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Evaluation of the Selection of the Submersible Pump Specification System of PDAM Tirtauli in Siantar Selatan District, Pematangsiantar City

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ABSTRACT

In this final project, a submersible pump has been applied. From the pump data obtained a capacity of 27.10 l/s. Pump head 14.62 m based on calculations in the field. By using empirical equations it can be determined the main parameters of pump planning, namely specific speed, pressure loss on the pipe wall, length, diameter and type of pipe, number and type of pipe accessories used. By conducting research and measurements in the field, the pipe diameter is 6 inches, the type of Ci and the length of the pipe is 1260 meters using the Hazen William formula and the continuity of flow and pressure loss along the pipe (head losses friction) and pressure losses (head losses minor) is 20.50 meters.

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1. INTRODUCTION

Pumps have been used by many people for a long time, from the smallest units in households to large industries. The increasingly widespread use of pumps from time to time has led to a very rapid development of types and forms of pumps. In the current era, various types of pumps with various advantages have been offered by many pump manufacturing companies. In fact, often a company makes certain pumps that are only used for special applications. Given the many types of pumps on the market, carefulness in choosing a pump is the main requirement in order to obtain optimum pump work in accordance with the system being served.

In households, pumps are widely used to pump water from wells for use in various activities of daily life. In agriculture, pumps are widely used in irrigation systems to irrigate rice fields. In providing drinking water for the community, pumps are used to distribute raw water to the IPA (Water Treatment Plant) and then distribute it to people's homes. In the oil industry, pumps are not only used in refineries but are also used in delivering oil to distribution centers. In power service centers, especially PLTU (Steam Power Plant), the pump is used as a *boiler feed pump* . In addition, it is also used to pump condensate (water condensed in the condenser) to the *boiler feed pump (boiler feed pump*) and to drain cold water into the condenser. In buildings the pump is used to deliver cooled water to the rooms in the central air conditioning system.

In the food industry in general, cleanliness in the production process is a major requirement to maintain product quality. Therefore, the pumps used in the food industry must be rust-resistant without any leakage of lubricating oil into the food. The cleaning process should also be made as easy as possible. In the food industry, sanitary pumps are widely used which meet the hygiene and health requirements. This pump is used to flow liquid raw materials (not yet processed) and also liquid food products before they are packaged. In addition, it is also used to supply clean water as a mixture of other ingredients in the factory process. The pipes used in the food/beverage production process must also meet hygiene requirements. Therefore, the pipe material must be resistant to rust. The material that is often used is *stainless steel* because in addition to being rust-resistant, the pipe also has a smooth surface and easy cleaning.

Formulation of the problem

A. How is the selection system for the submersible *pump* owned by PDAM Tirtauli *at the Simarito* water source ?
B. How is the pump efficiency with respect to power consumption?
C. Effective or not the pump selection in that location?

Theoretical Basis

To analyze the data obtained from the place (location) of the research carried out, the author uses a theoretical basis, while some of the theoretical foundations will be described below.

1. Raw Water Source

Sources of raw water for drinking water are generally categorized as :

a) Rainwater is the precipitation of water vapor that collects into clouds and falls to the earth's surface as water droplets
b) Surface water is water that is on the surface of the ground. Divided into 3 (three) namely: lake water, sea water, and river water
c) Groundwater is water that is in the soil or rock layers below the ground surface

Groundwater is divided into 3 (three) types, namely:

1. Shallow Groundwater

Shallow groundwater (unconfined aquifer) is free/unpressurized groundwater, which is limited by a water table (phreatic level) while the bottom is limited by aquitard or aquiclude or also known as shallow wells.

2. Deep Groundwater

Deep groundwater (Confined Aquifer) is confined groundwater, this aquifer is limited at the top by aquitard and at the bottom by aquitard or aquiclude, or also known as deep well.

3. Water springs

Spring water is groundwater that comes out by itself to the ground surface. Based on the discharge (appearance above the ground) caused by:

a. Seepage, where water comes out of mountain slopes.
b. Umbul, where water comes out to the surface on a plain.

2. Water Tapping Facilities

Tapping facilities are the most important part of the entire clean water supply system because if this does not work, then the whole system cannot function. The function of water taps is to provide raw water continuously to meet 3 (three) important factors that must be met by the water supply system namely quality, quantity and continuity.

The water tapping facility consists of 3 (three) parts, namely:

A. Construction:
   1) Water trap building
   2) Collector tub
   3) Pump station/house
B. Mechanics:
   1) Pump
   2) Transmission Pipe

C.Electric :
   1) Power supply
   2) Panel

3.Pump .

Pump is a device used to move a liquid from one place to another by increasing the pressure of the liquid. The increase in fluid pressure is used to overcome the flow resistance. These flow barriers can be in the form of pressure differences, height differences or frictional resistance, and according to their function, the pump is a device used to:

a. Moving fluids from one place to another (eg water from an underground aquifer to a water storage tank).
b. Circulating fluids around the system (eg cooling or lubricating water passing through machinery and equipment).

4.Pump Capacity

Pump capacity is the volume of liquid pumped per unit time which is usually measured in liters/second or m3/second, this capacity is usually called the actual capacity of the pump. The internal capacity of the pump is the amount of liquid flowing through the pump, equal to the actual capacity plus the leakage that occurs within the pump itself. Therefore there must be a correction factor in determining the pump capacity.

5.Pump Classification

In general, pumps can be classified into 2 (two) parts, namely:

a. Positive Work Pump

positive working pump, the increase in fluid pressure in the pump is caused by a reduction in the volume of the room occupied by the liquid. The presence of moving elements in the room causes the volume of the room to increase or decrease according to the movement of these elements. In general, positive work pumps are classified into:

b. Reciprocating Pump

A reciprocating pump is a type of pump in which the mechanical energy of the pump drive is converted into flow energy of the pumped liquid by means of an element that moves back and forth in the cylinder. The element that moves back and forth can be a membrane or plunger.

c. Rotary Pump

A rotary pump is a type of positive displacement pump in which mechanical energy is transmitted from the engine to the liquid by means of a rotating element (rotor) in the pump housing (casing). When the rotor rotates in the pump housing, pockets are formed which are initially large in volume (on the suction side) and then decrease in volume (on the pressure side) so that the fluid will be squeezed out. Some of the most common rotary pumps include:

a) External gear pump, the rotor is a pair of gears that rotate inside the pump housing. The gear can be single-helix, double-helix or straight-tooth.
b) The inner gear pump has a rotor in the form of an inner gear that is paired with a free outer gear (idler).
c) Cam and piston pumps, also known as rotary plunger pumps, consist of an eccentric sleeve and an upper slotted sleeve.
d) Ear pumps (lobed pumps), have two or more rotors with two, three, four or more ears on each rotor.
e) Screw pumps, have one, two, three screws that rotate in a stationary pump housing.
f) Vane pumps, the rotor of which is a rotating element eccentrically mounted with the pump housing. In the circumference of the rotor there are grooves filled with blades that can move freely. When the rotor is rotated, the blades move in a radial direction due to the centrifugal force, so that one end of the blade is always in contact with the inner surface of the pump housing, forming room dividers inside the pump.

2. RESEARCH METHOD

1. How to Collect Data and Data Sources

Accurate and systematic data collection methodology to obtain good data , the author will describe as follows: Data collection technique

2. Data collection techniques are carried out by:

a) Observation (Observation)

Direct observations made in the field directly during the research aimed to obtain direct data and information and prevent misunderstandings about the system of selecting specifications, operation, maintenance and repair of pumps, especially deep well pumps and the systems applied.

b) Interview

This activity is carried out to take an inventory of data that is not obtained directly from the field and then used as a complement to field data and analyzed to serve as a reference and guide in data collection techniques and attempted to conduct interviews with personnel (officers) whose information can be trusted.

c) Study of literature

Activities carried out throughout the study to obtain material or comparative data between practice in the field and the theory that has been studied during education. From the data on the system specification selection, operation, maintenance and repair of pumps obtained, it will be known whether the application of the existing system is in accordance with the theory obtained during education and has met the required criteria.

d) Research in the field.

Activities carried out directly at the practice location and helping the work carried out. From this activity, it is hoped that actual data will be obtained from the condition of the system selection of specifications, operation, maintenance and repair of the applied pump so that an evaluation of the system can be carried out.

3. Data Sources.

The sources of data that will be collected from the research location for analysis include:

A. Primary data.

Direct data collection was carried out during field observations assisted by previously appointed officers. The data to be taken are:

1. Pump operating capacity
2. Fluctuations in water level
3. Spring elevation
4. Pump elevation – reservoir
5. Pipe network length, diameter and accessories
6. Panel chart
7. Directions/booklet

B. Secondary Data.

The data obtained from the literature studies carried out, coupled with existing data in the PDAM or any data that already exists and is used by the PDAM concerned. The data to be taken are:

1. Description of PDAM Tirtauli Pematangsiantar City
2. As built drawing of pump installation
3. Pump specifications from the pump manufacturer in the form of curves, types and brands of pumps
4. Pump operating system
5. Electric power consumption for pump operation

3. RESULTS AND DISCUSSION

An overview of the velocity with the pipe used in the pumping system is a 1 5 0 mm GIP pipe with Q = 0.0 2 7 1 m 3 / second:

Flow Continuity Formula : Q = V x A

$$\frac{1}{4} \text{ x } \Pi \text{x } D^2 \text{ x } V = 0.0271 \text{ m}^3\text{/second}$$

$$V = \frac{4\,x\,Q}{\Pi\,x\,D^2}$$

$$V \frac{(4)(0,0271)}{(3,14)(0,15)^2} = = \mathbf{1.53 \ \ m/sec}$$

Energy Speed (Ek)

From the data on the flow rate, we can determine

Energy Velocity with formula $\frac{V2}{2g}$

Energy velocity (Ek) $= \frac{V2}{2g} = \frac{(1{,}53)^2}{2\,x\,9{,}81}$ = **0 , 12 m**

*c.*Calculation of Minor *Head Loss in Suction* and *Discharge* Pipelines

Table 1. Pump Network Equipment

No	Name of goods	Size	Total	Unit	K . value	CHW	Total Value "K"
I.	Suction network:						
1	Galvanized Pipe	1 5 0 mm	2	m		13 5	
2	Strainers	1 5 0 mm	1	Unit	1.97		1.97
						Total Ks:	**1.97**
II.	NetworkPress (Discharge):						
1	Galvanized Pipe	1 5 0 mm	1260	m		13 5	
2	Gate Valve	150 mm	1	Unit	0,140		0,14
4	Bend 90^o GIP	150 mm	7	Unit	0,26		1,82
5	Bend 45^o GIP	150 mm	6	Unit	0,14		0,84
6	Inlet Kereservoir	150 mm	1	Unit	1,000		1
Jl. Kd							**3 , 8**
T total Amount Ks + Kd							5.77

Source: Calculation results

In the table above, the values obtained are:
Ks = 1.97
Kd = 3 , 80
From the data above, minor *head losses* can be calculated using the formula

hm $= \text{Ks x } \frac{V^2}{2xg}$

hms $= 1{,}970 \text{ x } \frac{(1{,}53)^2}{2\,x\,9{,}81}$ = **0,24 meter**

hmd $= 3{,}80 \text{ x } \frac{(1{,}53)^2}{2\,x\,9{,}81}$ = **0,46 meter**

Total *head* minor
∑hm = hms + hmd
= 0,24 meter + 0,46 meter
= **0,70 meter**
Calculation of *Head Loses Friction* in Transmission Pipelines From Springs to Reservoir
Known data :
Q pump = 0.0 2 7 1 m 3 / second
D = 100 mm = 0.1 5 0 meters
Pipe GIP →Chw = 13 5
L *suction pipe* = 2 mtr
L *discharge pipe* = 1260 meters

Calculation of Major *Head Losses in Suction* Pipe Networks

$$hfs = \left[\frac{Q}{0{,}2785\,xCHWxD^{2{,}63}}\right]^{1{,}85} x\,L$$

$$= \left[\frac{0{,}0271}{0{,}2785\,x135\,x\,0{,}15^{2{,}63}}\right]^{1{,}85} x\,2\,meter$$

= **0.03 meters _**

Calculation of Major *Head Losses in Discharge* Pipelines

$$hfd = \left[\frac{0{,}0271}{0{,}2785\,x135\,x\,0{,}15^{2{,}63}}\right]^{1{,}85} x1260\,meter$$

= **1 9 , 77 meters**

So :

hf = hfs + hfD

= **0.03 _** meters + **1 9 , 77** meters

= 19 , **8 0 meters**

hl = hf + hm

= **19 , 8 0 meters + 0.70 meters**

= **20.50 meters _**

Calculation of *Head Static (ht)*

The static head in this case is the height between the deep well water level and the highest pump *outlet pipe*

ht = - 6 meters

Head Calculation (Hp)

head calculation can be determined by using the following theorem:

Hp = hl + ht + Velocity energy (Ek)

= **20.50 meters** + (-6 meters) + 0.12 meters

= 1 **4, 62 meters**

Then the coordinates of the pump needs can be known:

Q = 0.0 2 7 1 m ^{3}/s = **97.56 m ^{3}/hour**

H = **14.62 meters**

4. CONCLUSION

In accordance with the conclusions of the research results obtained are:

Submersible Pump Specification Selection System at the location of the Simarito spring, Aek Nauli Village, South Siantar District, Pematangsiantar City :

Pump Specification Selection :

The selection of specifications is carried out against the provisions of the target that have not been right on target, this is evidenced by the graphic images in the manual issued by the pump manufacturer. However, according to the existing *performance cuve* , the capacity that should be pumped up to *the reservoir is* 30 l /s and the pump head is 37 meters , but according to the author's direct observation in the field (in this case the water *meter*), the pump's operating capacity only reaches 27 ,10 l/s .

This can happen due to several supporting possibilities, including:

1. The water meter is not installed , so the measurement results (with a portable water meter) are not updated .
2. From several physical conditions, the installed *accessories* may be damaged, causing higher *head losses and this* can affect the operating capacity of the pump.
3. The physical condition of the pump and or electric motor may have decreased performance, considering that the pump operating hours are applied for 2 hours in 1 (one) day, causing damage to certain parts of the pump components.

4. possibility of a leak in the *discharge pipe* , so that the capacity carried by the pump is not maximal as expected.

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