PRESSURE HEAD ANALYSIS OF WATER SUPPLY DISTRIBUTION NETWORK OF ABUBAKAR TATARI ALI POLYTECHNIC BAUCHI USING EPANET 2.0

Sagir Yusuf A., Baba Babangida and Bukata Yakubu
Department of Civil Engineering
Abubakar Tatari Ali Polytechnic, Bauchi
engr.sagir@gmail.com

ABSTRACT
This research presents Pressure head analysis of water distribution network in Abubakar Tatari Ali Polytechnic, (ATAP) Bauchi. It consist of 19 pipes of different sizes, 15 junctions, 1 tanks and one source reservoir from which water is pump to the overhead surface reservoir and then distributed to the network. The current water demand was estimated to be 596.888 m3/day. The study applied EPANET 2.0 to analyse the distribution system. The current water distribution network system was analysed and it was found that the performance of the current water distribution network system under the present water demand is inefficient with 60% of the total nodes having negative pressure head after 3 hour of simulation. It was found that out of the 15 nodes 9 nodes have pressure head less than 14 m as against the AWWA recommended pressure head of 15 m to 70 m.

Keywords: Pressure head, Water distribution, negative pressure, demand, EPANET

1. INTRODUCTION

Water makes life possible, and without it no development will take place, as man's standard of living increase so his requirements of water (Arunkumar & Mariappan, 2011). In modern times there is a close relationship between availability of water, public health and economic development. Water is one of the abundant Resources as well as a basic needs of man and it management has become more important especially in the present of the current economic challenges. Water supply and distribution are central to improvements in so many aspects of human development, such as health, education and poverty reduction.

The importance of water in the maintenance of life and health makes it an essential human need that as a matter of right should be provided to all human beings, irrespective of class or residence (Ordinioha & Adeosun, 2008). One of the main objectives of water supply system is to provide safe portable water for domestic use, adequate in quantity at sufficient pressure for fire protection and for industrial use (Ayanshola & Sule, 2006).

Water supply system consists of source, treatment plant, pumping station, storage reservoirs and distribution system. Water supply sources that can be exploited usually include surface supply, ground water supply, reclaimed water and desalinated water. Large cities generally use surface water to meet their demand, whereas many small and medium size town/area use ground water of adequate quantity.

1.1 Location of Study Area

Abubakar Tatari Ali Polytechnic, Bauchi is located between latitude $10^0 18'$ 43" – 10^0 18' 45.4" N and longitude 009^0 46' 24.6"- 009^0 46'01.6" E (Observed by GPS 76), it is along Bauchi Jos road about 500 m to NNPC mega station. It is bounded by Tambari housing Estate to the East.

Water supply and distribution in Abubakar Tatari Ali polytechnic has become a serious concern of the current management of the institution, shortage of water lead to demonstration of student in so many campuses.

The study area has been witnessing an increase in student population in the past two years following the movement of School of General Studies to the Main Campus as well as increase in the number of accredited course by the National Board for Technical Education (NBTE).

Map of the study area

2. LITERATURE REVIEW

Early humans had to carry their water from the source to the point of consumption. With such an effort required, only minimal water for drinking and washing was available. The large volumes of water that we use today for showering, toilet flushing, fire fighting and irrigation could not be delivered manually (Walski, 2006).

2.1 Water Demand

Major consideration in designing water supply is the water demand of the population being served, the fire flow needed to protect life and properties and the proximity of the service area to source of water.

Total domestic water need is at least 115 litters per day in modern household for drinking, flushing, washing, laundry and personal hygiene (Saminu, Abubakar, & Sagir, 2013).
(Onuaha, Idike, & Orankwe, 2012), documented a water requirement of 135 litres per day in research conducted in Auchi, Edo state, while, (Bauchi State Ministry of Water Resources, 2012), recommends a demand rate of 80 litres per day in Bauchi State.

2.2 Population Data

Population data is another consideration in designing a well-articulated water distribution network. Forecasting future population of an area is very vital in the design of water distribution system because the system must be designed to meet the current and future demand of the area. The simplest models commonly used are:

i. Arithmetic method
ii. Geometric Method
iii. Graphical Method:

The current population of the study area was used to analyses the system and it was obtained from the Registry department of the polytechnic.

3. MATERIAL & METHOD

3.1 Data Collection

The data collected relied mainly on secondary information. In order to carry out the research work the following information were obtained;

i. Population Data from Registry Department of the Polytechnic. (2016 figures).
ii. Water supply records from Works Department ATAP

iii. Elevations of various point

3.2 Steps in Using EPANET

Typically the following steps are used to model water distribution system using EPANET

1. Draw a network representation of your distribution system.
2. Edit the properties of the objects that make up the system.
3. Describe how the system is operated.
4. Select a set of analysis options.
5. Run a hydraulic/water quality analysis.
6. View the results of the analysis.

4. RESULT AND DISCUSSION

4.1 Water use Estimation

The study area falls under the category of urban settlement and according to (Bauchi State Ministry of Water Resources, 2012) 80 lpcd was considered.

The water demand is evaluated by multiplying consumption rate per head per day with the estimated population; the result is shown in Table 1.

Table 1 Water use Estimation of Abubakar Tatari Ali Polytechnic

Year	Population	Consumption litres/head/day	Water Demand (litres/day)
2016(current)	7461	80	596,800

4.2 Estimations of Nodal Demand

In order to obtain the nodal demand the following are considered:

i. **Population Demand, Fire Demand** In this case 10% of the population demand is added as fire demand (Lingkunga, 2012). **Minor Losses:** A provision of 5% is made for minor losses. This is to take care of losses at fittings, valves and bends (Adeniran & Oyelowo, 2013). **Unaccounted For Water (UFW)**. UFW can range between 10% and 30%. The study area for this work is located in Bauchi State and 31.54% is allowed for as UFW (Bauchi State Water Board, 2014). The current nodal drawn off is evaluated as presented in Table 2. Table 2 Nodal drawn off

YEAR	POPULATION	DAILY DEMAND (Lpd)	DEMAND (lps)	FIRE DEMAND 10% (lps)	MINOR LOSS 5% (lps)	UFW 31.54% (lps)	TOTAL NODAL DRAWN OFF(lps)	NODAL DRAWN OFF(lps)
2016	7,461	596,880	6.91	0.69	0.35	2.18	10.12	0.14

One of the Node and the overhead reservoir (Tank)

4.3 Nodal Pressure Head Situations

The result of pressure head in meter for each of the node in the distribution system for an extended period simulation of 3 hour is as shown in Table 3.

Table 3 Pressure head at 3hr.

Node ID	Elevation (m)	Pressure Head (m)
Junc 1	619	19
Junc 2	620	18
Junc 3	620	18
Junc 4	622	16
Junc 5	626	12
Junc 6	630	8
Junc 7	629	9
Junc 8	632	6
Junc 9	628	10
Junc 10	626	12
Junc 11	630	8
Junc 12	628	10
Junc 13	617	21
Junc 14	619	0
Junc 15	626	11

Epanet 2.0 was used to design the water supply system of the case study area. The analysis of any water distribution system include the determination of pressure head at various junctions, quantities of flow as well as head loss in the pipe lines.

The minimum residual pressure for pipe network system varies from one country to another. According to Bhardwaj, (2001) the recommended minimum pressure heads very between 25m and 28m and maximum pressure heads vary between 70m and 84m. A lower value of residual pressure head looks to be economical since the distribution cost will be reduced as excess residual pressure head could lead to pipe busting. AWWA recommend a pressure head value of 15 m to 70 m (Bhardwaj, 2001). Generally, Pressure head of 4m to 14m could be viewed as insufficient since the value in these ranges generally fall below the minimum pressure requirement of some appliances (Jacobs & Strinjdom, 2009).

The results for the pressure heads at the nodes from the simulation under the current situation for time simulation of 3 hour in the Polytechnic as presented in Table 3 shows that at 3 hour out of the 15 nodes in the system 9 nodes have a pressure head range of 0 m to 14 m, 5 nodes have a pressure head range of 16 m to 21m.

However, 3 hour water supply is not sufficient for an academic settlement like Polytechnic; therefore the existing system is not adequate. A scenario of 4 hour simulation was considered and the result found shows worse scenario, in which all nodes has negative pressure head as shown in Table 4.

Table 4 Negative pressure Head – Nodes at 4hr.

Node ID	Elevation (m)	Pressure Head (m)
Junc 1	619	-14.69
Junc 2	620	-234.85
Junc 3	620	-119.87
Junc 4	622	-1.01
Junc 5	626	-0.99
Junc 6	630	-1.23
Junc 7	629	-263.89
Junc 8	632	-192.42
Junc 9	628	-15.4
Junc 10	626	-14.65
Junc 11	630	-66.59
Junc 12	628	-159.54
Junc 13	617	-179.76
Junc 14	619	-188.46
Junc 15	626	-122.56

Therefore, the resulting result above shows that the pressure in the network is generally low and the existing system is not efficient. Furthermore, situation that may give rise to negative pressure should always be avoided, because faecal organism and culturable human viruses may be present in ground water adjacent to a pipe line which can be drawn in to a pipe during negative pressure, and may lead to water borne diseases.

5. CONCLUSIONS

In this study, the analysis of pressure head of Abubakar Tatari Ali Polytechnic, Bauchi water distribution network system has been carried out using EPANET 2.0. The current situation of water supply and distribution in the polytechnic was appraised and analysed. The current average nodal drawn off was found to be 0.14 l/s. The result of the analysis indicate that the system can supply water in adequate pressure head for only less than 3 hours, when scenario of an extended period simulation of 4 hour was carried out on the current distribution system it reveal a worse condition in which all nodes have negative pressure head. Based on the above, it can be said that the current distribution system is not adequate. The distribution system should be re-design to meet the current (2016) and future demand.

6. RECOMMENDATIONS

Based on the result of the analysis carried out the following recommendations have been made:

- Redesign the existing system so as to meet the current (2016) and future demand of the Polytechnic community.
- Construction of additional tank to bust the pressure head.
- Provision of additional network to cover area not covered by the distribution network, this will ensure adequate supply of water to the affected area.
- Maintenance unit should be well equipped to avoid waste of water.
- Student and other user of water should be sensitized on the importance of managing water resources.

7. REFERENCES

Adeniran, E. A., & Oyelowo, M. (2013, June). An EPANET Analysis of Water Distribution Network of the University of Lagos, Nigeria. *Journal of Engineering Research, 18*(2).

Arunkumar, M., & Mariappan, V. (2011). Water Demand Analysis of Municipal Water Supply using EPANET Software. *International Journal on Applied Bioengineering, 5*(1), 90-19.

Ayanshola, A., & Sule, B. (2006). Assessment of flow Pressure in Selected Zones of Ilorin Township Water Supply Network. *USEP, Journal of Research Information in Civil Engineering, 3*(1), 83-101.

Bauchi State Ministry of Water Resources. (2012). *Water,Sanitation and Hygien Policy*. Bauchi: Bauchi State Ministry of Water Resources.

Bauchi State Water Board. (2014). *Bauchi Tool Kit.* IBNTET_Toolkit_Bauchi.

Bhardwaj, V. (2001). Reservoirs, Towers and Tanks: Drinking water Storage Facilities, Tech Brief;. *National Drinking Water Clearing house,*. Tap Magazine.

Jacobs, H., & Strinjdom, J. (2009). Evaluation of minimum residual pressure as Design Creterion for South Arican water Distribution. *Water SA, 35*(2), 183-191.

Lingkunga, B. (2012). Retrieved from http://nptel.iitm.ac.in/ courses/Webcourse

Onuaha, S., Idike, F., & Orankwe, L. (2012). Water Supply Resourse for Domestic Purposes in Auchi Metropolis of Edo State, Nigeria. *International Journal of Engineering & Technology, II*(6), 1032-1039.

Ordinioha, B., & Adeosun, A. (2008, July). A Survey of the Community Water Supply of Some Communities In Rivers State, Sourth-Sourth Nigeria. *Journal of The Nigerian Health, 8*(3-4), 39-43.

Saminu, A., Abubakar, N., & Sagir, L. (2013, July). Design of NDA Water Distribution Network Using Epanet. *International Journal of Emerging Science and Engineering*, 5-9.

Walski, T. M. (2006). A history of Water. *Journal AWWA*, 110-121.