



WATER DISTRIBUTION NETWORK USING EPANET: A CASE STUDY OF WESTERN ZONE OF AHMEDABAD

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Abstract : The need for water for home, agriculture, and industrial purposes is increasing as the population grows. As a result, the most efficient use and conservation of water are critical. Water provision to an ever-increasing population with limited water supplies is becoming increasingly difficult. To address this issue, new or updated water distribution networks (WDN) must be designed. STANET, LOOP 4.0, EPANET 2.0, and WATERGEMS software can be used to tackle such difficulties. The combined WDN of the elevated storage reservoir (ESR)-21, which is part of the water distribution system (WDS), is made up of a newly installed and proposed pipe network in Sabarmati western zones. This combined network has been intended to accommodate the population of 2053. The WDN of ESR in the Ahmedabad Municipal Corporation's (AMC) west zones is analysed to ensure that water in sufficient quantity and pressure is delivered to the various consumers in the year 2053, and the combined WDN is analysed for the population of the year 2053 using EPANET software. The EPANET results show that the pressures, flows, and velocities in all pipes are sufficient to supply water to the whole WDN. The findings of this study will assist hydraulic engineers in quickly analyzing WDN and will also act as decision assistance.

Index Terms - Water distribution network, EPANET, Sabarmati area, AMC, data comparison.

I. INTRODUCTION

The water distribution system is an electrical infrastructure that includes components such as pipes, reservoirs pumps and valves etc. It is important to provide drinking or drinking water to end users; therefore, an efficient water supply is critical in designing a new water distribution network or in expanding an existing one. Calculation of flow and pressures on a complex network has been a major challenge and interest for those involved in the construction, construction and maintenance of public water distribution systems. The analysis and design of pipeline networks poses a relatively complex problem, especially if the network contains a series of pipelines as is often the case with water distribution systems in major cities. In the absence of significant fluid acceleration, network behaviour can be determined by a sequence of robust conditions, which form a small but important part of assessing network efficiency. A water distribution network is a system of constructed hydrologic and hydraulic components that transports water from a source to a specific location. These systems must be able to to meet the various water demands that occur during the day which is highest throughout the day due to personal usage of water While cleaning, preparing food, and washing clothes, During the night, the water delivery is the least. With Future Scenario is changing at an increasing rate; it has grown fairly complex. Due to the difficulty in getting water to the masses, insufficient headcount to satisfy rising demand, owing to

climate change, such as inconsistent precipitation and other circumstances. This reduces the amount of water available at the source. Distribution of water Pipes, tanks, reservoirs, and other components make up the system.

One of the oldest ideas for input and output is known, but the flow within the network is unknown. The Hardy Cross method is familiar with the method of distributing Moment, which was also developed by Hardy Cross as a method of determining times in endless buildings. This method was later made obsolete with computer-solving algorithms using the Newton-Raphson method or other trouble shooting that eliminated the need to manipulate arbitrary mathematical systems manually. The solution for water flow and pressure in access to the water distribution network incorporates the popular Hardy Cross method which is a recurring method for determining flow in pipeline network systems where inputs and outputs are known, but flow within the network is unknown. Reasons to use EPANET software developed by the USA Environmental Protection Agency are accepted because it is used for the general public and for education and is available free of charge online. It has the ability to analyze an infinite number of pipes and tanks. EPANET has become a popular tool for analyzing complex and simple water distribution networks in both developed and developing countries around the world. EPANET is a computer program that simulates long-term hydraulic behaviour and water quality within dynamic pipeline networks. The network consists of pipes, nodes (pipe links), pumps, valves and storage tanks or dams. EPANET monitors the flow of water in each pipe, the pressure in each area, the height of the water in each tank, and the chemical composition of the entire network. EPANET is designed to be a research tool to improve our 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 paper has been used to perform hydraulic analysis of the distribution network of the study area.

II. LITERATURE SURVEY

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III. STUDY AREA, DATA COLLECTION AND METHODOLOGY

The study area selected is a part of the western part of Ahmedabad City, Sabarmati area where there is a problem in the water distribution network. The area has been identified with the help of Ahmedabad Municipal Corporation. The area has been selected due to very much arising cases of water theft as said by AMC officials and residents, also due to aging of distribution network, considerable reduction in head of water at the user end. The study area selected, methodology adopted for data collection, population of Sabarmati in 2038 and total water requirement in that year will be worked out. The methods adopted for obtaining the data are by direct measurements, quantitative estimates or by interview with staff of Water And Sanitation Management Organization (WASMO) & Gujarat Water Supply and Sewerage Board (GWSSB).

III.1 PROPOSED METHOD

The design of a water supply and sanitation system is based on the population of a particular city or village, which is estimated at the time of design. Any limited value will make the system insufficient for the intended purpose; likewise a limited number will make it expensive. A change in the population of the city over the years occurs, and the plan should be designed taking into

account the population at the end of the design period. Factors affecting human change are: Increase by birth, Decrease due to mortality, Increase / decrease due to migration, Increase due to expansion. The city's current and past population records can be found in demographic records. After collecting these demographics, the population at the end of the design period is calculated using a variety of methods appropriate to that city considering the growth pattern followed by the city.

Population forecasting is based on the following methods:

- 1) Arithmetical Increase Method
- 2) Geometrical Increase Method
- 3) Incremental Increase Method

Distribution Methods For successful distribution it is necessary that water should reach all users with the required flow rate. Therefore, a certain pressure in the pipeline lines is required, which should force the water to reach all areas. Depending on the distribution methods, the distribution system is divided as follows: Gravity System, Pumping System, and Dual System. Generally in practice there are four different systems of distribution system which are used. Depending upon their layout and direction of supply, they are classified as follows: 1. Dead end or tree system 2. Grid iron system 3. Circular 4. Radial.

Water may be supplied continuously 24 hours a day or may be provided only occasionally at peak hours in the morning and evening. A periodic supply system can lead to some savings in water use due to short-term losses and careful use of water by users. The occasional supply system is widely used in India.

Various steps of proposed method:

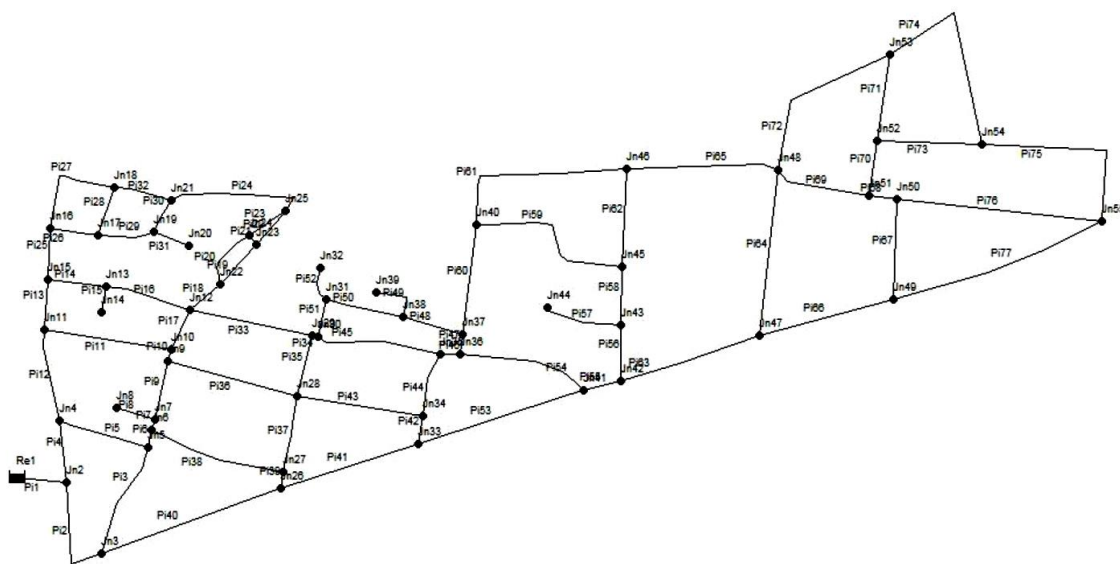


Figure 1: Developed network system EPANET

Step 1: Population forecasting for the year 2006-2020.

Step 2: Draw a network representation of distribution system or import a basic description of the network placed in a text file.

Step 3: Edit the properties of the objects that make up the system. It includes editing the properties and entering required data in various objects like reservoir, pipes, nodes and junctions.

Step 4: Describe how the system is operated and Select a set of analysis option.

Step 5: Run a hydraulic/water quality analysis

Step 6: View the results of the analysis which can be viewed in various form i.e. in form of tables and graphs.

Step 7: Repeat the procedure for two other distribution networks.

IV. MODEL DEVELOPMENT IN EPANET :

The model development in EPANET is carried out via help of google maps, epaCAD, and EPANET. At first, the AutoCAD sheet of the available distribution network (.dxf) is converted into (.inp) i.e., the format of the data that can be directly imported to EPANE, using EpaCAD software.

Then, assignments of the elevation data from google maps is imported for further development of the network, the same procedure i.e. using google maps is followed to assign the length of pipes. Also, other mandatory parameters required for EPANET analysis like, diameter of pipe, roughness co-efficient, etc. are assigned for every pipe individually.

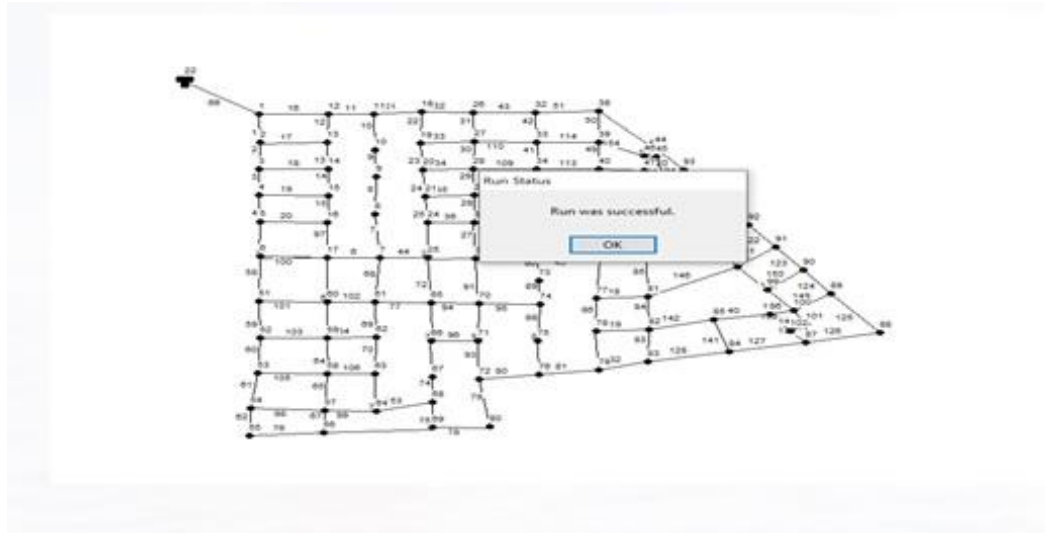


Figure 2: Model development in EPANET

V. EPANET ANALYSIS

After the development of layout, junction notation, pipe notation, roughness co-efficient of individual pipes are assigned to the layout for analysis. After that, location of source of water (if any nearby), location of pumping station, elevated service reservoirs, etc. physical storage structures are digitized in EPANET. The direction of flow is assigned such that sufficient pressure head by virtue of gravity is available at every node.

After feeding these data to the software, network is run and the outputs are obtained in tabular form as shown below:

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Unit Headloss m/km
Pipe Pi21	28	150	140	1.70	0.10	0.09
Pipe Pi22	83	150	140	15.36	0.87	5.11
Pipe Pi23	88	150	140	14.84	0.84	4.79
Pipe Pi24	322	150	140	12.02	0.68	3.24
Pipe Pi25	207	150	140	23.71	1.34	11.40
Pipe Pi26	113	150	140	11.69	0.66	3.08
Pipe Pi27	249	150	140	8.06	0.46	1.54
Pipe Pi28	109	150	140	3.55	0.20	0.34
Pipe Pi29	118	150	140	3.97	0.22	0.42
Pipe Pi30	74	150	140	3.29	0.19	0.29
Pipe Pi31	79	150	140	2.91	0.16	0.23
Pipe Pi32	120	150	140	1.60	0.09	0.08
Pipe Pi33	252	500	140	169.66	0.86	1.24
Pipe Pi34	14	500	140	151.17	0.77	1.00
Pipe Pi35	130	150	140	4.43	0.25	0.51
Pipe Pi36	281	150	140	9.47	0.54	2.09
Pipe Pi37	160	150	140	9.09	0.51	1.93
Pipe Pi38	293	150	140	10.91	0.62	2.71
Pipe Pi39	47	200	140	-10.72	0.34	0.65
Pipe Pi40	388	450	140	176.61	1.11	2.23

FIGURE 2: SAMPLE OUTPUT FROM EPANET SOFTWARE

VI. RESULT AND CONCLUDING REMARKS :

Results for the simulation via EPANET are with minimum fluctuation from field conditions. Various results of parameters like, velocity, discharge and head loss gradient, etc. are evaluated via EPANET and graph of pressure diagram is obtained (refer figure 4).

There are total 77 number of pipes are developed in model, and various parameters like, discharge, head loss, velocity, etc. are obtained as output and noted down in Table 1.

Label	Flow(L/s)		Velocity(m/s)		Headloss Gradient(m/km)	
	Actual	EPANE T	Actual	EPANE T	Actual	EPANE T
Pi1	516.15	516.15	1.83	1.83	4	4
Pi2	207.17	207.37	1.3	1.30	2.995	3
Pi3	-21.6	21.62	0.31	0.31	0.328	0.33
Pi4	305.47	305.27	1.08	1.08	1.514	1.51
Pi5	25.02	25.07	0.8	0.80	3.104	3.11
Pi6	29.82	29.88	0.42	0.42	0.596	0.60
Pi7	17.69	17.74	0.25	0.25	0.227	0.23
Pi8	3.06	3.06	0.17	0.17	0.257	0.26
Pi9	13.76	13.81	0.78	0.78	4.162	4.19
Pi10	-0.2	0.17	0.01	0.01	0	0.00
Pi11	233.27	234.35	1.19	1.19	2.234	2.25

Pi12	276.03	275.79	1.41	1.40	3.051	3.05
Pi13	25.84	24.52	1.46	1.39	13.374	12.14
Pi14	-4.33	3.09	0.24	0.17	0.489	0.26
Pi15	1.98	1.98	0.11	0.11	0.115	0.11
Pi16	11.14	9.90	0.63	0.56	2.814	2.26
Pi17	232.08	233.19	1.18	1.19	2.212	2.23
Pi18	40.66	43.22	1.29	1.38	7.626	8.54
Pi19	19.7	21.03	1.11	1.19	8.092	9.13
Pi20	17.72	18.96	1	1.07	6.65	7.53
Pi21	1.68	1.70	0.09	0.10	0.085	0.09
Pi22	14.06	15.36	0.8	0.87	4.334	5.11
Pi23	13.58	14.84	0.77	0.84	4.062	4.79
Pi24	9.46	12.02	0.54	0.68	2.08	3.24
Pi25	26.27	23.71	1.49	1.34	13.787	11.40
Pi26	13.15	11.69	0.74	0.66	3.829	3.08
Pi27	9.16	8.06	0.52	0.46	1.958	1.54
Pi28	4.3	3.55	0.24	0.20	0.482	0.34
Pi29	4.69	3.97	0.27	0.22	0.566	0.42
Pi30	-2.57	3.29	0.15	0.19	0.187	0.29
Pi31	2.91	2.91	0.16	0.16	0.234	0.23
Pi32	0.25	1.60	0.01	0.069	0.003	0.08
Pi33	169.87	169.66	0.87	0.86	1.241	1.24
Pi34	151.32	151.17	0.77	0.77	1.002	1.00
Pi35	-4.48	4.43	0.25	0.25	0.521	0.51
Pi36	9.46	9.47	0.54	0.54	2.08	2.09
Pi37	9.06	9.09	0.51	0.51	1.918	1.93
Pi38	10.9	10.91	0.62	0.62	2.705	2.71
Pi39	-10.69	-10.72	0.34	0.34	0.643	0.65
Pi40	176.43	176.61	1.11	1.11	2.225	2.23
Pi41	151.42	151.59	0.95	0.95	1.676	1.68
Pi42	8.43	8.47	0.48	0.48	1.68	1.69
Pi43	6.74	-6.73	0.38	0.38	1.109	1.11
Pi44	2.9	2.93	0.16	0.17	0.232	0.24
Pi45	137.98	137.85	0.87	0.87	1.411	1.41
Pi46	126.26	126.17	0.79	0.79	1.197	1.20
Pi47	118.55	118.47	0.75	0.74	1.065	1.06
Pi48	2.74	2.76	0.15	0.16	0.209	0.21
Pi49	3.87	3.87	0.22	0.22	0.397	0.40
Pi50	7.19	-7.17	0.41	0.41	1.252	1.24
Pi51	12.83	12.81	0.73	0.72	3.658	3.64
Pi52	2.73	2.73	0.15	0.15	0.208	0.21
Pi53	131.83	131.96	0.83	0.83	1.297	1.30
Pi54	6.25	-6.22	0.35	0.35	0.964	0.96
Pi55	113.87	113.97	0.91	0.91	1.755	1.76
Pi56	85.83	85.85	0.68	0.68	1.04	1.04
Pi57	5.94	5.94	0.34	0.34	0.878	0.88
Pi58	75.21	75.23	0.6	0.60	0.814	0.81
Pi59	6.6	-6.59	0.37	0.37	1.067	1.06

Pi60	109.63	109.53	0.69	0.69	0.922	0.92
Pi61	94.63	94.54	0.75	0.75	1.246	1.24
Pi62	64.08	-64.09	0.51	0.51	0.605	0.61
Pi63	25.34	25.42	0.81	0.81	3.177	3.20
Pi64	3.88	3.81	0.22	0.22	0.4	0.39
Pi65	136.21	-136.13	1.08	1.08	2.445	2.44
Pi66	10	10.15	0.57	0.57	2.304	2.37
Pi67	-2.93	-2.67	0.17	0.15	0.237	0.20
Pi68	46.2	-58.26	0.48	0.61	0.633	0.97
Pi69	66.47	-66.45	0.69	0.69	1.241	1.24
Pi70	6.74	7.12	0.38	0.40	1.112	1.23
Pi71	-21.06	-20.92	0.43	0.43	0.76	0.75
Pi72	48.87	48.73	0.51	0.51	0.702	0.70
Pi73	22.91	23.15	0.47	0.47	0.889	0.91
Pi74	4.93	4.92	0.28	0.28	0.622	0.62
Pi75	7.83	8.06	0.25	0.26	0.361	0.38
Pi76	38.38	-38.24	0.54	0.54	0.951	0.94
Pi77	5.21	5.12	0.3	0.29	0.69	0.67

Table 1: Comparison of various parameters between Actual vs EPANET

VII. REFERENCES:

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