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Design and Implement a Real Network in EPANET Tool and Detect Leak through Head Loss

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Abstract: Water distribution network (WDN) to design using EPANET tool for my problem statement areaGurthali, NARWANA-JIND, HARYANA and objective of this paper to improve in my previous simulation work. In this paper introduce the EPANET tool with installation and required tool for this. In EPANET tool we can also detect the leakage with a new method that is called Hazen-Williams and Chezy-Manning. In my previous paper I have discussed Darcy Weisbach method in detail my previous research paper.

Keywords:Leakage, EPANET, Head Loss

I. INTRODUCTION

EPANETis very important tool for water distribution network in all over world. I have already published a paper in scops at this tool. EPANET tool help to design the wireless sensor network in water supply system. This tool design by the US. EPANET tool to simulate the complete wireless sensor network for a selected area.EPANET tool consist various types of pipes, valves, tank, junctions as a node, reservoir as a system. EPANET tool to detect the leakage in pipes through flow and also detect the leakage through pressure at each node. With the help of this tool, we can manage the height of tank and property of valve and also select the control of valve according to our need.
EPANET specially designed for researchers which easily to monitor the all pipes and nodes in a wireless sensor network and detect the leakage at all points.This tool used for multiple applications in Hydrulic model, consumer requirement, sampling program design and water distribution systems.EPANET very helpful to improve the quality of water. In this paperdiscuss Hazen-Williams and Chezy-Manning formula.Hazen-Williams and Chezy-Manning formula use only for water

distribution network. First section described about EPANET tooland section two describe literature review. In section third EPANET installation. In section fourth EPANET algorithm. Section five describes the simulation result. Section six give the details of conclusion. At last, include the references.

II. Literature Review

EPANET tool apply at water supply network system with multiple nodes and also use a new tool like a EPANET that is Water Net Gen that also work onleakage [3].We can optimize the actual output from the tool. In this tool can track the flow and pressure in complete network and observe the reading of velocity, Unit Head Loss. [4]. Flow can be calculated with the help of mathematical formula like minor and major loss in pipelines.[5]. HL calculated at leak valves, links, junctions with different formulas. It used the demand pattern for consumer.[1]. Node to detect the actualratio and coefficient for each parameter that was also calculated [2].

III. EPANET Installation

3.1EPANET

EPANET installation is very easy and take very lass time in installation. EPANET tool free available with latest versions.
This tool also run at windows 10. It is available with setup in a single file.To install EPANET:

1. Download the setup form internet and it download in few seconds and run for window 10.
2. click on the setup file and start the setup process. It asks the folder or directory for installation.
3. You can choose default folder or c:\Program files\EPANET.
4. After installation it appear at the window
5. EPANET only to use the files of EPACAD. It is not direct use the any file.

If you want to delete the EPANET from your system, you can follow some steps:

1. Select start
2. Go to Control Panel
3. SelectAdd/Remove
4. Select EPANET 2.0.
5. Click the Remove button

3.2 EPACAD Installation

EPACAD is a free software which easily convert the AUTOCAD files into EPACAD file.
To install EPACAD:

1. Download the setup form internet and it download in few seconds and run for window 10.
2. click on the setup file and start the setup process. It asks the folder or directory for installation.
3. You can choose default folder or c:\Program files\EPACAD. After installation it appear at the window
4. EPACAD menu to select and open the AUTOCAD file.
5. Select the useful network for EPANET.

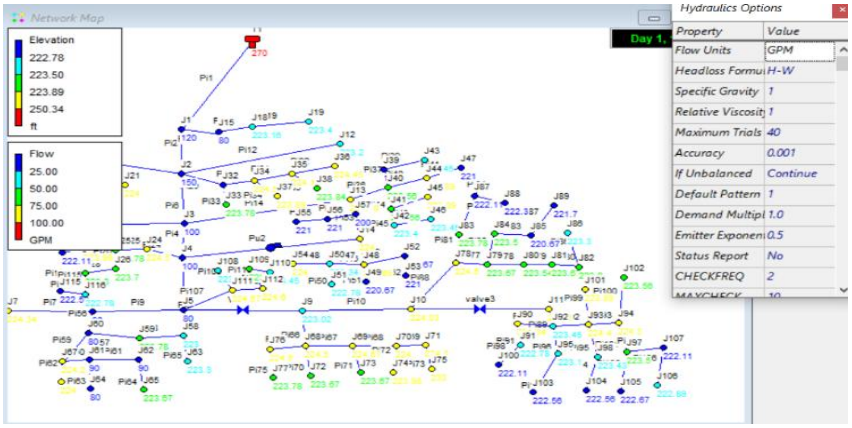

Figure1: Water distribution network with Elevation and Flow(Hazen-William's formula)

In the above figure to show the Hydrulic property with flow unit specific gravity.

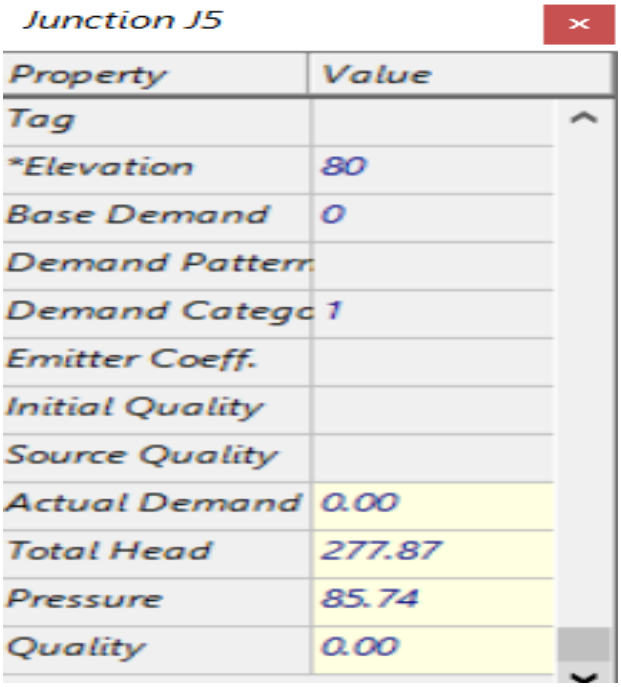

Figure2: Junction to show the property with value

EPANET tool consist many junctions, which consider as a node. Every junction to set by elevation and after simulation it display actual demand of consumer, total head, pressure and quality. Thus, we detect the pressure at every node.

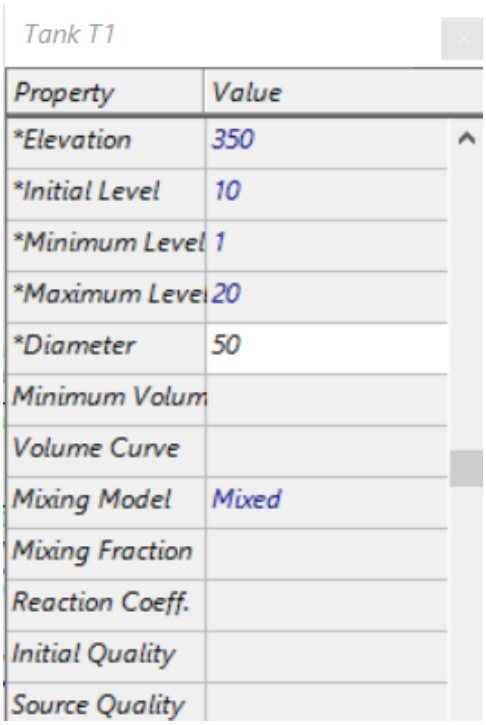

Figure3: Junction to show the property with value

Tank to be consider as a water storage system which have property with value like elevation, initial level, minimum level, maximum level and diameter.

Table 1:Nodes Data

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc J1	0.00	280.00	69.33	0.00
Junc J2	0.00	1047.69	388.97	0.00
Junc J3	0.00	1047.69	410.64	0.00
Junc J4	0.00	1166.23	462.00	0.00
Junc J5	0.00	1273.84	517.29	0.00
Junc J6	0.00	1273.84	512.96	0.00
Junc J7	0.00	1273.84	454.75	0.00
Junc J8	0.00	1273.84	454.50	0.00
Junc J9	0.00	1273.84	455.32	0.00
Junc J10	0.00	1290.19	461.97	0.00
Junc J11	0.00	1290.19	461.72	0.00
Junc J12	0.00	1047.69	357.25	0.00
Junc J13	0.00	1047.69	356.83	0.00
Junc J14	0.00	1166.23	408.27	0.00
Junc J16	0.00	1063.42	363.50	0.00
Junc J17	0.00	1047.69	356.88	0.00

Table 2: Nodes Data

Link ID	Velocity fps	Unit Headloss ft/Kft	Friction Factor
Pipe Pi2	0.00	8.52	2.738493E010
Pipe Pi4	0.00	2.81	1.995052E010
Pipe Pi5	0.00	1.85	1.461317E010
Pipe Pi7	0.00	0.00	0.000
Pipe Pi8	0.00	0.00	0.000
Pipe Pi10	0.00	0.27	0.000
Pipe Pi12	0.00	0.13	0.000
Pipe Pi14	0.00	0.00	0.000
Pipe Pi15	0.00	0.00	0.000
Pipe Pi17	0.00	0.00	0.000
Pipe Pi13	0.00	0.00	0.000
Pipe Pi18	0.00	0.00	0.000
Pipe Pi19	0.00	0.00	0.000
Pipe Pi21	0.00	0.00	0.000
Pipe Pi22	0.00	0.00	0.000

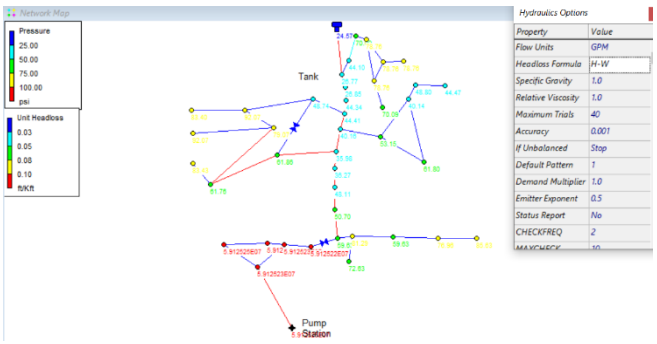

Figure4: Water distribution network with Pressure and Unit HL (Darcy Weisbach'sformula)

Table3: Pressure at each node with the Darcy Weisbach's formula

Node ID	Elevation ft	Head ft	Pressure psi	Quality
Junc J1	120	280.00	69.33	0.00
Junc J2	150	1047.69	388.97	0.00
Junc J3	100	1047.69	410.64	0.00
Junc J4	100	1166.23	462.00	0.00
Junc J5	80	1273.84	517.29	0.00
Junc J6	90	1273.84	512.96	0.00
Junc J7	224.34	1273.84	454.75	0.00
Junc J8	224.91	1273.84	454.50	0.00
Junc J9	223.02	1273.84	455.32	0.00
Junc J10	224.03	1290.19	461.97	0.00
Junc J11	224.6	1290.19	461.72	0.00
Junc J12	223.2	1047.69	357.25	0.00
Junc J13	224.18	1047.69	356.83	0.00
Junc J14	224	1166.23	408.27	0.00
Junc J16	224.51	1063.42	363.50	0.00
Junc J17	224.07	1047.69	356.88	0.00

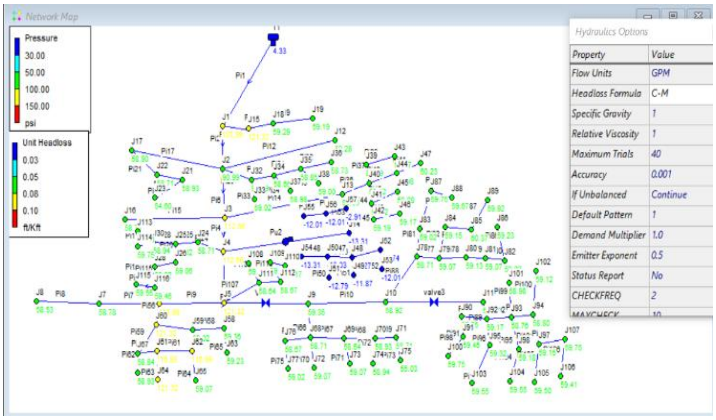

Figure 5: Water distribution network with Pressure and Unit HL (Chezy-Manningformula)

Table4: Pressure at each node with the Chezy-Manningformula

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc J1	0.00	360.00	103.99	0.00
Junc J2	0.00	360.00	90.99	0.00
Junc J3	0.00	360.00	112.66	0.00
Junc J4	0.00	360.00	112.66	0.00
Junc J5	0.00	360.00	121.32	0.00
Junc J6	0.00	360.00	116.99	0.00
Junc J7	0.00	360.00	58.78	0.00
Junc J8	0.00	360.00	58.53	0.00
Junc J9	0.00	360.00	59.35	0.00
Junc J10	0.00	360.00	58.92	0.00
Junc J11	0.00	360.00	58.67	0.00
Junc J12	0.00	360.00	59.28	0.00
Junc J13	0.00	360.00	58.85	0.00
Junc J14	0.00	193.27	-13.31	0.00
Junc J16	0.00	360.00	58.71	0.00
Junc J17	0.00	360.00	58.90	0.00

Comparison between figure 4 and figure 5 pressure

3.3. Mathematical equation:

3.3.1. Hazen William's and Chezy-Manning

Hazen William 'equation for Pipe flow

- It depends on the roughness of pipe.
  V=0.849C R^0.63 S^0.54
  V= Velocity
  C= Hazen-William's Co-efficient
  R= Hydraulic radius
  S= Hydraulic gradient

Chezy-Manning's equation for pipe flow

- It finds the flow velocity
- V=C R^1/2 S^1/2

V is average velocity
R=Hydraulic radius
S=Energy slope
C=Roughness co-efficient

Hazen William 'equation use for smooth flow and Chezy-Manning's equation use for rough flow. Both formulas commonly use in US but Darcy Weisbach not common for US. This tool use by all over world. Water flow depends on the pipe'squality and elevation.

IV.EPANET IMPLEMENTATION

Real water supply distribution network to design in AUTOCAD and select by EPACAD in EPANET tool. In my research I have used two formulas. Hazen Williams and Chezy Manning equation only use for water but Darcy Weisbach uses for all fluids.

Algorithm 1:**(Hazen-William)**
Input: Select the network from EPACAD tool.
Output: Simulate the network with all nodes and pipes also track the flow(Unit HL) with pressure.
Step1: Select the tank, nodes and pipes and valves.
Step2: Set the elevation of tank and each node and also set the pipes property with valves.
Step3:Set the valves at various rotations.
Step4: Apply Hazen-William's formulato detect the pressure and flow in network
V=0.849C R^0.63 S^0.54
V= Velocity
C= Hazen-William's Co-efficient
R= Hydraulic radius
S= Hydraulic gradient

Step5: Detect pressure at nodes and also detect flow at links.
Step6: Calculate demand and generate 24Hrs data in table
Step7: if t=0, not detect the appropriate resultotherwise repeat this

Algorithm 2: **EPANET(Chezy-Manning)**

Input: Select the network from EPACAD tool.
Output: Simulate the network with all nodes and pipes also track the flow (Unit HL) with pressure.
Step1: Select the tank, nodes and pipes and valves.
Step2: Set the elevation of tank and each node and also set the pipes property with valves.
Step3: Set the valves at various rotations.
Step4: Apply Chezy-Manning formulato detect the pressure and flow in network
V=C R^1/2 S^1/2
V is average velocity
R=Hydraulic radius
S=Energy slope
C=Roughness co-efficient

Step5: Detect pressure at nodes and also detect flow at links.
Step6: Calculate demand and generate 24Hrs data in table
Step7: if t=0, not detect the appropriate resultotherwise repeat this.

V.RESULTS

Simulation result depends on the flow. Hazen-William's formula depends on smooth flow. So, we consider the plastic pipes during this network. Plastic pipes have higher coefficient roughness than iron pipe.
EPANET tool to display the distribution of pressure at all nodes with 24 Hrs. In the below image pressure at some node constant and after some time increased.

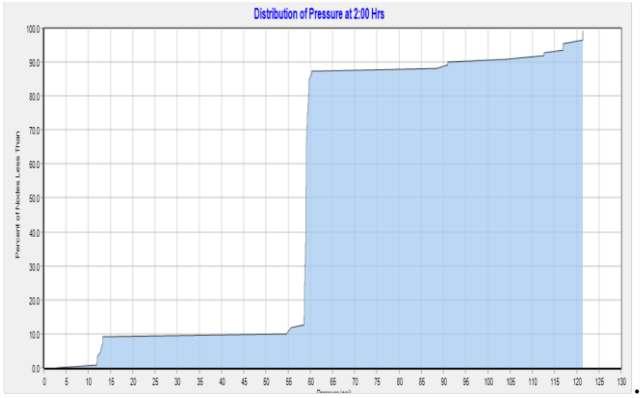

Figure6: Distribution of Pressure at 2Hrs.

Above figure to show the 2Hrs. above figure to show the pressure at different location.

Figure7: Contour Plot with Chezy-Manning formula

In the figure 7 contour plot to display the selected pipelines of distribution network and yellow color to display the main pipeline of water. Yellow color to represent the pressure between 100 and 150. Green color to display the pressure below 30 it means this area required a pump system for full pressure.

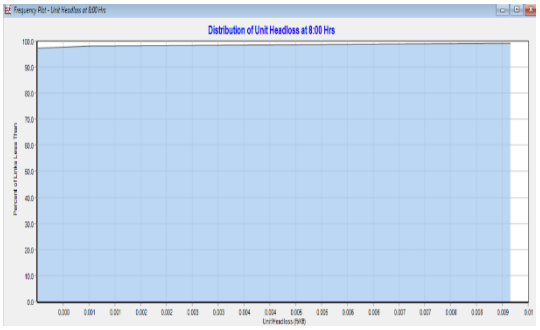

Figure8: Distribution of UNIT HL at 8:00Hrs

In the figure 8 to display the unit HL at all pipe link. This figure to represent the distribution of Head Loss at 8Hrs.

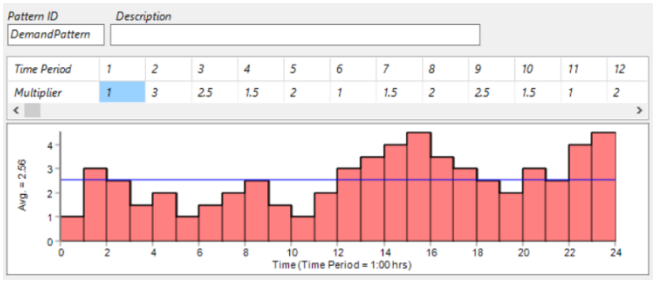

Figure9: Demand Pattern

In figure 9 demand pattern to represent the consumer requirement of water in per hours. Demand of water vary during time.

VI.CONCLUSIONS

This paper to describe the two new methods of EPANET tool. It is improvement in my previous research work and give the complete knowledge about water distribution network, that help us to save the water for human life. EPANET is a free application software so, researcher can use this at free cost. In my future work I will also to do the work on this tool and suggest the researchers to use this tool.

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Prof. P.K. Suri, Dean (R & D), Chairman & Professor (CSE/IT/MCA) of HCTM Technical Campus, Kaithal, since Nov. 01, 2012. He obtained his Ph.D. degree from Faculty of Engineering, Kurukshetra University, Kurukshetra and Master's degree from IIT Roorkee(formerly). He started his research carrier from CSIR Research Scholars,AIIMS. He worked former as a dean Faculty of Engineering & Technology, Kurukshetra University, Kurukshetra, Dean Faculty of Science, KUK, Professor & Chairman of Department of Computer Sc. & Applications, KUK. He has approx. 40 yrs experience in different universities like KUK, Bharakhtala University Bhopal & Haryana Agricultural university, Hissar.He has supervised 18 Ph.D. students in Computer Science and 06 students are working under his supervision. Their students are working as session judge, director & chairpersons of different institute. He has around 150 publications in International/National Journals and Conferences. He is recipient of 'THE GEORGE OOMAN MEMORIAL PRIZE' for the year 1991-92 and a RESEARCH AWARD – "The Certificate of Merit – 2000" for the paper entitled ESMD – An Expert System for Medical Diagnosis from INSTITUTION OF ENGINEERS, INDIA. The Board of Directors, governing Board Of editors & publication board of American Biographical institute recognized him with an honorary appointment to Research board of Advisors in 1999.M.P. Council of Science and Technology identified him as one of the expert to act as Judge to evaluate the quality of papers in the fields of Mathematics/Computer Science/ Statistics and their presentations for M. P. Young Scientist award in Nov. 1999 and March 2003.His teaching and research activities include Simulation and Modeling, Software Risk Management, Software Reliability, Software testing & Software Engineering processes, Temporal Databases, Ad hoc Networks, Grid Computing, and Biomechanics.