Micro-hydropower Project of monfleury

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The site is located in Tunis next to an administrative building of SONEDE in Montfleury.
The Montfleury Microhydropower Project
The drinking water network of the capital Tunis

Ghdir el Golla treatment plant

Reservoir of monfleury
simplified diagram of the southern branch supplying the tank of Montfleury

Station de traitement

Réservoir de tête de Ghedir el golla

15 km

Branche Sud (30 km)

15 km

piquage Montfleury (1 km)

BC

Réservoir Bir Kassaa

Réservoir Montfleury
Dissipation of hydraulic energy at the Montfleury reservoir

- Regulate the flow of the upstream pipe
- Dissipate the excess of pressure
The study of the project
Flow data
The hydrological analysis of measurement data taken every 15 minutes over four (04) years has shown the following characteristics:
- Average flow: 141 l/s
- Maximum flow: 157 l/s
- Minimum flow: 111 l/s (overflow > 99.5%)
The residual pressure at the Montfleury reservoir depends mainly on:

- The geodetic difference between GEG and Montfleury
- The pressure losses on the main pipe (depend on the flow of the main pipe).

The pressure losses caused by the flow of the Montfleury reservoir have only a limited influence.

A continuous measurement of residual pressure gives the following results: between 35.5m and 45.0m
Which turbine to choose?

Two solutions are possible:

• a conventional hydraulic turbine,
  • Francis,
  • cross-flow

• a pump as turbine: PAT

PAT offers the right solution in terms of investment cost and simplicity of operation and maintenance,
Range of use of PAT?

![Diagram showing the range of use of PAT with different types of pumps and power ratings.](image-url)

- **Ring-section pumps**
- **Volute casing pumps**
- **Single entry**
- **Double entry**

Several pumps operating in parallel:
- \( P = 750 \text{ kW} \)
- \( P = 500 \text{ kW} \)
- \( P = 200 \text{ kW} \)
- \( P = 100 \text{ kW} \)
- \( P = 50 \text{ kW} \)
- \( P = 25 \text{ kW} \)
- \( P = 10 \text{ kW} \)
- \( P = 5 \text{ kW} \)

Flow rate \( Q \text{ (l/s)} \):
- \( 2000 \)
- \( 1000 \)
- \( 600 \)
- \( 400 \)
- \( 200 \)
- \( 100 \)
- \( 50 \)
- \( 20 \)
- \( 10 \)

Head \( H_1 \text{ (m)} \):
- \( 300 \)
- \( 200 \)
- \( 100 \)
- \( 80 \)
- \( 60 \)
- \( 40 \)
- \( 30 \)
- \( 20 \)
- \( 10 \)
Turbine regulation

The rotational speed of the turbine will be regulated to recover the maximum energy over the entire flow range, using a regenerative frequency drive (4-quadrant drive) coupled to a cage asynchronous generator.

**Advantage:**
The FD allows to value more hydraulic energy and manage the Operation and the connection to the power grid.
It also provides the necessary protections against the electrical faults.
The necessary protections

In case of disconnection from the electric grid:

- rapid increase of the speed of the turbine (runaway of the turbine generator group)
- water hammer

Necessary protections against these phenomena:

flywheel (9) and bypass valve (2) isolation valve (5)
Main components of the microhydroelectric project

1. and 10. Motorized valve
2. Differential pressure sensor
3. Pressure sensor
4. Speed sensor
5. Turbine-generator with flywheel
6. Water level sensor
7. Pressure reducer
8. Water level sensor (for flow calculation)
9. Measurement overflow
11, 12 and 13 valves
14 and 15. Flowmeter
16 and 17. Water level detectors
Economic evaluation

The economic calculations for the microhydropower project were carried out with the following assumptions:

- **PAT** of $160\text{ l/s}$ with net drop of $45\text{ m}$
- Efficiency of the turbine-generator-FD : $70\%$
- The power of the microhydropower project : $50\text{ kW}$
- The annual availability : $98\%$
- The production factor: $68\%$

The electric production: $300\text{ MWh}$ per year.

The necessary investment (150 thousand euros):
- hydroelectromechanical equipments
- measuring and regulating equipment
- control system

Return of investment time : **6 years.** (lifetime : minimum 20 year)
Investments in micro-hydropower projects on drinking water systems are considered profitable with a relatively low cost per kWh produced. This is due to:

- the high load factor of turbines installed on drinking water pipes,
- the existence of civil engineering building ready to accommodate the turbines.

Several pressure reducers at SONEDE can be replaced by micro-hydropower (Identification of hydropower potential of: 4MW)

For this purpose, SONEDE will launch tenders for the installation of other micro-hydropower plant.

This example can be applied in drinking water and sanitation companies in the MENA region and in Africa