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ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

Energy Comparison between Tank Reservoir and Pumping Station System at Water Clean Network for Housing Complex

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ABSTRACT: Water is a vital necessity for the survival of the sector is living beings especially human beings. Because of it, the handle of good water is a priority needed. One of the way to complete the good water needs increase of the which is a good plan with making energy efficient way of its distribution. One of the way to good planning the distribution is doing by numerical method in this case use a EPANET software. This case compare the energy used for the tank reservoir method withe pumping station and result study showed value energy of the Pumping station was higher that than tank reservoir distribution it is This study give information about effectiveness Tank distribution comparison with pumping station in housing complex

KEYWORDS: Pump, Tank, Pipe Network, Housing Complex

I. INTRODUCTION

Water is the element that can not be separated from human life. Surely, without consistently of the development of water resources that human civilization will not reach the levels enjoyed till now. Therefore, development and processing of water resources are the basis of human civilization (Sunaryo et al , 2005). Because the importance of the need for clean water, it is normal if the water sector get priority treatment because concerns of major people's lives. Piping system is a component of the water supply, so developed properly in order to get an increase in the quality and quantity of the distribution is needed. One effort to increase the quantity of the water distribution is a good piping system plan. This planning is done by applying the concepts of hydraulics and minimize of using of energy.
In this time generally the energy that used in distribution in housing complex it is a pumps method, but we have to comparison with tank distribution method. Because tank distribution method will give solution for streamline distribution energy in housing complex. This research we will comparison between tank distribution method with pumps distribution method for looking where distribution method that streamline the energy consumption so we will to give opinion for streamline energy in housing complex.
This research using data from housing complex in Balikpapan city, where they use a pumps method for distribution water to houses, they think pump method is the better with the other method, and no method is better than this, so that. We will comparison the water tank method and pumping station method, for looking for that where method that use energy is smaller.

II. BASIC TEORY

Clean Water Distribution Systems

The hydraulic integrity of a water distribution system is defined as its ability to provide a reliable water supply at an acceptable level of service—that is, meeting all demands placed upon the system with provisions for adequate pressure, fire protection, and reliability of uninterrupted supply (Cesario, 1995; AWWA, 2005). Water demand is the driving force for the operation of municipal water systems. Because water demands are stochastic in nature, water system

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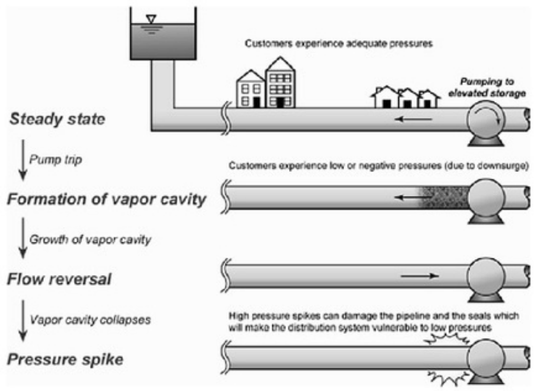
operation requires an understanding of the amount of water being used, where it is being used, and how this usage varies with time. For most water systems the ratio of the maximum day water demand to the average day water demand ranges from 1.2 to 3.0, and the ratio of the peak hour to the average day is typically between 3.0 and 6.0. Of course, these values are system specific, and seasonal variations may make these ratios even more extreme (Walski et al., 2003). Demands may be classified as follows (Clark et al., 2004):



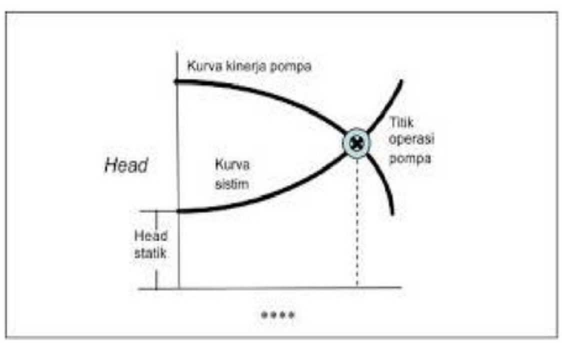


Figure 1Hydraulic events following a pump trip.

The picture 1 shown The system is pumping drinking water to an elevated storage tank while serving the intermediate customers with adequate pressures. Due to an unexpected power failure, the pump quickly runs down (loses speed). This will create a negative pressure wave (downsurge) that will propagate into the distribution system, putting the customers at a potential intrusion risk due to negative pressures. In addition, it is possible that the pressure drops to the point that a vapor pocket forms adjacent to the pump. Subsequently, this cavity will collapse and produce a large pressure spike that can damage the pipeline and the seals which will make the system even more vulnerable to low pressure events.

Pump is a device that used to move liquids by increasing the energy level of the liquid. Head and flow rate determine the performance of a pump which is graphically shown in a picture as a performance curve or the pump characteristic curve.Determine value of the power for a pump can be calculated using the calculation Shaft Power and Water Power.

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It also influence from the curve of pump, which is when the value of head or flow rate increase would making increase number of the shaft power and water power.

Hydraulics

Hydraulics is the engineering science that studies the behaviour of liquids in a state condition or moving either. Hydraulics can be divided into two areas, they are hydrostatic which study of a state condition liquid and hydrodynamics which study of liquid in motion. (BambangTriatmodjo , 1993) . In the pipeline are generally applicable Law Continuity and Bernoulli's Equation.

The continuity law is discharge of water that comes out on a pipeline would be the same if the water is not coming out on its distribution as in this following equation:

$$QA = QB \qquad (1)$$
$$A1\ V1 = A2\ V2 \ (2)$$

Where:

QA = Discharge on pipe A (m^3 / s)
QB = Discharge on pipe B(m^3 / s)
A1 = Area of the pipe 1(m^2)
A2 = Area of the pipe 2(m^2)
V1 = Velocity on pipe 1 (m / s)
V2 = Velocity on pipe 2 (m / s)

Then the Bernoulli equation of energy flow and energy loss that occurs in the piping system as shown in this following equation:

$$z_1 + \frac{\rho_1}{\gamma} + \frac{V_1^2}{2g} = z_2 + \frac{\rho_2}{\gamma} + \frac{V_2^2}{2g} + \sum h \ (3)$$

Where:

z = Elevation height (m)
$\frac{\rho}{\gamma}$ = High pressure (m)
$\frac{V^2}{2g}$ = High velocity (m)
$\sum h$ = Total power loss between two points that were reviewed (m)

Numerical Solution

Numerical program use Epanet where this program can which shown the hydraulic simulated and water quality that flowing in the pipeline. The EPANET is a computer program that performs extended period simulation ofhydraulic and water quality behavior within pressurized pipe networks. A networkconsists of pipes, nodes (pipe junctions), pumps, valves and storage tanks orreservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node,the height of water in each tank, and the concentration of a chemical speciesthroughout the network during a simulation period comprised of multiple time steps.In addition to chemical species, water age and source tracing can also be simulated.EPANET is designed to be a research tool for improving our understanding of themovement and fate of drinking water constituents within distribution systems. It canbe used for many different kinds of applications in distribution systems analysis.Sampling program design, hydraulic model calibration, chlorine residual analysis,and consumer exposure assessment are some examples. EPANET can help assessalternative management strategies for improving water quality throughout a system.These can include:

- altering source utilization within multiple source systems,
- altering pumping and tank filling/emptying schedules,
- use of satellite treatment, such as re-chlorination at storage tanks,

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· targeted pipe cleaning and replacement.

Running under Windows, EPANET provides an integrated environment for editingnetwork input data, running hydraulic and water quality simulations, and viewing theresults in a variety of formats. These include color-coded network maps, data tables,time series graphs, and contour plots.Full-featured and accurate hydraulic modeling is a prerequisite for doing effectivewater quality modeling. EPANET contains a state-of-the-art hydraulic analysisengine that includes the following capabilities:

- places no limit on the size of the network that can be analyzed
- computes friction headloss using the Hazen-Williams, Darcy - Weisbach, or Chezy-Manning formulas
- includes minor head losses for bends, fittings, etc.
- models constant or variable speed pumps
- computes pumping energy
- models various types of valves including shutoff, check, pressureregulating, and flow control valves
- allows storage tanks to have any shape (i.e., diameter can vary withheight)
- considers multiple demand categories at nodes, each with its ownpattern of time variation
- models pressure-dependent flow issuing from emitters (sprinklerheads)
- can base system operation on both simple tank level or timer controlsand on complex rule-based controls.

III. Research Methodology

This study separated into 3 stages , they are :

a. Stages of preparation
b. Stages of data collection
c. Stages of data analysis

Stages of Preparation

Stages of preparation is done by finding the formulation the purposes so it will get the related goals of research. Numeric application method needed for help analysis power pumps energy so need a map to be used as a simulation object as below,

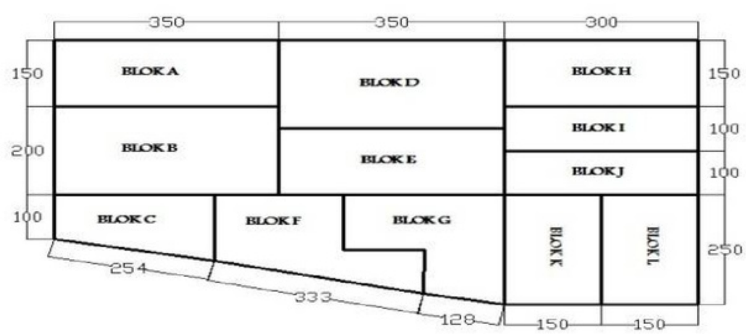

Figure 2 Map of the distribution network

The picture 2 showed housing complex to be designed water clean distribution where design will comparison between tank pressure distribution system with pump distribution system

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Stages of Data Collection
At this stage, the object to be studied have been available below,

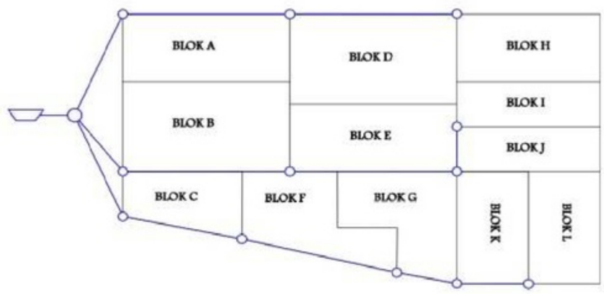

Figure 3 Direction of distribution pipes

The figure 3 showed made junction box picture and pipe distribution lines, for input to program but another data that need to known for doing the simulation including:

a. Direction of distribution network
b. Need for clean water
c. Pipe characteristic

Stages of Data Analysis
The data values are incorporated into numeric for the calculate hf value and we have to calibration with manual calculation. after that vertical direction of tank reservoir made higher that corresponding to hf that obtained from the horizontal calculation. It is intended that hf happens on distribution be replaced by gravitational forces created. figure 4 can shown it.

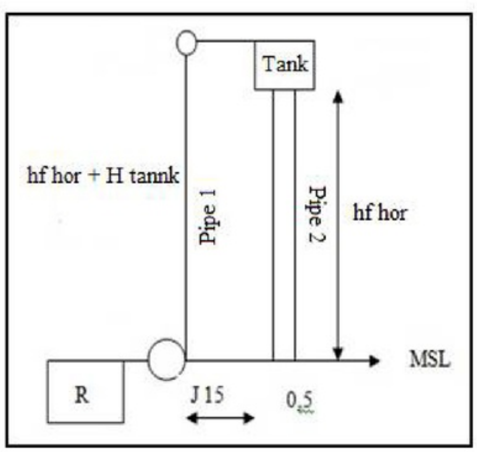

Figure 3 Direction pumping vertically

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The picture 3 showed hf value for pumping water to reservoir for distributed in housing complex, where this case the tank reservoir to be a pumps for distribution

IV. DISCUSSION RESULTS

Before simulation with the network complex we have to comparison between manual calculation and numerical calculation for doing testing the value of the high loss between the manual calculation and numerical values and result showed such in table 1

Table 1 Comparison of manual calculations and Epanet 2.0 software

		Friction	Velocity	H max	H min	Total
Calculation	Pipe 1	0.180	0.85	0.13		0.13
	Pipe 2	0.170	1.91	1.58	0.09	1.67
	Pipe 3	0.170	1.91	1.28	0.02	1.30
				Total Head		3.10
Numerik	Pipe 1	0.017	0.85	0.13		0.13
	Pipe 2	0.016	1.91	1.50		1.50
	Pipe 3	0.016	1.91	1.20	0.17	1.37
				Total Head		3.00

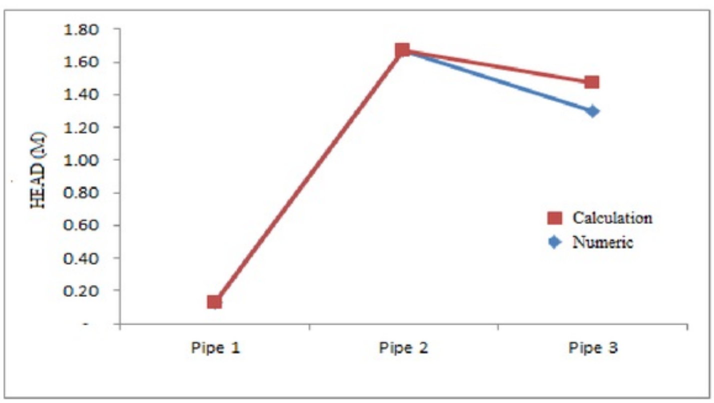

Figure 4 Comparison of manual calculations and Epanet 2.0 software

The table 1 and figure 4 showed the result trend between manual calculations with numeric method for, from that result we can say the numerik can be use for analysis at the network compleks, because result of numerical methode and manual calculation method is very identic.

At comparison energy between the simulated vertical direction of pump and horizontal direction of pump with a fixed discharge showed vertical system needed the greater than with horisontal system as show in following figure

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Table 2 Results of pumping both horizontal and vertical directions to fixed discharge

DIRECTION	Diameter (mm)	Debit (LPS)	Head (m)	Energi (kWh/m3)
Horisontal	101.6	47.85	22.05	**0.08**
Vertikal	101.6	47.85	30.06	**0.11**

The difference of energy requirements is due to the influence of the head loss value due to friction force (hf), This value makes the energy consumption of pump becomes higher in the vertical direction of pumping, but in housing cluster the water discharge for distribution not fixed, because very depending on the activities of housing occupants..
After knowing time of teactivities of housing occupants, so we can calculate energy requirement for the network, where the result can be showed in table 3 and table 4

00:00 - 04:00 = multiplier 0.5
04:00 - 08:00 = multiplier 1.75 (peak hours)
08:00 - 12:00 = multiplier 1
12:00 - 16:00 = multiplier 1
16:00 - 20:00 = multiplier 1.75 (peak hours)
20.00 - 24.00 = multiplier 0.5

Those values are then inputted into Numeric analysis and the resulting value as following

Table 3 Results of horizontal direction of pumping with the fluctuate discharge

TIME	Head (m)	JP Faktor	DISCHARGE	Δ t	Volume (Liter)	Energi (kWh/m³)
00.00 - 04.00	7.01	0.5	23.96	4	345024	0.03
04.00 - 08.00	**61.11**	**1.75**	**83.77**	**4**	**1206288**	**0.22**
08.00 - 12.00	22.05	1	47.85	4	689040	0.08
12.00 - 16.00	22.05	1	47.85	4	689040	0.08
16.00 - 20.00	**61.11**	**1.75**	**83.77**	**4**	**1206288**	**0.22**
20.00 - 24.00	7.01	0.5	23.96	4	345024	0.03
TOTAL					**4480704**	

Table 4 Results of vertical direction of pumping withthe discharge follow the volume of fluctuations

Waktu	Head (m)	DISCHARGE	Δ t	Volume (Liter)	Energi (kWh/m³)
00.00 - 05.00	87.81	62.2	5	1120176	0.32
05.00 - 06.00			1		
06.00 - 11.00	87.81	62.2	5	1120176	0.32
11.00 - 12.00			1		
12.00 - 17.00	87.81	62.2	5	1120176	0.32
17.00 - 18.00			1		
18.00 - 23.00	87.81	62.2	5	1120176	0.32
23.00 - 24.00			1		
TOTAL				**4480704**	

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The results of calculation the value of energy showed using pumps for distribution water in housing clusterrequiring greater energy than the tank pressure distribution method. this matter showed in Figure 5 and Figure 6.

Data for numeric simulation can be seen below

Horizontal:	Vertical:
Q = 90 l/sec	Q = 90 l / sec
H = 70 m	H = 90 m
Eff = 75 %	Eff = 75 %
Power = 67 kW	Power = 72 kW

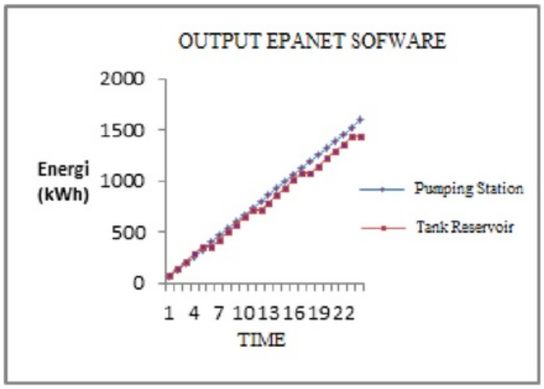

Figure 5 The comparison graphof pump energy between Pumping Station and Tank Reservoir distribution of long periods with software Epanet 2.0

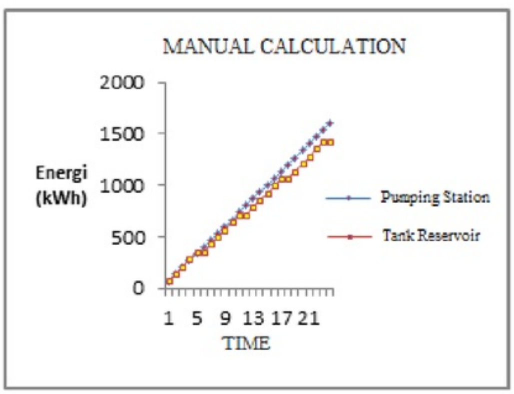

Figure 6 The comparison graphof pump energy between Pumping Station and Tank Reservoirdistribution of long periods with manual calculations

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From the analysis, so it can get the conclusion that the distribution with tank for long periods is much more efficient than pumping in the horizontal direction. This value is due to the horizontal pump direction have to have permanent a large capacity to meet the water needs fluctuate, while the discharge flowed not always much but the power that used is still big. This value certain is bigger than the power used in pumping the tank distribution method, because the tank distribution method does not made a pump work all time.

V. CONCLUSION

1. Numerical Method has in common trend with the calculations manually so for the more complex system of distribution network would be more efficient to use numerical method for ease in carrying out the calculations.
2. Energy pump for tank distribution system more efficient compared with the station pump system on a long period with fluctuate discharge of analysis that tailored to the with the needs of residents of the housing, where energy for tank distribution need 1400 kWh per day and for pumping station need 1600 kWh per day.

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