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Energy recovery from the treatment water plant of Lakhdaria for electricity production

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ABSTRACT/RESUME

Abstract: *The water that reaches our taps follows a path represented by the pipelines. It must be supplied with energy so that it can circulate along the pipeline, which therefore creates a link between energy and water.*

Water treatment plants in Algeria consume electrical energy for its pumping and lighting systems.

The objective of this work is the study of feasibility of recovering energy at loads breezes which are generally installed on the field to break the water pressure to the reservoir. This gives an opportunity for innovation in the water sector, bringing water and energy without Co_2 *emissions and with inexhaustible energy and economic able to provide hydroelectric power almost continuously.*

I. Introduction

Algeria is experiencing a population growth and rapid development in urban planning. The continued demand for energy and water consumption is increasing. The energy bill of Algeria was multiplied by a factor of 2.5 in 10 years, rising from 20.5 in 2002 to 50.9 million TOE (tonnes of oil equivalent) in 2012. The energy consumption of only the water sector in 2011 amounted to 4983 GWhs. With an estimated cost of between 0.7 and 0.8 kWh / m3 is estimated that this consumption will reach 16,090 GWh in 2030, nearly three times that of 2011 [1]. Water networks in existing pipes are a vast hydroelectric potential, distributed and untapped. The energy recovery on these networks is a profitable investment with a very good environmental impact. And so that relatively recent research prospects are beginning to look at this small scale hydropower potential [2]. The work of this study is examining the possibility of exploiting the energy potential of water pipe flows that rise by gravity at reservoir and dam pumping stations. These are resources capable of producing hydroelectric power almost continuously. Indeed, the pressure measured at the arrival of these flows to treatment plants is important. It is usually controlled by valves or plugs that can dissipate its charge [2]. In the present case, the objective is to substitute the currently installed load breezes at the water treatment plant Taksebt Accerdoune, a suitable turbine facility that would convert the charge into electric energy instead of dissipating. Hydroelectric power produced will be inexhaustible, since water requirements are only increasing, and economic, as it may be self-consumed and enable the company to substantially reduce its energy bill. An evaluation of the hydroelectric potential existing at the level of the station and of the equipment suitable for its exploitation, constitutes a preliminary project for the design and the realization of a test bench on which one will be able to carry out simulations for the analysis of the performances, of a prototype turbine installation

II. Materials and methods

II.1. Hydraulic Energy

Water is vital to the human (60% of the body is formed). It is considered the first of renewable energy in the world. It stands out for its quality and ecologicalless expensive. It is available and easy to use. The high electricity relentless demand leads to increased consumption of fossil, which causes a detrimental effect on climate change *[3]*. The operation of conventional and non-conventional water depend on energy production. Indeed, electricity is mainly used for the operation of pumping stations and injection for drinking and industrial water (including desalination, irrigation water, sanitation and wastewater) [4]. The development of water infrastructure was a priority for Algeria to cope with droughts and floods in the recent decades, today the available water resources are already mobilized at a rate exceeding 75% [4].

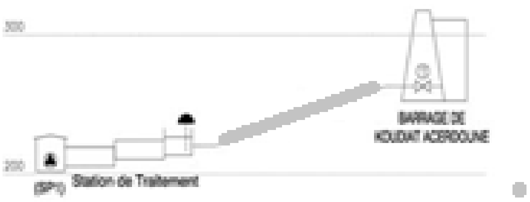


Figure 1.*Portion between processing station and barage Koudiat Acerdoune [6].*

.II.2. *Water Treatment Plant Koudiat Acerdoune*

The production of drinking water station Koudiat Acerdoune is administratively attached to the common djebahia (wilaya of Bouira) and is about 15.4 Km Koudiat Acerdoune Dam (capacity 640 m3 Million) It occupies an area of 28 hectares .
The plant is designed to supply nearly 1.5 million residents of the provinces of the center of the country with drinking water. It is considered the main water production infrastructure conventional feeding the wilaya of Bouira, Tizi-Ouzou, Medea and M'sila. The disc valves allow the breaking of the water load coming from the dam, and also to control the raw water flow entering the station [6].

II.3. Studu of potential site

To determine energy production, there are two main parameters: the height of the fall and the water flow [5].
The raw water is fed to the processing station through a pipe of nominal diameter 1800mm length of about 17 km, then by two DN 1000 pipes discharging water in an inflow chamber. Beyond this part, the water follows a single path.
The inlet structure is equipped with two air valves, upstream or is installed a flow meter per chamber (1 flow meter per valve) to calculate the raw water flow. This raw water flow will be based on the number of treated water pumps in service at the pumping station [6].
InIndeed, with the hydro on drinking water systems, a turbine positioned between the capture and the reservoir may play the same role as the disc valves while producing electricity. To determine the production of electricity, there are two main parameters: water and the waterfall height. Given this, it is very important to determine as precisely as possible the water flow and fall of water head.

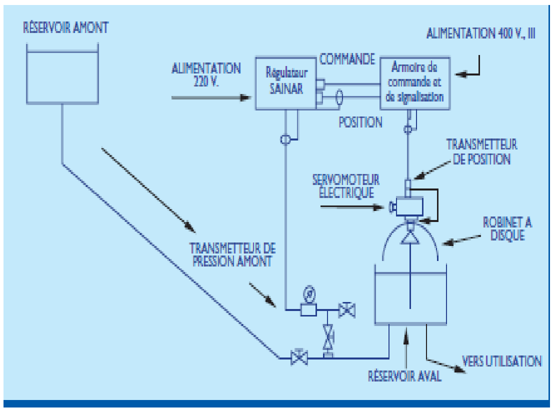


Figure 2.*Treatment plant [6].*

Figure 3.*Break load [6].*

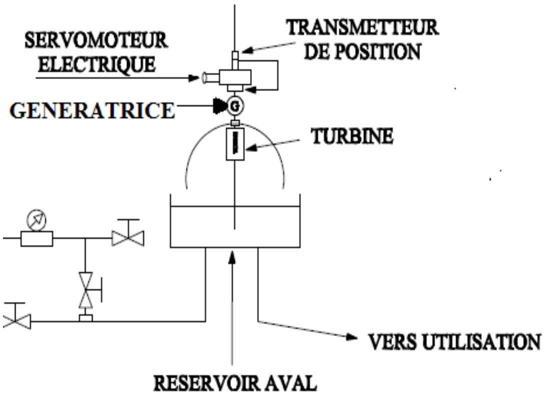


Figure 4.*Break load with turbine*

.II.4. Turbines

A turbine is a component of hydro that converts hydraulic power into mechanical power. It is rotated by the flow of water. There are two classes of turbines: turbines action as Pelton turbine and reaction turbines such as Kaplan turbines. Pelton turbines are used for high heights of up to 2000 m, Francis turbines up to 700 m and Kaplan turbines up to 40 [7]. Turbine operation depends on nominal flow and high drop [8].

III. Results and discussion

III.1. Evaluation and selection of the hydroelectric potential of the turbines

The installed power which expresses the effective power of development, it is defined by the following formula:

$$P_i = \rho g Q H_n \eta \textbf{(1)}$$

With g constant of gravity, ρ density of water, Q flow equipment, H_{NE} net head and η the efficiency. The best hydraulic turbines can have a efficient that varies between between 80% and 90%, this estimate decreases as the size of the turbine is reduced, therefore we speak of a return that varies between 70% and 80% for hydroelectric facilities under of 50Kw.
Considering the losses in the speed multiplier (box or speed belt drive if necessary) and that of the generator, there will be a return that varies between 60% and 80%. If we take 70% as a typical value of the performance of the entire system $g \approx 10\ m/s^2$ and $\rho = 10^3\ m3/kg$ Expression (1) becomes:

$$P = 7 \times Q \times H_n \textbf{ (2)}$$

To give P in KW.

III.2. *Selection of the turbine types for recovery of hydropower*

The use of turbines depends on the nominal flow of the sharp drop [9].

In this case, as shown in the graph in Figure (5) above, the turbine that is suitable for the application must be a Francis or Kaplan turbine.

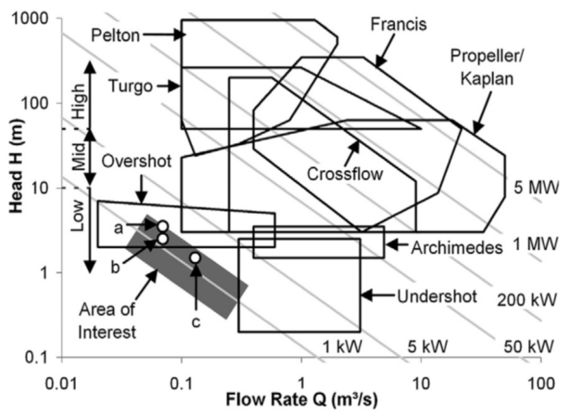


Figure 5.*Table typical turbine application beache [3]*

It can be seen from Table I that the estimated net head available at the input of the hydroelectric unit is 38.04 m for a flow rate of 1.25. Thus, the estimated potential hydroelectric power is equal to 332.85 kilowatts. Assuming the efficiency of conversion of electrical energy from hydro to 50%, the electrical power will be estimated 166.425 kilowatts; that is to say 6.93 4kWh production daily energy capacity for a single load breeze giving 27.737 kWh at four breaks loads of the station [10].

Table 1. *Flow test with single tap [5].*

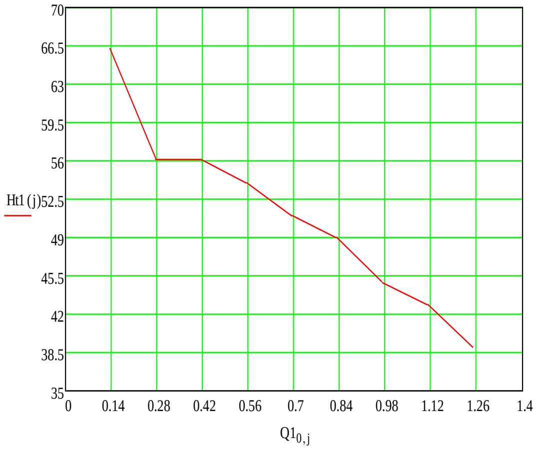
Q flow (m3 / s)	Opening (%)	P(pressure read bar)
0.138	*8*	*6*
0.555	31	5.4
0.694	*38*	5.2
0.833	*45*	*5.0*
0.972	*52*	*4.8*
1.111	*58*	*4.5*
1.25	*65*	*4.0*

The maximum hydroelectric power available at Lakhdaria is calculated using the formula (2):

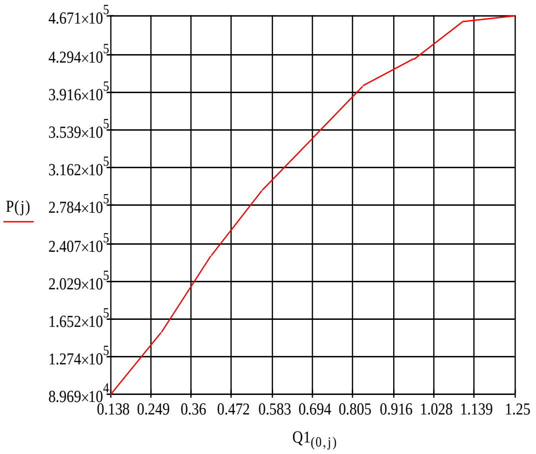
$$P = 7 \times Q \times H_n = 7 \times 1.25 \times 38{,}04 = 332{,}85KW$$

III.3. ***Results***

The sharp drop represents the effective energy between the inlet and the outlet of the turbine [11]. It is calculated from the gross head which consists of the pressure drop between the inlet and the outlet ΔHL; due to the kinetic energy dissipated, therefore it varies according to the flow, the net height decreases when the flow increases since the variation of the flow causes a pressure drop. The hydraulic power varies proportionally depending on the height of fall as well as the flow rate, the power increases when the flow increases.



Figur 6. *Change in net height (m) depending on the flow rate (m^3/s)*



Figur 7. *Change in puissace (kw) depending on the flow rate (m^3/ s)*

IV. Conclusion

In this study, we set our selves the objective of recovering the residual hydraulic energy of treated water at Koudiat Acerdoune handling unit (Lakhdaria) in Algeria. These energy dissipation systems (broken loads) are replaced by hydraulic turbines. The potentially recoverable energy is proportional to the height of the channel relative to the station level, and the total water flow. We estimated hydroelectric potential of up to 27.737 Kwh, and we selected the right turbine type.

Thus a design idea of a micro turbine for simulation and performance analysis is our next article with the concept of a test bench.

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