Hydraulic analisys of drinking water pipeline inter island

by Tri Suyono

IOP Conference Series: Materials Science and Engineering

PAPER · **OPEN ACCESS**

Hydraulic analisys of drinking water pipeline inter island

To cite this article: Tri Suyono *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **508** 012035

Hydraulic analisys of drinking water pipeline inter island

Tri Suyono[1*], Wati Asriningsih Pranoto[2], Agustinus Purna Irawan[2]
[1]Doctoral Civil Engineering Universitas Tarumanagara and Faculty of Engineering Universitas Khairun
[2]Faculty of Engineering Universitas Tarumanagara

* tri_suyono78@yahoo.com

Abstract. One important study is the hydraulic study of water flow in the pipeline so that it can provide technical certainty that the water distributed to the destination island is in accordance with the plan to meet the drinking water needs of the island until the projected year between 15-30 years. This study used as a reference for selecting pipe specifications that are in accordance with the workload, so that the pipe is not damaged when the system is operated. Hydraulic analysis performed using Epanet 2.0 software with preferred output analysis is the flow velocity, pressure and capacity of water coming out of the pipe. In the hydraulic study of the underwater drinking water pipeline from Tidore Island to Maitara Island, the maximum pressure that works on the sea-based pipeline is obtained, the minimum speed up to the maximum water in the pipeline and the water capacity entering the Maitara island reservoir is 17.20 bar, 0. 4 - 2.26 L/s and 25.82 L/s. Considering the results of these calculations, the pipe specifications were selected with a 110 mm PN diameter High Dencity Polyethelin (HDPE) pipe with 20 lined three lane lines, with technical considerations of installation and operation and maintenance. The system, this pipeline can meet the drinking water needs of Maitara Island both domestic and non-domestic until the projected year of 2040 is 22.7 L/s. Keywords: Hydraulic, pipeline, drinking water

1. Introduction

Some uninhabited islands in Indonesia do not have the potential of raw water for drinking water, so that local people currently rely on rainwater to meet their drinking water needs, while in the long dry season local residents take water from nearby islands. The development of drinking water pipelines between islands is one solution to meet drinking water needs, islands that do not have the potential for raw water for drinking water. In the design of inter-island drinking water pipelines one of the main factors that must be studied is hydraulic analysis [1]. The need for hydraulic analysis is to get the confidence that the water flowed to the destination island is able to meet the expected needs and technical aspects. Some technical aspects that are needed are capacity, pressure and speed. These three factors are very important because to find out the level of security of the pipe that is high from the influence of pressure in the pipe. The capacity of the water flowing to the destination island must be in accordance with the needs, and the pressure in the pipe must not exceed the capacity of the pipe, as well as the flow velocity is not less than 0.3 m/s and 2.5 m/s. If the hydraulic studies have been carried out by producing study results that are in accordance with the criteria of planning that are carried out carefully and carefully, then after the construction of the completed pipeline will not cause severe technical problems [2]. Hydraulic analysis also functions to get pipe specifications and accessories, so that the pipes and accessories are not damaged when and after the system is operated [3], [4].

Inter-island drinking water pipelines with subsea pipelines are strongly influenced by the depth of the sea and the distance between islands, water conditions and the condition of the seabed. Contour conditions in the sea tend to be uneven, this will result in a lot of pressure flow losses in the pipe, as well as friction in the flow in the pipe, the longer the pipe, the greater the friction value [5], [6], [7]. The high value of friction in the pipe will reduce the water pressure in the output section. For this reason, this study needs to be done carefully by selecting the appropriate pipe size. This study was carried out on the underwater drinking water pipeline from Tidore Island to Maitara Island along 1,600 m with an average depth of 42 m below sea level.

2. Pipeline

Provision of drinking water in Maitara Island, North Maluku is carried out with an inter-island underwater drinking water pipeline system by extracting water from bore wells in Fobaharu village, Tidore Island, drilling wells having a depth of 100 m below ground level and installing pumps at a depth of 60 m below ground level, then the water is flowed into the reservoir and then distributed by gravity to Maitara island [8], [9] [10]. The wellbore elevation is 132 m above sea level and the reservoir elevation is at an elevation of 146 m above sea level, which is channeled to the Maitara island by gravity by passing the sea which has an average depth of 42 m below sea level and water is fed into the reservoir on Maitara Island which is at an elevation of 52 m above sea level, and then distributed to community settlements which are at an elevation between 2 - 34 m above sea level, with the distance to the farthest settlement is 5.8 km so that the distribution can be done with a gravity system. Schematic of the drinking water pipeline system from Tidore Island to Maitara Island as shown in Figure 1.

Figure 1. Schematic of the pipeline of Tidore Island to Maitara Island

3. Analysis Method

Hydraulic analysis is done using Software Epanet 2.0 using the following equation:

a. HARDY CROSS method

Some equations used:

- Mass Balance Equation [11]

$$\mathbf{Qin} = \mathbf{Qout}$$

Continuity Equation [1]

$$\mathbf{Q} = \mathbf{V \cdot A}$$

$$= \mathbf{V \cdot (\tfrac{1}{4} \cdot \pi \cdot D^2)}$$

$$A1 \cdot V1 = A2 \cdot V2$$

Where:

Q	: flow rate	(m^3/s)
D	: pipe diameter	(m)
A1	: initial cross-sectional area	(m^2)
A2	: final cross-sectional area	(m^2)
V1	: initial flow speed	(m/s)
V2	: final flow speed	(m/s)

- Hazen Williams Equation [12]

$$Hf = \left\{ \frac{Q}{0.2785 * C * D^{2.63}} \right\}^{1.85} \times L$$

Where:

L	: pipe length	(m)
Hf	: head loss / major head along a straight pipe	(m)
D	: pipe diameter	(m)
Q	: flow rate	(L/s)
C	: Hazen Williams coefficient (the amount depends on the type of pipe used)	

- Debit Correction (ΔQ) [13]

$$\Delta Q = - \left\{ \frac{\Sigma Hf}{1.85 \times \Sigma (Hf/Q)} \right\}$$

- Check debit [14]

$$Q = Qa - \Delta Q$$

Where:

Q	: actual debit
Qa	: assumption debit
ΔQ	: debit correction

The calculation method is:

a) Assume the direction, discharge, and diameter of the pipe in the system, with the amount entering the same amount of discharge coming out with the flow velocity in the pipe ranging from 0.3 - 2.5 m / s.
b) Calculate the headloss of each loop based on the assumption debit by observing the direction of flow (if clockwise (positive), if counterclockwise - (negative)).
c) Calculate the number of Hf/Q atau k x $Q^{0.25}$ values regardless of the sign.
d) Calculate the correction discharge, and correct each loop.
e) Repeat the above procedure for each loop, to obtain the smallest possible discharge correction (near zero) [15].

4. Results and discussion

Selection of pipe specifications based on hydraulic studies on the underwater drinking water pipeline will also determine several other technical aspects, including the determination of pipe

IOP Conf. Series: Materials Science and Engineering **508** (2019) 012035 doi:10.1088/1757-899X/508/1/012035

weight concrete which includes weight, size, installation distance and quality of concrete. In addition, it will also affect the dimensions and type of towing rope, specifications for pipe pulling pipes and pipe ballast mounting pipes. Knowing the hydraulic conditions of the flow in this pipe is the basis of other technical calculations [16], [17], [18]. Analysis carried out with Epanet 2.0 on the underwater drinking water pipeline from Tidore Island to Maitara Island with a distance of 1,600 m as shown in figure 2, 3 and 4 obtained a maximum pressure of 17.20 bar, flow velocity between 0.4 - 2, 26 m/s and the capacity of water entering the Maitara Reservoir is 25.82 L/s. The highest pressure occurred in the pipeline at the deepest sea level at a depth of 68 m.usl of 17.20 bar. Taking into account the results of the analysis, the use of HDPE PN pipe type 20 bars outer diamater 110 mm with a thickness of
2.2 cm are in accordance with technical criteria.

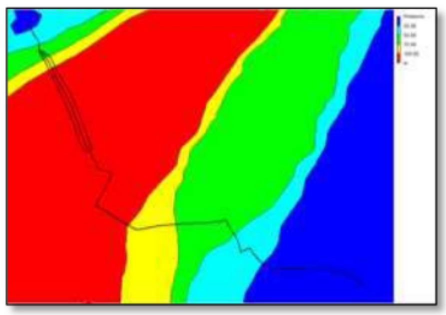

Figure 2. Contour Plot Pressure of drinking water pipeline from Tidore Island to Maitara Island

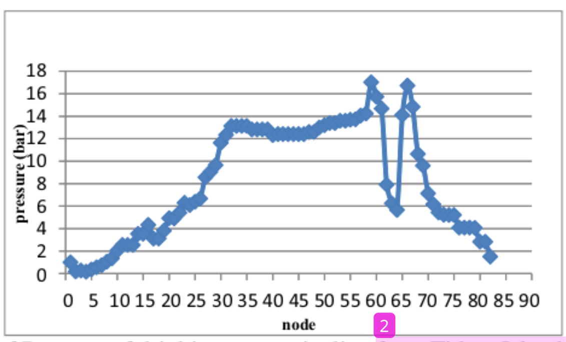

Figure 3. Chart of Pressure of drinking water pipeline from Tidore Island to Maitara Island

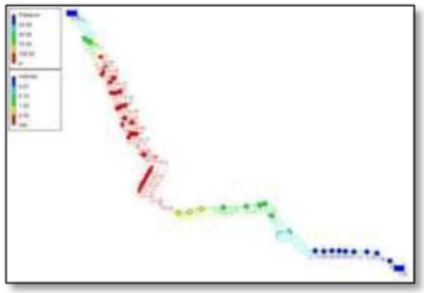

Figure 4. Map of pressure and velocity of drinking water pipeline from Tidore Island to Maitara Island

Figure 5. Documentation of drinking water pipeline from Tidore Island to Maitara Island

5. Conclusion

Hydraulic study is a basic study in the technical calculation of underwater drinking water pipelines, and is a reference of all technical calculations. The inter-island drinking water pipeline system installed on the very seabed from Tidore Island to Maitara Island based on hydraulic studies using software Epanet 2.0 is very suitable when using HDPE type pipes with 20 bars Pressur Nominal specifications with 110 mm diameter and 3 lanes pipes that are installed in a row with a certain distance follow the condition of the seabed. Water capacity that can be distributed at 25.82 L/s can meet the needs of the community on the island of Maitara in the 2010 projected year of 22.7 L/s and maximum water pressure at the deepest sea point of 17.20 bars.

6. References

[1] Brennan, M. K., Karimi, M., Almeida, F. C. L., Almeida, F. C. L., de Lima, F. K., Ayala, P. C., Obata, D., Paschoalini, A. T., Kessissoglou, N. 2018 *Journal of Sound and Vibration* 427: 120-133.
[2] Dey, S., Singh, N. P. 2007 *Journal of Hydro-enviroment Research* 1:157-162.
[3] Li, X., Chen, G., Zhang, R., Zhu, H., Fu, J. 2018 *Process Safety and Environmental Protection* 19: 46-57.
[4] Rizzini, D. L., Kallasi, F., Aleotti, J., Oleari, F., Caselli, S. 2017 *Computer and Electrical Engineering* 58: 560-571.
[5] Shamsuddoha, Md., Islam, Md. M., Aravinthan, T., Manalo, A., Lau, K. 2013 *Composite Structures* 100: 40-54.

[6] Sibue, C. Mulyadi, Y., Rochani, I. 2016 *Jurnal Teknik ITS,* Vol. 5, No. 2. ISSN: 2337-3539.
[7] Yang, L., Nie, S., Yin, S., Zhao, J. Yin, F. 2015 *Ocean Engineering* 104:168-184.
[8] Zhu, H., You, J., Zhao, H. 2017 *Applied Ocean Research* 64:217-235.
[9] Guo, B., Song, Shanhong, Ghalambor, A., Lin, T., Chacko, J. 2005 *Gulf Professional Publishing*. ISBN: 9780080456904.
[10] Hardi, W., Suyono, T. 2016 *Semnas Maritim, Sains dan Teknologi Terapan*, Vol. 01.
[11] Ibrahim, M., Masrevaniah, A., Dermawan, V. 2012 *Jurnal Pengairan*, Universitas Brawijaya.
[12] Lock, A., Spiers, G., Hostetler, B., Ray, J., Wallschlager, D. 2016 *Water Research 93: 289-295*.
[13] Cheng, L., Yeow, K., Zang, Z., Lie, F. 2014 *Coastal Engineering* 83: 137-149.
[14] Abidin, Z. 2008 *Skripsi*. Fakultas Teknik Sipil dan Lingkungan, Institut Teknologi Bandung.
[15] Brennan, M. K., Karimi, M., Almeida, F. C. L., de Lima, F. K., Ayala, P. C., Obata, D., Paschoalini, A. T., Kessissoglou, N. 2017 *Procedia Engineering* 199: 1350-1355.
[16] Supena, M. 2011 *Skripsi*. Fakultas Teknik, Universitas Indonesia.
[17] Wang, Z., Xiong, W., Ting, D. S. K., Carriveau, R., Wang, Z. 2016 *Applied Energy* 180: 810-822.
[18] Wang, Y. G., Liao, C. C., Wang, J. H., Jeng, D. S. 2018 *Ocean Engineering* 164: 114-126.
[19] Cheung, B. C., Carriveau, R., Ting, D. S. K. 2014 *Applied Energy* 134: 239-247.

Hydraulic analisys of drinking water pipeline inter island

ORIGINALITY REPORT

6%	6%	3%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	mafiadoc.com Internet Source	3%
2	bpsdm.pu.go.id Internet Source	1%
3	arpnjournals.org Internet Source	1%
4	Kalle Sognnes. "ON SHORELINE DATING OF ROCK ART", Acta Archaeologica, 10/2003 Publication	1%
5	www.24houranswers.com Internet Source	1%
6	psecommunity.org Internet Source	<1%
7	ebin.pub Internet Source	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		