ELECTRICITY MICROGENERATION IN PRESSURE HYDRAULIC NETWORKS

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Abstract:

The aim of this study is to analyze and evaluate the installation of microturbines placed at selected points of water distribution systems to generating electricity from excess and unused hydraulic energy. In order to achieve this objective, we have considered some alternatives to installation in hydraulic pressurized networks of two municipalities in the province of Huelva: Cañaveral de León and Aracena. These water distribution systems are managed by the public company Giahsa. An economic feasibility analysis of the proposed installation alternatives as well as a proposal for amortization of the investment were shown in this work.

Keywords: microturbine; Banki turbine; water distribution systems; sensibility analysis.

1. INTRODUCTION:

Given the continued growth in electricity demand, the need for energy is growing worldwide [1]. The option of the microgeneration is a good alternative to reducing fuel requirements and increasing the uses of renewable sources [2]. The investigation carried out in this study implied a sensitivity analysis to evaluate the

microturbines could be installed. This analysis allows us to know that the Banki turbine is the most suitable for the urban water distribution systems at study. Concretely, this turbine is able to generate an annual energy of 12 MWh per year in Cañaveral de León and approximately 55 MWh per year in Aracena. Once this analysis is done, the investment return period (PRI) is calculated [3].

Finally, both alternatives are compared, determining which of them is the most cost-effective. Therefore, the aim of this research is to analyze and evaluate the feasibility of installing a microturbine with the objective of maximizing the hydraulic energy dissipated in pressurized water distribution systems in Aracena and Cañaveral de León (Huelva).

2. MATERIALS AND METHODS:

To calculate our installation we follow several steps. First of all, it is necessary to consider where and how the microturbine is going to be installed, i.e. at what point of the pipe of the study and if it is placed in series or parallel to the regulating valve in the paths of the study.

For the optimal location of the microturbine, four factors are taken into account: (a) the altitude that must be as low as possible so that the power with which the water arrives due to gravity is greater; (b) the distance at which said chosen point of the exit raft is located since the farther away it is there will be a greater loss of load due to friction with the pipe; (c) the energy of the water at the outlet of the microturbine is the minimum necessary to reach the regulating valve; and (d) the jump is not very high if the flow is low, if the jump is excessive the turbine would not work properly.

allation has been chosen, the speed with which the water fluid would reach the microturbine as well as the energy that reaches it must be calculated. To calculate the friction energy losses, the equations of Hazen-Williams and Darcy-Weisbach.

3. RESULTS AND DISCUSSION:

Cañaveral de León: We are going to study the point where the regulating valve is located. At the exit of the valve we would need a net jump of 29,4 m so that the water can be distributed by the population. Therefore, the actual net jump we have to use in the microturbine would be:

52,742-29,400 = 23,342 m

PVal= 0,85.9810.0,005.23,342= 973,186W

Annual energy=8760.973,186= 8,525MWh/año

In our case we would choose BANKI turbine model R125 which has the following operating ranges:

Power: 0.5 a 5 kW

Net jump: 10 a 35 m

Flow: 0,005 a 0,020 m^3/s

Aracena: At the exit of the valve we would need a net jump of 29,4 m as in Cañaveral de León so that the water can be distributed by the population. Therefore, the real net jump we have to use in the microturbine would be:

50,813-29,400 = 21,413 m

PVal = 0,85. 9810. 0,015. 21.413 = 2678,284 W

Annual energy = 23,462 MWh/year

In our case we would choose BANKI turbine which is the one that offers us greater performance, more specifically the R189 model that has the following operating ranges:

Power : 6 a 20 kW

Net jump : 10 a 80 m

Annual energy : 0,005 a 0,350 m^3/s

Having calculated the return on investment, we obtain that the proposed microturbine installation in Cañaveral de León would need 47 years to recover the investment, while it would only take 10,7 years to recover the investment in Aracena.

The main objective of this paper is to evaluate the viability of the insertion of a microturbine in a water supply pressure network. The results show that the amount of usable energy is significant. The microturbines chosen in both locations are Banki type. An important aspect to take into account has been the microturbine placement point. We have decided to place in both cases parallel to the regulating valve because at this point it would be easier to control the minimum pressure necessary for water distribution by the population. On the other hand, in these points the greatest net usable jump of the route is obtained.

4. CONCLUSIONS:

This research shows how effective the insertion of a microturbine can be in a hydraulic network and how a renewable source is capable of generating alternative energy. This type of installation has already been studied in the literature with great interest in recent years because it is considered as an efficient alternative for many urban and irrigation water distribution systems. In addition, taking into account the growing need to obtain other sources of external financing due to the increase in energy consumption, this study is considered of great importance.

Regarding the profitability of this project, we can conclude that this project would not be viable in Cañaveral de León since the years necessary to amortize the investment involved in the installation of a microturbine in the network are greater than the useful life of the same due to the few MWh that microturbine is capable of generating. On the contrary, this investment is profitable in Aracena because it is able to amortize the investment in 10,7 years thanks to the high existing flow.

This study is described in more detail in Rodríguez-Pérez et al. (2019) [4].

5. REFERENCES:

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