Journal of Physics: Conference Series

PAPER • OPEN ACCESS

The Loss Analysis Of Fresh Water Pump Pressure On PVC/*Paralon* Pipeline

To cite this article: Sri Pramono and Eko Julianto 2019 *J. Phys.: Conf. Ser.* **1273** 012082

The Loss Analysis Of Fresh Water Pump Pressure On PVC/*Paralon* Pipeline

Sri Pramono[1] and Eko Julianto[2]

[1]Teaching Staff at Veteran Naval Architecture Academy *(AkademiTeknikPerkapalan)* Semarang
[2]Teaching Staff at Diploma 3 Naval Architecture of Diponegoro University Semarang

Email: sripramono@yahoo.com

Abstract. Calculating fluid pressure number is important in designing a pipeline system. When fluid is passing through the pipe, the pressure number is decreased, resulting in the decreasing of height set by the pump. If the height of fluid pressure in the pipeline is higher than that set by the pump, the fluids will fail to deliver. This research used a *Sanyo* pump type P-WH137C with 125 Watt electrical power, 1.55 Ampere electric current, 220V-50Hz voltage, maximum capacity 30 liter/minute with maximum flow height on 30 m and maximum water temperature at 45°C. This research aimed to find out the loss of water pressure's height on two plastic pipes *(paralon)* sized 0.5 inch with 177 cm long and another one sized 0.75 inch with 102 cm long, each of which has one elbow and uses two valves.

1. Introduction

There are some components made up the the pipeline system, such as the pump as the power source to transfer fluid, pipe as the means of fluids distribution, elbow or connector and valve to control the fluids distribution.

Pump is a tool used to transfer or distribute fluids from one place to another. Fluids can be water, oil, lubricant, and fuel. To make the fluids move, the pump is needed as supporting component. The pump used in this research is a *Sanyo* pump type P-WH137C with 125 Watt electrical power, 1.55 Ampere electric current, 220V-50Hz voltage. It has maximum capacity of 30 liter/minute with maximum flow height on 30 m and maximum water temperature at 45°C.

Pipe is a long cylindrical thing whose base and end have holes. In the pipe, fluid or liquid can flow through it with certain rate of speed because there is pressure from the pump. Pipe can be categorized into some types based on its materials such as carbon steel pipe, carbon moly pipe, stainless steel pipe, duplex pipe, galvanized pipe, ferro nickel pipe, chrome moly pipe, and PVC/*paralon* pipe (www.cnzahid.com/2015/08/mengenal-fungsi-jenis-dan-komponen-pipa.html).

To control the flow of the fluid, a valve is needed to let the fluid flow when it is opened, and vice versa. The fluid's flow isl not always straight, sometimes it will turn right, turn left, go up or go down. Therefore, a connector or elbow which can in the form of L, T or I is needed. Because of the lack of

Journal of Physics: Conference Series **1273** (2019) 012082 doi:10.1088/1742-6596/1273/1/012082

knowledge in determining the size of pump's pressure, the intended height of the fluid, as a result, cannot be obtained.

2. Purpose

This research is aimed to find out the loss of water pressure's height in PVC/*paralon*pipes. If the loss number is below the height pressure set by the pump's default, then the water fluids can flow smoothly.

3. Method

The research data were collected as follows:

- Literature review: finding supporting theory from the internet, books, literature, magazines, pump's brochures and experts' study.
- Observation: implementing direct trial by arranging a work unit of pipeline system in the Campus Laboratory of ATP Veteran Semarang
- Interview: conducting interview with the Head Lecturer of UNDIP's Pump and Pipeline System course.

4. Result and Discussion

Pump's data: Maximum flow pressure height: (Ht) Maximum = 30 m
Maximum capacity = 30 liter/minute = 0.03 m^3/minute
= 0.03 m^3/60 second
= 0.0005 m^3/second

Continuty Equation: Q = $\boldsymbol{V . A}$
Where: Q = Flowrate (liter/second)
V = Flow velocity (m/second)
A = Area (m^2)
Formula: V = Q/A
Solution: V = 0.0005 (m^3/second)/0.00027597(m^2)
= 1.811 m/second
Measured data:

0.5 Inch pipe length	= 177 cm = 1.77 m
0.5 Inch pipe diameter	= 12.5 mm = 0.0125 m
0.5 Inch pipe elbow	= 2 pcs
0.5 Inch pipe valve	= 1 pc
0.75 Inch pipe length	= 102 cm = 1.02 m
0.75 Inch pipe diameter	= 18.75 mm = 0.01875 m
0.75 Inch pipe elbow	= 2 pcs
0.75 Inch pipe valve	= 1 pc

4.1 Head loss on pressure pipe with 0.5 inch diameter

The loss on the pressure pipe:
Due to friction:

$$Hf1 = \lambda \frac{I \cdot v^2}{d \cdot 2 \cdot g}$$

Where:
I = Pipe length ; 1.77 m
d = Pipe internal diameter ; 0.0125 m
λ = Friction factor from Reynold's number (Re)

Vmax = Maximum fluid velocity ; 1.811 m/second
Vmin = Minimum fluid velocity; 2.445 m/second

Then :
λ = 0.02; according to Darcy's Law
g = Standard gravity; 9.81 m/second^2
Therefore :

Hf1 max $= 0.02\ \frac{(1.77\ m)\ (1.811\ m/second)^2}{(0.0125\ m)\ (2)\ (9.81\ m/second)^2}$
= 0.473 m

4.2 Due to pipe 90^o degree bend

Hf2 = $fv\ \frac{v^2}{2\ .\ g}$ x 2 bend

Where:
Fv = Valve loss factor (Table 1)
= 0.946 sin^2 (Ø / 2) + 2.074 sin^2 (Ø / 2)
= 0.98
v max = Maximum fluid velocity; 1.811 m/second
v min = Minimum fluid velocity; 2.445 m/second
g = Standard gravity; 9.81 m/det^2

Therefore:

Hf2max= $0.98\ \frac{(1.811\ m/second)^2}{(2)\ (9.81\ m/second)^2}$ x 2
= 0.3275 m

4.3 Due to valve

Hf3 = $fv\ \frac{v^2}{2.g}$ x 1 pcs of valve

Where:
fv = Constant of rotary valve ; 0.6 (Table 1)
v max = Maximum fluid velocity; 1.811 m/second
v min = Minimum fluid velocity; 2.445 m/second
g = Standard gravity; 9.81 m/second^2

Therefore:

Hf3max $= 0.6\ \frac{(1.811\ m/second)^2}{(2)\ (9.81\ m/second)^2}$ x 1
= 0.10026 m

Total head loss due to friction on pressure pire (Hft) with 0.5 inch diameter is:
Hft max = Hf1 max + Hf2 max + Hf3 max
= 0.473 m + 0.3275 m + 0.10026 m
= 0.90076 m

4.4 Head loss on pressure pipe with 0.75 inch diameter

The loss on the pressure pipe:
Due to friction:

Hf1 $= \lambda \frac{I \, . \, v^2}{d \, . \, 2g}$

Where:
I = Pipe length ; 1.02 m
d = Pipe internal diameter ; 0.0875 m
λ = Friction factor from Reynold's number (Re)
Vmax = Maximum fluid velocity ; 1.811 m/second
Vmin = Minimum fluid velocity; 2.445 m/second

Then :
λ = 0.02; according to Darcy's Law (Picture 5)
g = Standard gravity; 9.81 m/second^2

Therefore :
Hf1 max $= 0.02 \frac{(1.02\ m)\ (1.811\ m/second)^2}{(0.01875\ m)\ (2)\ (9.81\ m/second)^2}$
= 0.1818 m

4.5 Due to pipe 90° degree bend
Hf2 = $fv \frac{v^2}{2 \, . \, g}$ x 2 bend

Where:
Fv = Valve loss factor (Table 1)
= 0.946 sin^2 (Ø / 2) + 2.074 sin^2 (Ø / 2)
= 0.98
v max = Maximum fluid velocity; 1.811 m/second
v min = Minimum fluid velocity; 2.445 m/second
g = Standard gravity; 9.81 m/det^2

Therefore:
Hf2max= $0.98 \frac{(1.811\ m/second)^2}{(2)\ (9.81\ m/second)^2}$ x 2
= 0.3275 m

4.6 Due to valve
Hf3 = $fv \frac{v^2}{2.g}$ x 1 pc of valve

Where:
fv = Constant of rotary valve; 0.6 (Table 1)
v max = Maximum fluid velocity; 1.811 m/second
v min = Minimum fluid velocity; 2.445 m/second
g = Standard gravity; 9.81 m/second^2

Therefore:
Hf3max $= 0.6 \frac{(1.811\ m/second)^2}{(2)\ (9.81\ m/second)^2}$ x 1
= 0.10026 m

Total head loss due to friction on pressure pipe (Hft) with 0.5 inch diameter is:
Hft max = Hf1 max + Hf2 max + Hf3 max

= 0.1818 m + 0.3275 m + 0.10026 m
= 0.60956 m

The pump's fluid pressure loss on 0.5 and 0.75 inch pipes are contributed by several factors for instance friction, 90^o degree bend and valve. With maximum height of pump's flow is 30 m, the flow on 0.5 inch pipe is decreasing. The calculation is as follows: 30 m – 0.90076 m = 29.09924 m. Meanwhile, 0.75 inch pipe also has a loss as follows 30 m – 0.6095 m = 29.3905 m.

5. Conclusion

From the above explanation, it can be concluded that the *Sanyo* pump type P-WH137C can deliver the fluids through PVC/*paralon* pipes smoothly. It was because the pressure loss of the pipe was still below the set criteria.

6. Suggestion

In designing the pipeline system, there may be a pressure loss caused by several factors. Based on the conducted experiment, it is suggested to choose a pump with bigger capacity to avoid a bigger pressure loss in order to make the fluid flow smoothly.

7. References

[1] Austin H.C, 2014 Pompa dan Blower Centrifugal, terjemah Zulkifli Harapan,Huntington, New York
[2] Biro Klasifikasi Indonesia, 2013, "Rules for Machinery Installations" Volume 3 Section 11
[3] https://sahputra1410.blogspot.com/2015/09/warna-warna-di-atas-kapal menurut-imo.html
[4] https://sekedartulisanweb.wordpress.com/.../bagian-bagian-dari-pompa-air sentrifugal/11 Mei 2016
[5] http://kapal-cargo.blogspot.com/2011/06/jenis-pipa-pada-kapal.html
[6] http://kawatlas.jayamanunggal.com/2011/06/sistem-perpipaan-di-kamar-mesin/
[7] Kiryanto,MT,Ir. 2015, "Buku Ajar Sistem Dalam Kapal"Semarang.
[8] www.cnzahid.com/2015/08/mengenal-fungsi-jenis-dan-komponen-pipa.html.