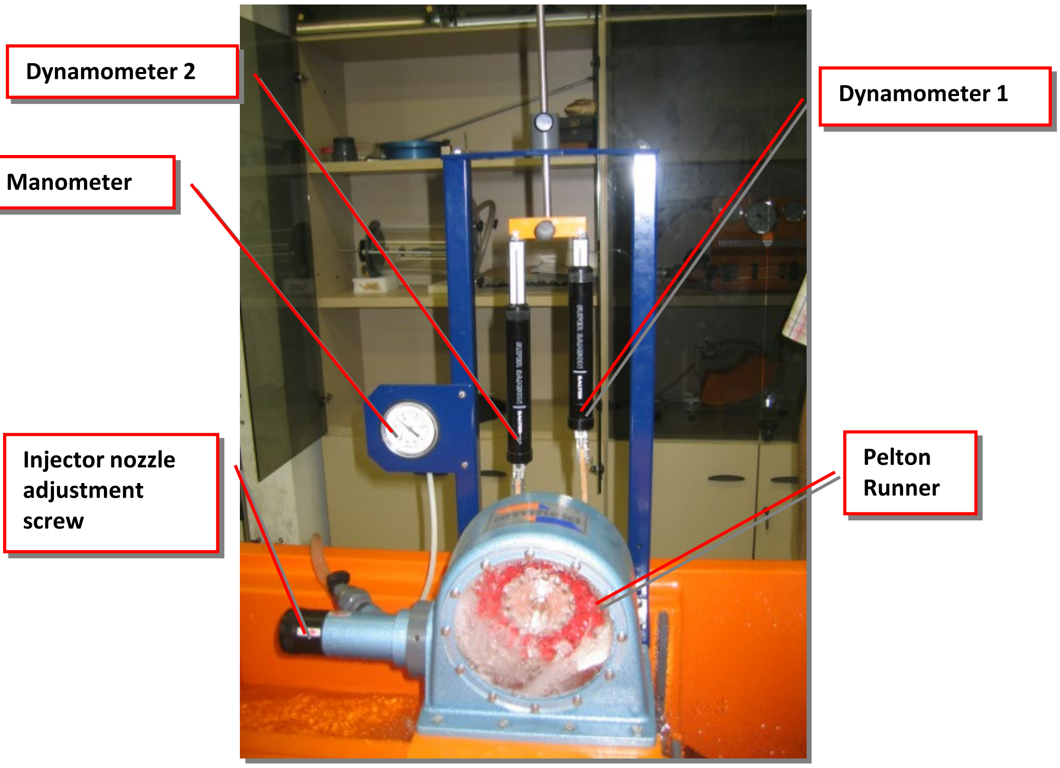

Figure 14: *Pelton turbine set up.*