Engineering



Case Study on Designing Water Supply Distribution Network Using Epanet for Zone-Iof Village Kherali

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cT	This study presents the u is acomputer program th pipenetworks. A networ	se of EPANETsoftwareinthe design ofwater distributionnetwork forZone-Iof Kherali Village. EPANET hat performs extended period simulation ofhydraulic and waterquality behavior within pressurized k consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET

ABSTRACI

This study presents the use of EPANETsoftwareinthe design ofwater distributionnetwork forZone-lof Kherali Village. EPANET is acomputer program that performs extended period simulation ofhydraulic and waterquality behavior within pressurized pipenetworks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracksthe flow of water in each pipe, the pressure at each node, theheight of water in each tank, and the concentration of a chemicalspecies throughout thenetwork, EPANET is designed to be aresearch tool for improving our understanding of the movementand fate of drinking water constituents within distributionsystems. It can be used for many different kinds ofapplications indistribution systems analysis. In this paper it was used to carryout the hydraulic analysis of the distribution network in the studyarea. The results obtained verified that the pressures at alljunctions and the flows with their velocities at all pipes arefeasible enough to provide adequate water to the network of thestudy area.

KEYWORDS

EPANET, Water Distribution Network, System

Research Paper

INTRODUCTION

The resource management issues have become more critical in places where rainfall is less. The water distribution system is component connected between the water supply sources and the consumer. It is careful conveyance system that allows water to be moved through piping before reaching the consumer's tap.Water distribution systems are usually owned and maintained by local governments such as cities but are irregularly operated by a commercial enterprise. Firstly planning of water distribution systems city planners' engineer who must consider many factors such as location, current demand, future growth, pipe sizes, head loss, firefighting, leakages, etc. using pipe network analysis and other tools.

Water distribution system is a hydraulic infrastructureconsisting of elements such as pipes, tanks reservoirs pumpsand valves etc. It is crucial to provide water to theconsumers; effective water supply is of paramountimportance in designing a new water distribution network orin expanding the existing one. It is also essential toinvestigate and establish a reliable network ensuring adequate head. Computation of flows and pressures in network pipes hasbeen of great value and interest for those involved withdesigns, construction and maintenance of public waterdistribution systems. This studyaimed at performing the hydraulic analysisof Zone-I of Kherali Village waterdistribution network using Epanet Software.

LITERATURE STUDY:

Jacob (1991), proposed a technique for simulation of water distribution system in developing countries, where supply is less than demand i.e., intermittent supply.

Walski (2001), while discussing the issues related to water distribution system focused on some of the most compelling problems facing optimization viz.(i) Designer must strike a balance between cost minimization and net benefits (benefit minus costs)(ii) Reliability of the water distribution networks should not be reduced for the sake of cost reduction.

Chunping Yang, ZhiqiangShen, Hong Chen, Guangming-Zeng, YuanyuanZhong (2006)A lot of technological problems including advanced treatment processes, pH regulation, sterilization, and pipe selection have been solved cost-effectively.

Vicki L. Van Blaricum and Vincent F. Hock (2007) This paperdescribes the demonstration and validation of multi-parameter waterquality sensors and corrosion rate sensors that were permanentlyinstalled at a U. S. Army installation to detect corrosionproblems and fine-tune the chemical treatmentprogram. The use of water qualityand corrosion rate sensors has been demonstrated and validated in the field.

Andrea Bolognesi, Cristiana Bragalli, Angela Marchi, SandroArtina DISTART, (2009)This paper proposes a new model namedGenetic Heritage Evolution by Stochastic Transmission GHEST, a multipopulationevolutionary-strategy-like algorithm applied to the designof water distribution networks (WDN).GHEST makes use of hydraulicnetwork solver EPANET 2

STUDY AREA:

In this paper, the brief notes about the study area selected, methodology adopted for data collection, population of Kherali village in 2043 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).



Figure 1: Google Map image of Kherali Village Sources:

https://www.google.co.in/maps/place/Kherali,+Gujarat+363020/@22. 6897398,71.6018435,1468m/data=!3m2!1e3!4b1!4m2!3m1!1s0x-3959406c20d1f173:0x9619e6125dfeb593?hl=en

The Kherali village, Taluka: - Wadhwan, District:-Surendranagar is selected for the study purpose. The existing Elevated Service Reservoir (ESR) of 1,20,000 lit. Capacity and 12 m height and sump of 5,00,000 lit. Capacity in usable condition. During the summer and monsoon season, it become very difficult task to go for water because during summer season, the temperature raises up to 42 to 45° C, and during the monsoon season the surface became slippery & muddy. Hence, it becomes necessary to upgrade the existing system of water supply arrangement. Following data are collected for present study:

- 1. Hydrological data: Average rainfall of Surendranagar district is 760mm.
- 2. Geological data: Kherali is a village in Surendranagar district in the Indian state of Gujarat. It comes on the way from Surendranagar to Limli, and this route leads to Muli. The village is grown around one abandoned palace. The village has got one big lake and other many wells including one step-well. It has few temples including Swaminarayan temple, Rama temple and one well-built mosque. The village is mostly surrounded by farms.
- 3. Water quality data: The Available water is of good quality. The source of water is Dholidhaja Dam.
- 4. Public survey: Opinion poll regarding need of village people has been carried out.

POPULATION FORECAST:

Population for the	Year of 2023,	2033 and 2043
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Types of Methods	2023	2033	2043
Arithmetical Increase Method	4917	5424	5931
Incremental Increase Method	5298	6567	8217
Geometric Increase Method	5232	6208	7366

The demand is adopted as 70 lpcd. (Considering domestic requirements only without sewer line).

Types of Methods	Demand in year 2043 litres per day			
Arithmetical Increase Method	₅₉₃₁ × ₇₀₌₄₁₅₁₇₀			
Incremental Increase Method	8217×70=575190			
Geometric Increase Method	7366 × 70=515620			

Public Demand in LPCD In 2043

The population of Kherali is considered as per Incremental Increase Method 8217 (because in this method the combination of arithmetic & geometric comes.) and water demand is worked out as 575190 litres per day for year 2043. Here only Zone-I is considered, so the Population of Zone-I is as 1826 considered as shown in Table.

Information about EPANET 2.0 Software: Program version: EPANET Version 2.0 (Release 2.00.09a)

Distribution: Web downloads(<u>http://www.epa.gov/ORD/NRMRL/</u> wswrd/epanet.html)

OS requirements: DOS, MS-Windows (95, 98, ME, NT, 2000)

Hardware requirements: Processor: 80486 or higher

Hard disk: 2 Megabytes

RAM: 16 Megabytes

Calculation method: Hazen-Williams, Darcy-Weisbach, Chezy-Manning

Calculation capacity: No limit on number of nodes, pipes, pumps, valves, reservoirs, etc.

 $\ensuremath{\textbf{Data}}$ Input: Graphic oriented input with optional import of ASCII text file

Data Output: Graphic and tabular output including export to Windows clipboard and files.

Network Layout: True scale or unscaled network layout with optional background map

Language: English

Handbook: English, 200 pages with tutorial (pdf-file, down-loadable)

Support: On-line help, web page, EPANET Users Group list server

No. of installations: Thousands of users world-wide

Pricing: Free

Freely Available: Full source code and Programmer's Toolkit (for customization).

EPANET Workspace:



Figure 2: Print screen of EPANET in working mode.

RESULTS AND DISCUSSION:

In this research the distribution network of Zone-I of Kherali village was obtained and analyzed. It consists of 49 pipes of PVC materials, 49 junctions, 1 tank and 1 source reservoir from which water is pumped to the surface reservoir and later distributed to the network, as shownbelow:



Figure 3: Print screen of Map in EPANET.

Reduced Level, Node and Length for Kherali Village										
Data of flow in LPS @ 70LPCD										
Zone - I	$\frac{2010 - 1}{2020}$									
lotal Le	ngth =	2057	Рор	1826	ILPCD	127841				
		r	1		1					
NODE	· · · · · ·	4	RL	POP		I PS				
From	To	-	Node to	1 01.	LI CD	LI 3				
ESR			83.00	0	0	0.000				
ESR	4	97	81.85	86	6028	0.070				
4	5	26	81.80	23	1616	0.019				
4	6	111	82.90	99	6899	0.080				
6	7	36	81.95	32	2237	0.026				
7	8	25	80.95	22	1554	0.018				
8	9	21	80.65	19	1305	0.015				
9	10	26	80.30	23	1616	0.019				
10	11	17	80.25	15	1057	0.012				
7	12	51	81.05	45	3170	0.037				
12	13	70	80.85	62	4350	0.050				
13	14	53	79.75	47	3294	0.038				
14	15	51	79.65	45	3170	0.037				
12	16	11	81.80	10	684	0.008				
13	17	15	80.80	13	932	0.011				
14	18	21	79.75	19	1305	0.015				
8	19	70	81.00	62	4350	0.050				
9	20	63	80.70	56	3915	0.045				
10	21	21	80.35	19	1305	0.015				
6	22	25	82.85	22	1554	0.018				
22	23	26	82.90	23	1616	0.019				
23	24	15	82.80	13	932	0.011				
23	25	13	82.55	12	808	0.009				
25	26	100	82.50	89	6215	0.072				
25	27	224	80.40	199	13921	0.161				
27	28	25	80.55	22	1554	0.018				
27	29	34	80.55	30	2113	0.024				
22	30	13	83.25	12	808	0.009				
30	31	137	81.20	122	8514	0.099				
30	32	37	83.50	33	2300	0.027				
32	33	59	82.65	52	3667	0.042				
32	34	34	84.15	30	2113	0.024				
34	35	32	83.95	28	1989	0.023				
34	36	26	84 30	23	1616	0.019				
36	37	18	84.20	16	1119	0.013				
36	38	32	84.80	28	1989	0.023				
38	39	14	84.60	12	870	0.010				
38	40	28	85.35	25	1740	0.020				
40	41	16	85 30	14	994	0.012				
40	42	40	83.90	36	2486	0.029				
42	43	40	83.80	36	2486	0.029				
43	44	28	83 55	25	1740	0.020				
44	45	25	82 95	22	1554	0.018				
	175	120	102.33	<u> </u>		0.010				

45	46	30	82.20	27	1864	0.022
46	47	36	81.70	32	2237	0.026
43	48	29	83.75	26	1802	0.021
44	49	30	83.60	27	1864	0.022
45	50	32	83.00	28	1989	0.023
46	51	32	82.25	28	1989	0.023
42	52	42	84.05	37	2610	0.030
		2057		1826	127841	1.480

KHERALI WDN								
Network [·]	Table - N	odes at 0:00) Hrs					
Node ID	Ele. m	Base Demand LPS	Demand LPS	Head m	Pres sure m			
4	81.85	0.06	0.18	92.98	11.13			
5	81.8	0.019	0.06	92.98	11.18			
6	82.9	0.08	0.24	92.94	10.04			
7	81.95	0.026	0.08	92.94	10.99			
8	80.95	0.018	0.05	92.93	11.98			
9	80.65	0.015	0.05	92.93	12.28			
10	80.3	0.019	0.06	92.93	12.63			
11	80.25	0.012	0.04	92.93	12.68			
12	81.05	0.037	0.11	92.93	11.88			
16	81.8	0.008	0.02	92.93	11.13			
13	80.85	0.05	0.15	92.92	12.07			
17	80.8	0.011	0.03	92.92	12.12			
14	79.75	0.038	0.11	92.92	13.17			
18	79.75	0.015	0.05	92.92	13.17			
15	79.65	0.037	0.11	92.92	13.27			
19	81	0.05	0.15	92.93	11.93			
20	80.7	0.045	0.14	92.93	12 23			
21	80.35	0.015	0.05	92.93	12 58			
22	82.85	0.018	0.05	92.93	10.09			
22	82.05	0.019	0.05	92.94	10.03			
25	82 55	0.009	0.03	92.93	10.38			
26	82.55	0.005	0.05	92.93	10.30			
20	82.8	0.011	0.03	92.92	10.42			
27	80.4	0.011	0.05	92.55	12.5			
28	80.55	0.018	0.40	92.9	12.5			
20	80.55	0.010	0.03	92.5	12.35			
30	83 25	0.009	0.04	92.93	9.68			
30	81.2	0.005	0.05	92.95	11 72			
32	83.5	0.027	0.08	92.92	9.43			
32	82 65	0.027	0.00	92.93	10.28			
3/	8/ 15	0.042	0.15	92.93	8 78			
35	83.95	0.023	0.07	92.93	8 97			
36	8/1 3	0.025	0.07	92.92	8.67			
37	8/1 2	0.013	0.00	92.92	8 72			
38	8/ 8	0.073	0.04	92.92	8 12			
30	8/ 6	0.025	0.07	92.92	8 32			
10	85 35	0.07	0.05	92.92	7 56			
40	85.3	0.02	0.00	02.01	7.50			
42	83.9	0.079	0.04	92.91	9.01			
52	8/ 05	0.029	0.09	92.91	8.86			
43	83.87	0.029	0.09	92.51	9.00			
48	83 75	0.021	0.05	92.5	9 15			
44	83 55	0.02	0.00	92.9	9 35			
49	83.6	0.022	0.07	92.9	9.35			
45	82 95	0.012	0.05	92.5	9.9			
50	83	0.073	0.05	92.9	9.95			
16	82.2	0.023	0.07	92.9	10.7			
51	87.75	0.022	0.07	92.9	10.7			
17	81 7	0.025	0.07	02.9	11.0			
	87	#NI/A	-30 66	87	0			
FCB	83		26.20	02	10			
	دە		20.20	رو	110			

KHERA	KHERALI WDN									
Network Table - Links at 0:00 Hrs										
Link ID	L in m	Dia. In mm	Flow in LPS	V in m/s	Unit Head loss in m/km	Friction Factor				

7	36	110	1.19	0.13	0.2	0.028
8	25	90	0.52	0.08	0.12	0.031
9	21	90	0.32	0.05	0.05	0.033
10	26	90	0.14	0.02	0.01	0.038
11	17	75	0.04	0.01	0	0.049
12	51	90	0.59	0.09	0.15	0.03
16	11	75	0.02	0.01	0	0.042
13	70	90	0.45	0.07	0.09	0.031
17	15	75	0.03	0.01	0	0.049
19	70	75	0.15	0.03	0.03	0.036
20	63	75	0.14	0.03	0.02	0.037
21	21	75	0.05	0.01	0	0.044
14	53	90	0.27	0.04	0.03	0.034
18	21	75	0.05	0.01	0	0.038
15	51	75	0.11	0.03	0.02	0.037
22	25	140	2.72	0.18	0.29	0.025
23	26	110	0.91	0.1	0.12	0.029
24	15	75	0.03	0.01	0	0.049
25	13	90	0.82	0.13	0.27	0.029
26	100	75	0.22	0.05	0.06	0.034
27	224	90	0.58	0.09	0.14	0.03
30	13	140	1.75	0.11	0.13	0.027
31	137	75	0.3	0.07	0.1	0.033
32	37	125	1.43	0.12	0.15	0.028
33	59	75	0.13	0.03	0.02	0.037
34	34	125	1.22	0.1	0.11	0.028
35	32	75	0.07	0.02	0.01	0.04
36	26	125	1.08	0.09	0.09	0.029
37	18	75	0.04	0.01	0	0.039
38	32	110	0.98	0.1	0.14	0.029
39	14	75	0.03	0.01	0	0.042
40	28	110	0.89	0.09	0.12	0.029
41	16	75	0.04	0.01	0	0.039
42	40	110	0.79	0.08	0.09	0.03
52	42	75	0.09	0.02	0.01	0.038
43	40	90	0.61	0.1	0.16	0.03
44	28	90	0.46	0.07	0.09	0.031
45	25	90	0.34	0.05	0.05	0.033
46	30	90	0.21	0.03	0.02	0.035
47	36	75	0.08	0.02	0.01	0.04
48	29	75	0.06	0.01	0.01	0.042
49	30	75	0.07	0.01	0.01	0.039
50	32	75	0.07	0.02	0.01	0.04
51	32	75	0.07	0.02	0.01	0.042
28	25	75	0.05	0.01	0	0.04

29	34	75	0.04	0.01	0	0.045
5	26	75	0.06	0.01	0	0.041
6	111	160	4.15	0.21	0.33	0.024
1	97	180	4.38	0.17	0.21	0.025
Pump	#N/A	#N/A	30.66	0	-11	0

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CONCLUSIONS:

At the end of theanalysis it was found that the resulting pressures at all the nodes and the flows with their velocities at all links are sufficient enough to provide water to the study area.

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