Building a prototype for functional analysis of the energy potential of the water flow in pipe ½ "using microturbines applied to Unidades Tecnológicas de Santander

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Summary: The project aims to build a working prototype for analysis of potential energy of water flow in pipe ½ "by using micro tangential turbines with a loss running low, constituting a small-scale model for the study power generation thereof, setting parameters related to a hydraulic distribution system operation residential drinking water. Taking advantage of the electric power, a microturbine is obtained by decanting flow through it. The research methodology is descriptive quantitative approach, to develop the project initially performed a literature review, followed by identification of the electrical variables and characteristics of the prototype to generate a simulation of a real hydraulic circuit, it followed this comes the recognition and selection of the elements for retrofitting. Thus, as looking through prototype and analysis of the energy potential, generating an academic, social and environmental impact on the institution; since being pioneers in this type of project it is expected to generate the conceptual foundations in the community, enabling understanding of the use of this resource and future implementation. social and environmental in the institution; since being pioneers in this type of project it is expected to generate the conceptual foundations in the community, enabling understanding of the use of this resource and future implementation.
1. Introduction
Currently, one of the biggest concerns is the high demand for electricity [1] due to population growth [2] and industrial development of the country [3] that have generated an energy deficit [4] considerable [5]. Which it has generated various analyzes of possible alternative energy solutions [6] not conventional [7] , Conducting studies [8] and looking that in everyday activities, you can generate electricity [9] needed to help combat this problem.

Thus, as within the various alternative systems under study, there are micro turbines [10] they tend to operate in much the same compared as do large and expensive turbines [11] installed in conventional hydroelectric [12] without having to be subject to multiple failures [13] and its devastating effects [14] such as those who have registered several hydraulic generation plants [15].

One of the most innovative technologies [16] projected [17] today for power generation [18] are the microturbines [10], Primarily because they tend to have a small size [19]. Because of its low-weight size allows these are easy to locate in a water system [20] or a process plant [21].

Contemplating other forms of clean energy generation and renewable [22] as produced by eoliths systems [23] and solar panels [24] a system of micro turbines installed in the sanitary water system can produce electricity [25] at times there is a consumer [26].

These micro turbines [10], they can be exploited at suitable locations where water circulates natural draft without [27] intervention pumping systems [28].

Given the above concept is intended to route the first phase of the investigation [29] to the nearest study area being the Technological Units of Santander. Accordingly to the above and according to the technical information provided by the Office Infrastructure Technology unit Santander (UTS), viability analyzes [30] to use this potential in the water system [31] Health Building B.

To this end it plans to build a prototype that simulates like the water system health conditions Building B, which will allow us to understand the behavior [32] the microturbine, his generation [33], possible losses [34] and other data needed for evaluation, taking into account that is not being used efficiently, the excess energy generated in the sanitary water system.

2. Methodology used
For the project, the construction of a working prototype for analysis of potential energy of the water flow in pipe ½ “using microturbines applied to Technological Units of Santander, which perform arises through descriptive research methodology [35] with which it compile [36] information [37] with a quantitative approach [38] for further statistical analysis, through collection of electrical variables such as current, voltage and power and pressure so ON-LINE manually for OFF-LINE aftertreatment in the generator program trend curves [36] (GNU) in order, to perform the respective pressure comparison [37] input regarding the generation of micro turbine.

3. Used items
3.1 Hydraulic motor pump
The centrifugal motor pump is operating principle convert electrical energy into velocity and pressure of flow through the impeller or turbine rotating in the housing. The main purpose of the centrifugal pump is to move a volume of liquid from two different levels and / or use the pressure that it can supply. [38]

Rangel QB60 the pump seen in Figure 1, has a power half horsepower, a maximum flow rate of 35L / min, a dynamic head of 35 m. Table 5 shows all characteristics.
3.1.1. Performance curve motor pump Ranger QB60. The performance curves shown in Figure 2, contains information from two motor pumps Ranger mark and for selecting one considers the curve 1 as is corresponds to the motor pump of 0.5HP QB60.

This curve parameters are the flow rate (GPM) vs. Pressure (psi) for this model.

![Performance curve motor pump Ranger QB60](image)

Figure 2. Motor Pump curve Ranger QB60

The motor pump Ranger QB60, generates a maximum pressure of 50 psi and a maximum flow of 35LPM, which are similar to the pressure handled in the water system because under NTC-1500 [37], We define the range of managed systems in conventional water pressures, which are 25 to 35 psi.

3.2 Hydroelectric Generator Microturbine

The AIYIMA brand in its product catalog, have a variety of hydraulic microturbines called HYDROELECTRIC GENERATOR MICROTURBINE [39], Which select the microturbine hydraulics model, shown in Figure 3, the main features are described below:

- Magnetic coupling clutch double single
- Inlet, outlet pipe are available to match a straight line or right angle mounting type L
- Ultra-Low Loss Flow
Starting low water pressure
isolation diode power directly to the rechargeable battery or power the capacitor 5F farads. [39]

Figure 3. Hydroelectric Generator Microturbine

The hydraulic microturbine is used in lighting shower and sound system, gas water heater with power and other electrical products. This high-power generator can energize light emitting diodes (LED).

Table 1 shows the technical specifications such as voltage, pressure range, initial flow among others described.

Table 1. Micro sheet Hydroelectric turbine Generator

| Specification                           | Value                                |
|-----------------------------------------|--------------------------------------|
| Diameter inlet and outlet               | ½ "                                  |
| Output voltage                          | 9.8V to 18.5V DC                     |
| Current Range                           | 128mA to 260mA                       |
| Pressure range                          | 0.08MPa to 0.55MPA                   |
| Maximum pressure                        | 0.55MPA                              |
| Lost by traffic                         | 3.6% (to 0.25MPa)                    |
| Initial flow                            | 1 L / min                             |
| Operating temperature range             | 5 °C to 85 °C                        |
| Dimensions                              | 81.4mm x 43.8mm x80mm                |
| Maximum power output                    | 5W                                   |
| Price                                   | € 10.41                              |
| Minimum Run                             | It does not require                  |
| Retail Distribution                     | YES                                  |
| External diameter                       | 20mm                                 |

With the yield curve you can know what the operating conditions of hydraulics, such as flow rate, minimum and maximum operating pressures are microturbine. Graphical representations voltage Vs Flow and Pressure Flow Vs is shown in Figure 4 and 5 respectively.
Figure 4. Flow Vs Voltage curve

Figure 5. Flow Vs Pressure curve
3.3 Pressure gauges

A gauge is an instrument for measuring the pressure in fluid (Liquids and gases) in closed circuits. Measure the difference between the actual or absolute pressure and atmospheric, calling this value, gauge pressure. This type of gauge is also known as "pressure gauges". [40]

The gauge shown in Figure 6, is used for this research project will be a range from 0 to 60 PSI. They will be used in order to measure outlet pressure of the motor pump, inlet pressure turbine and pressure loss of the fluid to decant it.

![Figure 6. Pressure gauge from 0 to 60PSI](image)

3.4 Check valve

The check valves or valves are used to keep back a fluid within a line. This implies that when the pumps are closed for any maintenance or just gravity does its work of returning the fluid downward, this valve closes instantaneously letting only the flow running in the right direction. That is also why they are called non-return valves. Obviously, it is a one-way valve that must be positioned properly to perform its function using the direction of traffic flow is correct. [41]. The check valve shown in Figure 7 will be used to avoid a possible shock at the motor pump Ranger QB60.

![Figure 7. Check Valve](image)

4. Selecting the area to simulate the prototype

It is important that site selection is the most appropriate because it must take into account that water consumption caused by the high traffic of students in health services, will generate the flow and pressure of water that is required for there is a generation of effective and representative electrical energy, this can be captured, since this electric potential is being wasted.

In the study performed for selecting the right place, requested the Office of Infrastructure of Technological Units of Santander (UTS), the respective health plans designed for module Building B, so this study will focus on said location.
According to the design of Building B, it has 7 floors and a basement, where there are restrooms on each floor, distributed as follows:

From the first floor to the sixth, they are distributed four health Batteries that are intended for general use described as follows:

- Two sanitary units for men.
- Two health Battery for ladies.
- On the seventh floor they are distributed health services as follows:
  - 5 private health services.
  - A Cafeteria.
- Finally, in the basement, according to design drawings, these are not updated with the latest reforms made.

Given the foregoing, it has been determined for this study, the water distribution points, as described in the following items, are most suitable.

5. **Inventory overall battery health building b.**

Based on the above analysis, we found that building a sanitary battery B has made up a considerable amount of toilets, sinks and other type push.

Table 2 shows the number of individual services installed will be displayed and detailed for each floor. These are points potable water supply that may become points of facilities microturbines. These points are regulated by the NTC-1500 standard [37]Where defines minimum operating pressures and minimum pipe diameter distribution. For this research project, only the points having a pipe diameter of 1/2 inch is taken into account.

| Floor      | Gentlemen | Ladies | Others |
|------------|-----------|--------|--------|
| First      | 22        | 16     | 0      |
| Second     | 22        | 16     | 0      |
| Third      | 22        | 16     | 0      |
| Quarter    | 22        | 16     | 0      |
| Fifth      | 22        | 16     | 0      |
| Sixth      | 22        | 16     | 0      |
| Seventh    | 5         | 4      | 0      |
| bathroom Vice | 2        | 0      | 2      |
| Private bathroom | 5  | 4   | 0      |
| Rectory    | 0         | 0      | 2      |
| Cafeteria  | 0         | 0      | 2      |
| Total      | 141       | 100    | 4      |
6. **Base standard NTC-1500**

The committee hydraulic facilities in ISO-1500 standards in its third update defines the rules of facilities supply and distribution of water to plumbing devices that provide water for drinking, personal hygiene, preparation or food processing, medical products and pharmaceuticals It must be potable. Also it specifies parameters that must be considered for its design defining the minimum dimensions of the pipe to be selected such that under the conditions of peak demand cater to sanitary equipment for flow capacities and defines the minimum flow and minimum pressure [37] flow provided to the devices listed in Table 3. [37]. Based on this regulation, operating pressures and minimum diameters are considered for the selection of the microturbine are determined.

**Table 3.** minimum diameters for water supply pipes in the plumbing equipment

| Apparatus                                           | minimum pipe diameter (inches) |
|-----------------------------------------------------|--------------------------------|
| Bathtubs 1524 mm x 813 mm (60 inches x 32 inches)   | (1/2)                          |
| Bathtubs larger 60-inch x 32 inch                   | (1/2)                          |
| Bidet                                               | (1/2)                          |
| Poceta combination and tray                         | (1/2)                          |
| Dishwasher, domestic sprue                          | (1/2)                          |
| Hose taps                                           | (1/2)                          |
| Dishwasher                                         | (1/2)                          |
| Laundry 1, 2 or 3 compartments                      | (1/2)                          |
| Handwash                                           | (1/2)                          |
| Shower or shower                                    | (1/2)                          |
| Poceta, with overflow                               | (1/2)                          |
| Poceta Service                                     | (1/2)                          |
| Urine discharge tank                                | (1/2)                          |
| Urinal, flushometer                                 | (3/4)                          |
| Hydrant wall                                        | (1/2)                          |
| Toilet flush tank                                   | (1/2)                          |
| Odorless, wastegate                                 | (1)                            |
| Toilet tank pressurization                          | (1/2)                          |
| Toilet, a piece                                     | (1/2)                          |
7. **Count people entering and using the building battery health b**

This count is done in the health batteries for women and men on the first floor of Building B, because for us it is the largest influx of students and outsiders, being located close to the goal of access to the institution, which concentrates most human activity.

Counting that takes place on Thursday 22 and 29, Friday 23 and November 30, 2018 between the hours of 6:00 a.m. to 6:00 p.m. give us as a result the number of people using health battery daily ladies and gentlemen Technology unit Santander, is plotted in figure 8.

![Figure 8. Graphical representation of the total number of people who entered and used battery health ladies and gentlemen](image)

According to the data obtained in Figure 8, equation 1 raises to find the average people using these services daily.

\[
\text{average (week)} = \frac{(\text{D}_1 + \text{D}_2)}{2}
\]  

Where:
- D1: First day where the count is made
- D2: Second day where the count is made

The data obtained with equation 1, are shown in Table 4

| Table 4. Average number of people entering the building sanitary batteries B |
|-----------------------------------------------|
| Average (Week 1) | 957 persons / day |
| Average (week 2) | 1096 persons / day |
| **Total average** | **1026 persons / day** |

According to the results shown in Table 4 it is determined that the lavatories of ladies and gentlemen of the first floor of Building B, enter the first week 957 people a day in the second week fall 1096 people. Calculating the total average between Week 1 and Week 2, we need to such lavatory’s ladies and gentlemen
of the first floor of Building B enter 1026 people a day, assuming that at least driven once sinks type push the bathrooms.

Accordingly, the average input is the time that the sink type pushes actuated.

In order to be able to measure the amount of water coming out at a given time sinks type push of the bathrooms on the first floor of the building B, the Laboratory of Environmental Resources Technological De Santander (UTS) Units provide us a suitable container for this they are as 600ml beaker and 100ml test tube, shown in figure 9.

![Figure 9. Beaker and test tube](image)

From this test it was determined that a time 5.18seg, the beaker was filled to the level shown in Figure 10.

![Figure 10. Beaker with water that came out in 5.18seg](image)

To more accurately measuring the specimen 100ml in order to hear more about the amount of water that came out at this particular time is used.

The 100 ml graduated cylinder is completely filled twice and a third time reaching 14 ml partially, as shown in Figure 11. This tells us that in the water service 5.18seg gives us a flow rate of 214 ml
In order to determine the microturbine generation, we must know approximately how much time in a day lasted keys sinks push open type. Therefore, we perform equation 2.

\[ T_{FGPD} \approx T1P \times CPP \]  

Where:

- **TFGPD**: Water flow time average day
- **T1P**: Time 1 push
- **CPP**: Average amount of push

Applying equation 2:

\[ T_{FGPD} \approx 5.18 \text{seg} \times 1026 \text{ drive day} \]

\[ T_{FGPD} \approx 5314.68 \text{ Driver*seg day} \]

Knowing that one hour is 3600 seconds raised the equation 3:

\[ T_{FGPD \ (hours)} \approx 5314.68 \text{ Driver*seg day} \times \frac{1H}{3600\text{seg}} \]

\[ TFAPF \approx 1.5 \frac{\text{Driver*seg}}{\text{day}} \]
8. **Comparison and Selection of the microturbine**

Microturbine to select the most suited to water design, we consider the following parameters:
- Inlet and outlet diameter of $\frac{1}{2}$ "
- Maximum working pressure greater than or equal to 20psi
- Less flow to start power generation
- It does not require a minimum operating time

With the above considerations the international market for microturbines these analyzes, finding few companies developing this technology. At European level there are two companies that develop these microturbines, which are:
- Tecnoturbines with Picoturbina model.
- Aiyima with model Micro Hydroelectric Generator turbine

Significantly, the domestic market is a limited supply of this type of hydraulic microturbines, since the use of these is still incipient in our country.

To make a correct selection of the microturbine to be used in prototype construction, a comparison of specifications between the Picoturbina and microturbine is Hydraulic. This comparison is carried out in Table 5.

**Table 5. Comparative table between Picoturbina and microturbine Hydraulics**

| Specifications                  | Picoturbina | microturbine |
|---------------------------------|-------------|--------------|
| Diameter inlet and outlet       | $\frac{1}{2}$ " | $\frac{1}{2}$ " |
| Voltage range                   | 105V to 12VDC | 18.5 9.8V DC |
| Current Range                   | 0A to 2A    | 120mA to 260mA |
| Minimum operating pressure      | 0.045MPA    | 0.08MPa      |
| Lost by traffic                 | not specified | 3.6% to (0.25MPa) |
| Operating minimum flow          | 0.5 L/s (30LPM) | 1LPM         |
| Maximum power output            | 25W         | 5W           |
| Minimum operating time          | 20 minutes  | It does not require |
According to Table 5, the microturbine that is closest to the selection parameters, set in this item, is the hydraulic microturbine mark Aiyima since, unlike Picoturbina not required minimum operating time and operating pressure initial is the lowest.

9. Behavioral tests of hydraulic microturbine

To determine the characteristics of the prototype for simulation of water service, evidence which shows the operation and behavior of the hydraulic microturbine are made, as this gives us the idea of how you can be the design for this research project.

9.1 Test 1
In this first test the assembly of the microturbine and a manometer inlet, shown in Figure 12 is performed to make the measurements at different pressures and thus know the behavior of the microturbine, starting with the lower pressure to higher pressure in the water system of the selected place to test.

![Figure 12. Mounting conducted for test No. 1, with pressure from 0 to 60 psi](image)

At a pressure of 10 psi, as shown in Figure 13, you are obtained one has a voltage of 13.80 volts, which is optimal for charging a 12V battery.
Figure 13. Evidence of voltage generation at a pressure of 10psi

Figure 14. Graphing voltage Vs Pressure testing behavior

The graphical representation as that found in Figure 14 has the trend equation to the expression shown in equation 4:

$$y=-0.0195x^2+1.125665x+2.0699$$  \hspace{1cm} (4)

Where:
- **Y**: Pressure Psi
- **X**: Voltage in Volts

Trend equations fit to describe how the variable that is measured, changes over time. The form of the equation adjusted trend depends on the model type is selected, as shown in Table 6 [42]
Table 6. Trend equations

| Model type                        | Equation                        |
|-----------------------------------|---------------------------------|
| Linear                            | $y_t = b_0 + (b_1 \cdot t)$     |
| Quadratic                         | $y_t = b_0 + b_1 \cdot t + (b_2 \cdot t^2)$ |
| Exponential growth                 | $y_t = b_0 + (B_1T)$            |
| S curve (logistics Pearl-Reed)    | $t = (10a) / (b_0 + b_1 \cdot B_2T)$ |

Where:
- $y_t$: The variable
- $b_0$: constant
- $b_1$ and $b_2$: coefficients
- $t$: Value of the unit time

9.2 Test 2

With this test installation of gauges and out of the microturbine is performed, as shown in Figure 15, in order to determine the losses caused by friction of the flow are, and to know whether these match losses they give us in the data sheet factory, which are 3.6% to 0.25MPa.

In our case, they will vary the results given by the manufacturer, since we work with a maximum pressure of 22psi. These tests for higher accuracy work, performed with air pressure in the Industrial Instrumentation Laboratory Technology unit of Santander, under the guidance of tutor’s teachers.

Figure 15. Mounting conducted to determine traffic losses

In this test as shown in Figure 16, the inlet pressure takes 20psi to have a point of comparison with the output gauge.
In Figure 17 note that the loss of output pressure is very low, therefore it can be concluded that the pressure does not affect the health system, and its output pressure is very close to 20psi.

To allow comparison of the loss in output pressure, the respective theoretical calculations were performed to make a comparison with the actual data.

9.3. **Theoretical calculations**

Because the inlet pressure shown on the gauge is in the range of Psi, the conversion is performed megapascals, using equation 5:

\[
PIN(\text{MPA}) = \frac{1(\text{MPA}) \times PIN(\text{PSI})}{145,038(\text{PSI})}
\]  

(5)
Where:
Pin (mpa): found value for equation 5.
Pin (psi) inlet pressure supplied by the pressure gauge.

Applying equation 5:

\[ Pin(\text{mpa}) = \frac{1(\text{mpa}) \cdot 20(\text{psi})}{145,038(\text{psi})} = 0.137894897 \]

Finally, to find the percentage of loss in the microturbine, we use equation 6.

\[ X(\%) = \frac{3.6\% \cdot Pin(\text{mpa})}{0.25(\text{mpa})} \quad (6) \]

Applying equation 6:

\[ X(\%) = \frac{3.6\% \cdot 0.137894897(\text{mpa})}{0.25(\text{mpa})} \approx 2 \]

From this we conclude that the loss is very low and therefore not affect the operation of the water system.

10. **Prototype development**

To perform this prototype takes into account multiple factors, such as flow rate and pressure of hydraulic system design of the building B Technology unit Santander (UTS), the pressures in and out of the microturbine, the outflow of the motor pump, recirculation water to avoid waste, the construction of the base or support for the installation of the tank and the motor pump and the pipes and the necessary accessories.

As the motor pump Ranger QB60 has an outlet diameter of 1 " and the microturbine has inlet and outlet ½", the corresponding line in PVC and accessories as ball valves, universal fittings, check valve, elbows, reducers, joints used, test.

also, it takes account of a bypass in order to decrease or increase the inlet pressure to the microturbine, since, if opened or ball valve (1) is closed, the pressures vary allowing to different measures them and obtain different voltages in power generation. Furthermore, in order to perform a purge upon completion of tests, and help us to drain the water in the upper pipeline.

To make a comparison of electrical variables, relative to the pressure, a pressure gauge at the inlet and
outlet in the microturbine because with this variation values obtained support the calculation of loss of the microturbine is installed.

Based on the above considerations the final draft program performed in a computer assisted design, CAD, as shown in Figure 18 is made, all with the assistance of teacher tutors.

Significantly, with elaborate design with CAD, the losses are calculated by means of hydraulic calculation software, which is 2.0 Epanet General Public License (GNU)

![Sketch drawn in CAD](image)

**Figure 18. Sketch drawn in CAD**

10.1 Calculation of loss per charge

To determine the feasibility of building sketch drawn in CAD, the respective calculations in order to interpret the losses that exist in this system to perform these calculations for hydraulic calculation software, Epanet V2.0 (GNU) is used it is made. This procedure is performed by pipe lengths according to their diameters and the results obtained are shown in a graph, generated by the program representation.

For these calculations the maximum flow of the motor pump QB60 Ranger, which is 35L / min is used. To develop these calculations, the constants shown in Table 7 are obtained.

| Table 7. Constants water and PVC |
|----------------------------------|
| Density of water at 25 ° C       | 997 kg / m³   |
| Roughness PVC                    | 0.005mm       |
| PVC friction factor              | 0.0252        |

These constants together with the flow, are introduced into the Epanet V2.0 (GNU) software and we automatically generate the data shown in Table 8. These calculations are made as sections of pipe according to its length, the results vary.
Table 8. Data entered the software

| Description       | Quantity | K factor |
|-------------------|----------|----------|
| Flow              | 35 l/min |          |
| Density           | 997 kg/m³ |          |
| Dynamic speed     | 0.00089 Pa s |          |
| Inside diameter   | 35 mm    |          |
| Speed             | 0.61 m/s |          |
| Reynolds number   | 23772    |          |
| Rugosity          | 0.005 mm |          |
| Friction Factor   | 0.0252   |          |
| Pressure drop per | 0.01349 m|          |
| meter             | 0.01913627437 psi/m |          |

10.2 Calculation of load losses for section 1"

To prepare loss calculations for the pipe section 1", the length generated is used by the DAC, which is 0.6211 m, this being introduced in the software, we generated the data shown in Figure 19.

| Description          | Value    |
|----------------------|----------|
| Pipe Length          | 0,6221 m |
| Total, load loss in straight sections | 0,0084 m |
| Loss of load (1)     | 0,012 psi |

Figure 19. Head loss in straight sections

For this stretch of 1", it is necessary to know the constants accessories and the number of them, for the losses in accessories shown in Table 9.

Table 9. Losses in valves and fittings

| Description      | Quantity | K factor |
|------------------|----------|----------|
| T 1 in, linear flow | one | 0.2 |
| Check valve      | one      | 14.5     |
| Ball valve 1 in  | one      | 0.05     |
| 90 ° elbow 1 in  | one      | 0.05     |

Load loss valves and accessories = 0.393 psi

For total load losses, must have the elevation of the pipe, since the losses of total charge is the sum of the losses between the straight sections, fittings and elevation, these losses are shown in table 10.
Table 10. Total load losses

| Pressure Difference by Pipeline Elevation |          |
|------------------------------------------|----------|
| elevation (h)                            | 0.4858 m |
| Difference in Pressure Due to Unevenness | 0.68766 psi |
| TOTAL LOAD LOSS (Straight sections + Accessories + Elevation) |          |
| 0.7715 m                                 | 1.094 psi |

After typing all the above data, hydraulic calculations software, Epanet V2.0 (GNU), generated graphical representation of total losses shown in the red curve. The design uses a 1” pipe SCH 40, which has an inner diameter of 26.2mm. This pipe section has a loss 0.741 psi, as shown in Figure 21.

![Graphical representation of pressure drop](image_url)

**Figure 20.** Graphical representation of pressure drop

10.3 *Calculation of losses to stretch ½ “*

For calculations of losses in the pipe section of 1/2 “, the total length of this stretch generated by the CAD, which is 1.749m, is to be introduced into the software, we generated data is used, shown in figure 22.
**Loss of load in straight sections**

pressure loss per meter:

| Description               | Quantity | K factor |
|---------------------------|----------|----------|
| Reduction cone type 1in to 0.5in | one      | 0.37     |
| Universal Valva           | 3        | 0.08     |
| T linear 0.5in 90° elbow  | two      | 0.3      |
| Ball valve open 0.5in     | 3        | 0.05     |

Headloss in valve and accessories = 0.052 psi

**Pipe Length**: 1,749 m

**Total load loss in straight sections**: 0.0236 m

**Loss of load (1)**: 0.033 psi

**Figure 21.** Losses in straight sections

For the section of 1/2", it is important to know the constants accessories and the amount of these in order to meet the losses in accessories that are reflected in Table 10.

To know the total load losses, we must have the elevation of the pipe as losses total load is the sum between losses of straight sections, accessories and elevation in this stretch of 1/2" elevation is negative since this is in the upper circuit and carries the water back to the tank, the pressure losses are represented in figure 23.

After typing all the above data, hydraulic calculations software, Epanet V2.0 (GNU), generated graphical representation of total losses shown in the red curve. In the sketch tubing 1/2" SCH 40, this has an internal diameter of 15.5mm and a loss of 0.980 psi, as shown in Figure 24 is used.
Pressure Difference from Pipe Elevation

elevation (h) \(-0.485\) m

Difference in Pressure \(-0.6878\) m
due to Unevenness

TOTAL LOAD LOSS (Straight sections + Accessories + Elevation)
\(-0.4247\) m
\(-0.6\) psi

Figure 22. Total load losses

11. Conclusions
- For this construction of a prototype for an analysis of energy potential it should be pressure and operating time to be handled in the prototype because it must be like to run in the bathrooms on the first floor of building B of Technological Units Santander, considering that:
  - The NTC-1500 standard set pressure and minimum flow according to the design water distribution, in the case of building design B are of 25psi and 1 GPM
  - Due to health battery is installed in the baths and then make a measurement operation time and operation duration time 1.5 hours / day distributed between 1092 drives set 5.18seg
- As shown in the development of this project to make the selection of the microturbine were considered, certain conditions and requirements, these lead us to choose the HYDROELECTRIC GENERATOR MICROTURBINE because it is the one that meets the parameters established both pressure
and their behavior. In paragraph 8 "comparison and selection of the microturbine" compared with other types of microturbines and define why your selection

- Because the microturbine will be in contact with potable water that meets the parameters set out in resolution 2115 of 2007. It is important to submit to the microturbine and water after trash to the respective studies such as:
  - Determine with certainty the material with which the microturbine is constructed, to know its behavior and degradation time.
  - Define if when in operation after a long time, degradation of the material occurs which is built the propeller of the microturbine and if some substance like mercury, selenium and other begin to exist in drinking water, being harmful these harmful to the human being.
  - Determine when trash water by dissolved oxygen increases microturbine, this index is determined under the risk of water quality for human consumption - Irca-

- Because the market is booming microturbines is important to use other types of microturbines creating new analysis, measurements of electrical variables and thus experience different types of microturbines to take over this type of energy.

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