Department of Water Resources & Environmental Engineering, NTUA

Μάθημα: Renewable Energy & Hydroelectric Works

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Exercise 1: Assessment of characteristic design quantities of a hydroelectric system

We plan to exploit the hydrodynamic potential of a river site, with mean annual inflow of 13.5 m^3/s, by building a dam, in order to formulate a reservoir of over-annual regulation, a hydropower station. The minimum and maximum operation level of the reservoir are +420 and +460 m, respectively. Th water will be transferred to the power plant via a steel penstock of 1800 m length and 2.5 m diameter. After passing through the turbines, the water will return to the river course, at an elevation of +240 m.

The environmental impacts assessment study has determined the maintenance of an ecological flow of 1.5 m^3/s in continuous basis, to be released through an independent outflow pipe just downstream of the dam, without passing from the turbines. Finally, according to the electromechanical study, the total efficiency of the system (turbines, generator, transformer) will be up to 0.85.

1. For the given hydrological and topographical characteristics, estimate the theoretical hydrodynamic potential of the system and the appropriate type of turbines.

2. After considering three alternative annual operation schedules for the power station (8000, 4000 και 2000 h), estimate**:**

- the design discharge of the system;
- the mean annual generation of electric energy;
- the nominal capacity of the power station;
- the capacity factor of the system.

3. For each of the three operation schedules, plot the friction slope, the net head, the annual energy production and the associated power capacity of the turbines, as function of the penstock diameter. In the respect, consider alternative diameter values within range 1.0 to 4.0 m, using a step of 10 cm.

Recommendations: Within hydraulic calculations, assume an equivalent roughness coefficient of 1.0 mm and a compound local loss factor of 1.50.