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Water Distribution System in Lovely Professional University

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Abstract

This paper is concerned with water distribution network for hostels at Lovely Professional University(LPU), Jalandhar, Punjab, India. The proposed water distribution network provides water to 15,000 students with daily demand of 135 lpcd (litres per capita per day). The main objective is to analyse the flow rate and pressure at every node/junction of the network and water demand on the region as well. The values of flow velocity and pressure head lies in permissible range as in known standard and specification of water distribution network. The use of EPANET software saves effort and time and gives result with maximum precision. By using EPANET software analysis can be done even for complex network.

Keywords: - water distribution, daily demand, flow rate, pressure head, Epanet

Introduction

Water is essential in our day-to-day life for drinking, cooking, washing, sanitation, agricultural etc. But the provision of safe and proper supply of drinking water for rural and urban people is the major unfinished task. Lack of access to safe water affects the health of various sections of society, especially the economically weaker section and undeveloped areas of the country. If the quality of water is not good, then it directly affects the health. In order to supply water, it must be pure and in sufficient quantity. According to World Health Organisation (WHO) safe water does not contain any odour, harmful chemicals and micro-organisms in quantity that leads to any kind of illness.

Human life, as with every animal and plants on the planet, depends upon water. Not only do we want water to grow our food, generate our electricity and run our industries, however we need it as a fundamental part of our everyday lives - our bodies ingest water each day to keep functioning. "Basic desires of approximately 135 litres in line with individual as day-to-day basis". It includes the need for water to preserve a primary standard of personal and domestic hygiene enough to preserve health. The outcomes of insufficient water deliver reasons disease, time and strength expended in every day collection, excessive unit costs, etc. provision of basic day to day need of water desires is yet to be regarded by many nations as a human right.

Providing pure and sufficient amount of water to populated and developing countries, especially in India is a challenging task. Water distribution system is crucial for supply of water in different place like residential areas, hospital, educational, industrial zone The purpose of water distribution system is to deliver water to consumer with appropriate quality, quantity and pressure according to topography. Designing of water distribution system means using proper size of pipelines keeping in mind that internal and external pressure in the pipeline is proper. Design of distribution network must be safe from environment point of view also. Water distribution system should be capable of supplying water at all

the intended places to fulfil the daily needs. It should be capable of supplying the requisite amount of water during firefighting or any other state of emergency.

The geographic and physical characteristics of an area influence the design of a system. An interlocking loop design that allows water to flow in multiple paths to each part of a network offers maximum flexibility. Urban systems typically include ring networks, although the network is divided into hydraulically separate sections for demand and leakage management. Dendritic (tree-like) designs are more common for backbone networks and local distribution in rural areas. The most economical design for Mathematical models can be used to analyse the hydraulic performance of existing mains and distribution lines, design new networks, and evaluate system operational performance under a variety of utility and service conditions. Detailed hydraulic analysis can define both the physical performance of the pipeline and design parameters, control regimes for pumps, control and accumulator valves, and determine the behaviour of reservoirs, their inlets and outlets, and the effects of a burst main or major fire demand. However, the modeler should always remember that the accuracy of a model is no better than the quality and availability of the data from which it is developed. Confidence in the results requires a corresponding confidence in the input data especially for estimated nodal demands.

The water distribution system is a review of fluid properties and some fundamental properties of hydraulic with the help of Bernoulli and Continuity equation. Many methods have been used in the past to calculate the flow in pipeline network such methods ranging from graphical methods to the use of visual measurements and finally to the use of mathematical models. Calculation of flow and pressures on a complex network has been a major challenge and interest for those involved in the construction and maintenance of public water distribution systems. Analysis and design of pipeline networks is not easy, especially in metro cities. Each and every time an analysis is required when there is a change in delivery patterns or addition of new pumps, pressure control values, storage tanks etc. The analysis requires to find the minor and major losses of the reservoir, tank, pump etc. and all the above can be done by the software known as EPANET.

EPANET software developed by the USA Environmental Protection Agency is approved for the use of general public for education and designing. EPANET is designed to be a research tool for improving our understanding of the movement and fate of drinking water constituents within distribution systems. EPANET can help assess alternative 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, Targeted pipe cleaning and replacement. It has the ability to analyse an infinite number of pipes and tanks. EPANET is a computer program that simulates long-term hydraulic behaviour and water quality within dynamic pipeline networks. EPANET is designed to be a research tool to improve understanding of the movement and endpoint of drinking water components within distribution systems. It can be used for many types of applications in the analysis of distribution systems. This study has been used to perform hydraulic analysis of the distribution network of university. The results obtained are considered that pressure at all junction and flow velocity across all pipelines are sufficient to provide water for the university network.

Study Area

In this paper, Water distribution system has been designed effectively at Lovely Professional University situated in Kapurthala district of Punjab, India. The University campus spreads over 600 acres in boundary on the outskirts of Jalandhar and population for the same is around 30,000 students (as of 2021). The co-ordinate of university is 31.2560°N, 75.7051°E. As the design of distribution network for supplying ample amount of water in hostels at this location is not optimised, hence, this area is considered for the present analysis in this paper.

Figure 1:Represents Base Map of Study Area

On adding to above information such as base map, layout for water distribution network, population of hostels for which water distribution system to be designed was collected from concerned authorities. The present population of the hostels is around 15,000. By assuming 1% growth in the population every year, the rate of demand per capita is taken as 135 lpcd (litres per capita per day) including losses.

Research Methodology

The study area collected from the Google Earth Pro by using Google Satellite imagery system as per the known latitudes, longitudes of University and that image is opened in Paint to change the extension from jpeg to bmp. The bmp file is then opened in EPANET through the backdrop option for designing of water distribution network. After that, start locating the nodes as per demand and elevation and connect them with pipes as per demand on the basis of reservoir elevation and pump head. If the network plan is ready for whole study area, then start assigning the length, diameter, roughness coefficient of the pipes. As EPANET software is very user friendly, the following steps has to be carried out in EPANET for the simulation:

a. Draw water distribution network on backdrop.
b. Enter parameters such as length, diameter, roughness coefficient, water demand, pattern and other properties if any.
c. Check carefully that the pipes and nodes are properly connected at intersections.
d. Set the simulation period for 24 hours.
e. Run the hydraulic analysis.
f. Check the results and analysis.

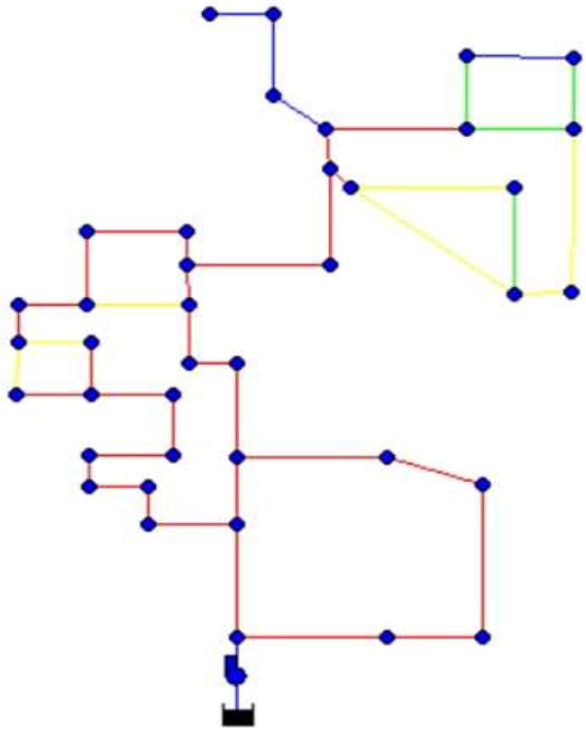

Figure 2:Represents Layout of Water Distribution System

Objectives

a. To find out the pressure and base demand and head at various level of node of the water distribution system
b. To find out the flow and velocity with roughness at various link of the water distribution system.
c. To distribute the water uniformity at the various locations with sufficient pressure.

Result and Discussion

The water distribution network is obtained and analysed in this paper. Throughout the whole water distribution network, it consists of 46 pipes of same material, 40 junctions and 1 source reservoir from which water is sourced to higher elevation various purposes as shown in figure number 3.

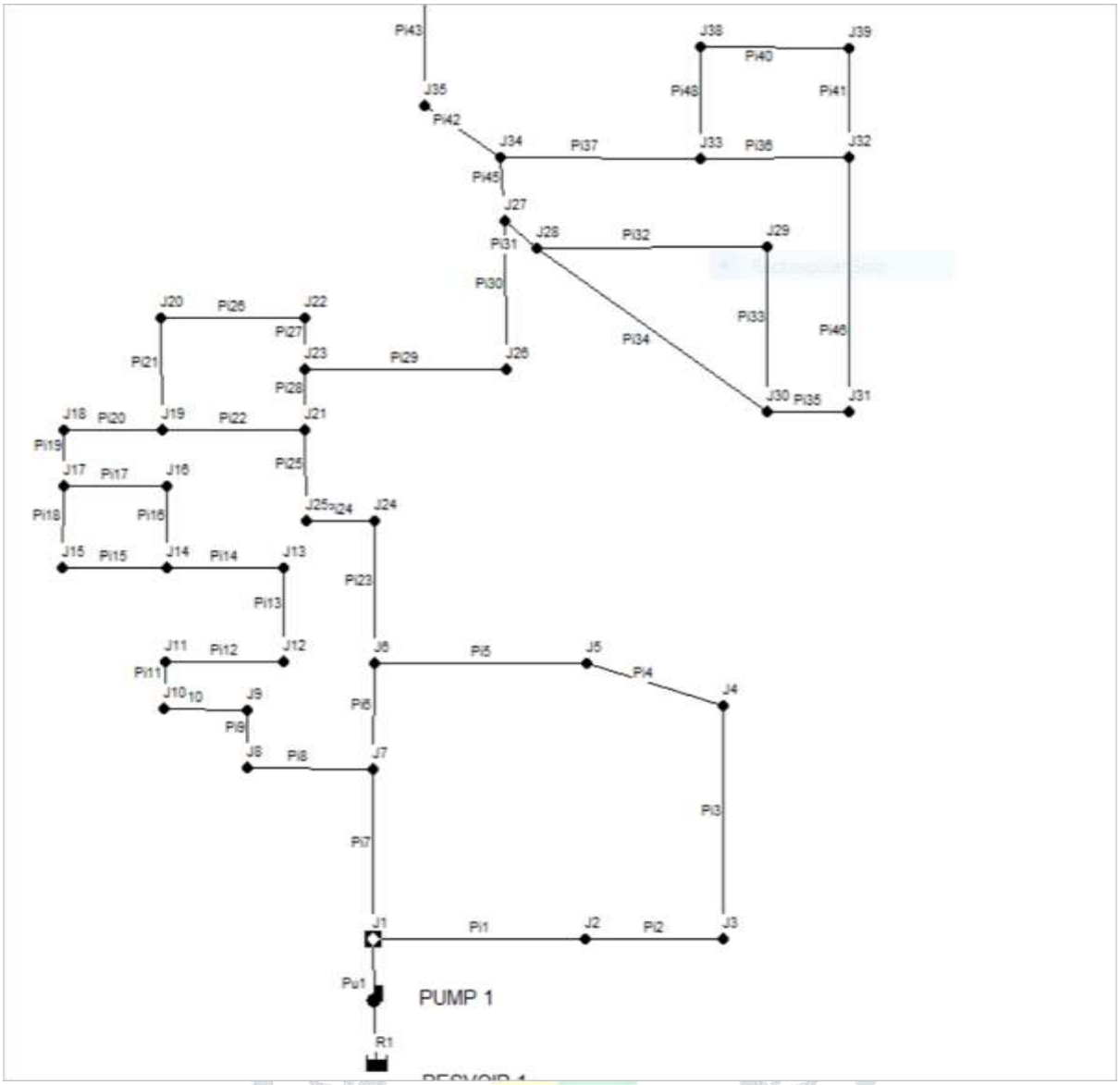

Figure 3:Represents Pipe network in EPANET

As mentioned earlier the whole population of hostels is considered to be 15,000 and the population growth rate is assumed as 1% every year. Also, by considering the rate of consumption per capita as 135lpcd (litres per capita per day) and the corresponding demand in LPM is shown in Table 1.

Table 1 Population and Demand

Population	Rate of Demand
Population as per 2022(Base Year)	15000
Projected population in 2032 (1% growth)	16570
Demand rate for 2022	2531.25 lpm
Demand rate for 2032	2796.18 lpm

In the above table the population and the demand rate corresponding to that population is given with per capita demand as 135 lpcd. For the year 2022 the rate of demand in LPM is given to be 2531.25 lpm and for the next 10^{th} year rate of demand is obtained to be 2736.18 lpm. After calculating the rate of demand the network has to be designed according to the calculated LPM.

For effective water distribution network, these basic parameters like length between nodes, coefficient of the roughness and diameter of the pipe has to be assigned and these values are given in Table 2.

Table 2:Details of network from EPANET tool

ID	NODE 1	NODE 2	LENGTH(ft)	DIAMETER(inch)	ROUGHNESS
P1	1	2	700	12	100
P2	2	3	300	12	100
P3	3	4	800	12	100
P4	4	5	350	12	100
P5	5	6	700	12	100
P6	6	7	300	12	100
P7	1	7	750	12	100
P8	7	8	300	12	100
P9	8	9	200	12	100
P10	9	10	300	12	100
P11	10	11	200	12	100
P12	11	12	400	12	100
P13	12	13	400	12	100
P14	13	14	400	12	100
P15	14	15	375	12	100
P16	14	16	300	12	100
P17	16	17	400	12	100
P18	15	17	300	12	100
P19	17	18	300	12	100
P20	18	19	400	12	100
P21	19	20	500	12	100
P22	19	21	600	12	100
P23	6	24	700	12	100
P24	24	25	300	12	100
P25	25	21	300	12	100
P26	20	22	600	12	100
P27	22	23	250	12	100
P28	21	23	400	12	100
P29	23	26	700	12	100

P30	26	27	600	12	100
P31	27	28	250	12	100
P32	28	29	650	12	100
P33	29	30	600	12	100
P34	28	30	800	12	100
P35	30	31	250	12	100
P36	32	33	400	12	100
P37	33	34	500	12	100
P38	39	40	400	12	100
P39	40	32	400	12	100
P40	34	35	400	12	100
P41	35	36	600	12	100
P42	36	37	400	12	100
P43	27	34	400	12	100
P44	31	32	900	12	100
P45	33	39	400	12	100

For analysis of any water distribution network, it includes quantity of water flowing through the pipe, head losses in whole system of pipe and residual pressure at different nodes in the network. In the same pipe the nodal demand was also calculated by taking the per capita demand as 135 lpcd and the results were calculated and shown in Table 3.

Table 3Nodal demands at nodes of the network

Node Number	**Demand at nodes (lpm)**
Node 1	0.00
Node 2	0.00
Node 3	30.28
Node 4	30.28
Node 5	30.28
Node 6	37.85
Node 7	22.71
Node 8	30.28
Node 9	30.28
Node 10	37.85

Node 11	37.85
Node 12	45.42
Node 13	37.85
Node 14	37.85
Node 15	37.85
Node 16	37.85
Node 17	45.42
Node 18	45.42
Node 19	30.28
Node 20	30.28
Node 21	37.85
Node 22	30.28
Node 23	56.78
Node 24	22.71
Node 25	30.28
Node 26	45.42
Node 27	75.70
Node 28	56.78
Node 29	45.42
Node 30	37.85
Node 31	30.28
Node 32	45.42
Node 33	56.78
Node 34	68.13
Node 35	22.71
Node 36	0.00
Node 37	0.00
Node 38	45.42
Node 39	37.85

Conclusion

The following conclusions can be made out from the study:

1. The pressure at all junctions is found to be enough. Hence, the supplied water is enough to serve all the buildings.
2. The internal diameter of the pipe is 12 inch and it is sufficient to bear pressure for the whole network.
3. The designed network is capable for 5% increase in population, although it is designed for 1% population only.
4. By using EPANET, the analysis can be done even for complex network.
5. By considering all the conditions, there is no shortage of water on distribution.

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