

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 8, August 2018

# Experimental Analysis of Water Distribution Network and its Hydraulic Simulation by EPANET

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**ABSTRACT:** Water distribution network is a system of engineered hydraulic components which supplies water from the source to the required area. The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity and pressure. A pipe network is treated as analyzed when all the unknown parameters are determined with the help of the known parameters and the available interrelating equations. Analysis of complex water distribution network becomes simple due to hydraulic simulation. Due to hydraulic simulation of water distribution network we can check the feasibility of the network without implementing it. This project is an attempt to analyse the physical model of double loop water distribution network experimentally and by hydraulic simulation. Hardy Cross method is used to analyse the network manually and hydraulic simulation is done using EPANET. Physical model of double loop network was tested for varying source head and it was simulated for the same conditions as the physical model was tested and the results were compared.

**KEYWORDS:** EPANET; Hardy Cross Method; Hydraulic simulation; Double loop network.

## I. INTRODUCTION

Most of the fund of a water supply scheme is allocated to the distribution part rather than the lifting the water from the source. This is because it is hard to maintain the adequate pressure which is required to supply the demand at the consumer end or at any node of the distribution network. The pressure reduces due to mainly leakages and other minor losses. Relation between pressure and discharge has to be studied to reduce the cost of the distribution of water and also the water losses. There are three basic methods for analysis of water distribution network, Hardy Cross method, Newton Raphson method, Linear theory method. Softwares like EPANET, WATERGEMS etc are used for hydraulic simulation is very important to tackle day today water problems without actually facing them. Many a scenarios for a single network can simulated and the most feasible one can be selected without actually implementing the network. Forecasting of many results can be done with help of simulation.

## II. OBJECTIVES OF PROJECT

- 1) To analyse the water distribution network experimentally.
- 2) To simulate the water distribution network using EPANET.
- 3) To compare results of experimental analysis and hydraulic simulation.

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## III. RELATED WORK

Literature reviewed is related to water distribution network analysis by Hardy cross method using excel and simulation of water distribution network using EPANET. The major objective of this paper was to give an alternative to time consuming calculations of solving an water distribution network by Hardy Cross Method by using spreadsheet software(1) In this paper, a new method categorized as a modification to the  $Q-h$  equations was pro- posed for the analysis of pipe networks. The method is inspired by the Kani method which is used for analysis of structural frames. The new method can be considered as an iterative procedure which does not require a large system of nonlinear equations to be solved simultaneously.(2) The present system of supply adopted in Chirala municipality is an intermittent supply and the network adopted is a dead end system. This system of supply of water in Chirala municipality may or may not be reliable to the upcoming years. Hence the research is all about the analysis of the existing network and concludes about the reliability on the network for the future.(3) Excel spreadsheet reduces the cumbersome calculations involved in analytical methods like Hardy Cross method. Different modifications in Q-H equations can be proposed which would reduce the non linearity in the equations EPANET is a reliable software and it is freely available and can be effectively used for simulation of water distribution network A lot of research is going on the effect of different leakage patterns on pressure in WDN. So there is scope for further research.

## IV. METHODOLOGY

Experimentation was done on double loop network consisting of one source three outlets. The arrangement was done similar to as shown in the schematic diagram. The experimental observations were further used for manual analysis Form the experimental data the network was analyzed by Hardy Cross method and flow rate through each pipe was found. Hydraulic simulation was done using EPANET by following steps given in manual. Simulated results were compared with the Hardy Cross method results.

## V. NETWORK SETUP FOR EXPERIMENT

The setup consists of 2 loops with dimensions - 2.25 x 2.5m for each loop. It consisted of UPVC pipe with inner diameter 1". Three way and four way brass elbows of 1" diameter were used for joints and connections. 1" UPVC valve was used as an inlet valve. Wooden piezometers of height 1.4m were prepared for measuring pressure at each node. Scale was marked on the wooden piezometers for accurate reading. A 500 lit tank is provided as a main source of water and another 225 lit tank is provided to collect water coming out from the network and further re-circulated to main tank. ¼" copper taps were used at all nodes to attach piezometers and also to introduce demand. Flow-meter was used at inlet pipe to measure the inflow. Measuring tank was used to measure outflow and the demands at two other nodes. The flow was allowed to pass under gravity and it was controlled by an inlet valve. An extra tapping besides the tapping at the node was provided for measuring the pressure at demand nodes. Overhead tank was marked with five levels at an interval of 5 cm to study the behavior of pressure and discharge at various source heads.

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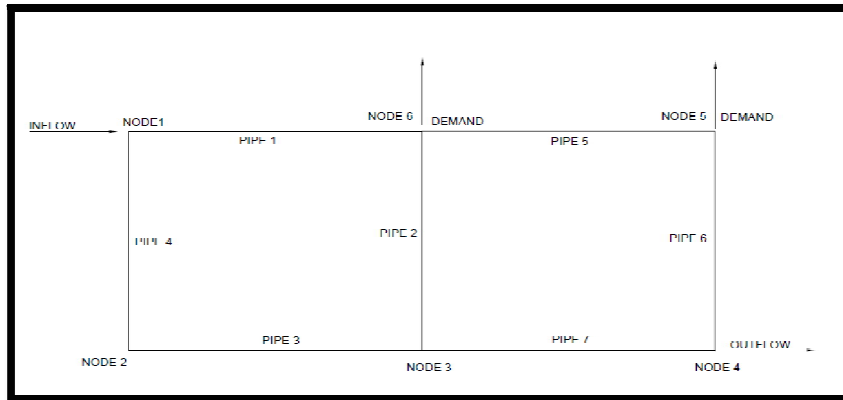


Fig 1: Schematic diagram of double loop network

The following figure shows the experimental setup for the double loop network



Fig 2: experimental setup for double loop network

## VI. RESULTS

This chapter deals with the results from analysis of double loop network by Hardy Cross Method and its simulation in EPANET for varying source head.

The results from experimental analysis (Hardy Cross Method) and hydraulic simulation are compared in table below.

Table No 1: comparison of discharges

Sr. no.	Source head (cm)	Pipe1 (LPS)		Pipe 2 (LPS)		Pipe 3 (LPS)	
		HC	EP	HC	EP	HC	EP
1	93	0.182	0.18	0.0350	0.03	0.127	0.13
2	88	0.176	0.17	0.0323	0.03	0.123	0.13
3	83	0.164	0.16	0.0328	0.03	0.115	0.12
4	78	0.156	0.15	0.0320	0.03	0.108	0.11
5	73	0.147	0.15	0.0308	0.03	0.102	0.11

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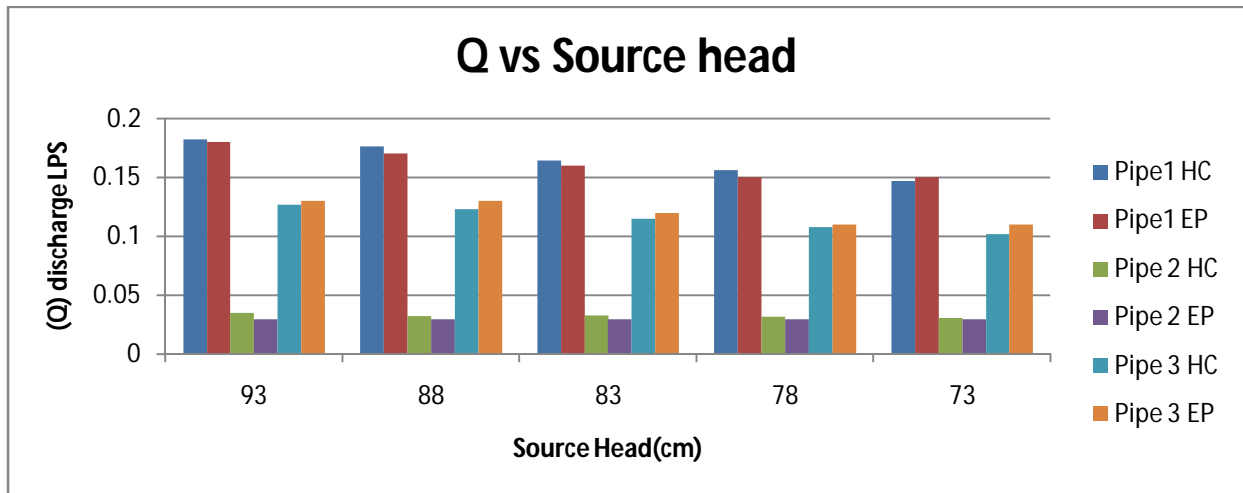
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The table below gives the comparison of discharges through the remaining pipes.

Table no 2: Comparison of discharges

Sr no	Source head (cm)	Pipe 5 (LPS)		Pipe 6 (LPS)		Pipe 7 (LPS)	
		HC	EP	HC	EP	HC	EP
1	93	0.127	0.13	0.097	0.10	0.162	0.16
2	88	0.120	0.12	0.094	0.10	0.155	0.15
3	83	0.112	0.12	0.091	0.09	0.148	0.15
4	78	0.107	0.11	0.088	0.09	0.141	0.14
5	73	0.101	0.10	0.083	0.09	0.133	0.13

The following graph no 1 shows the comparison of discharge values calculated by Hardy Cross method and that from EPANET results.



Graph no 1: comparison of discharges

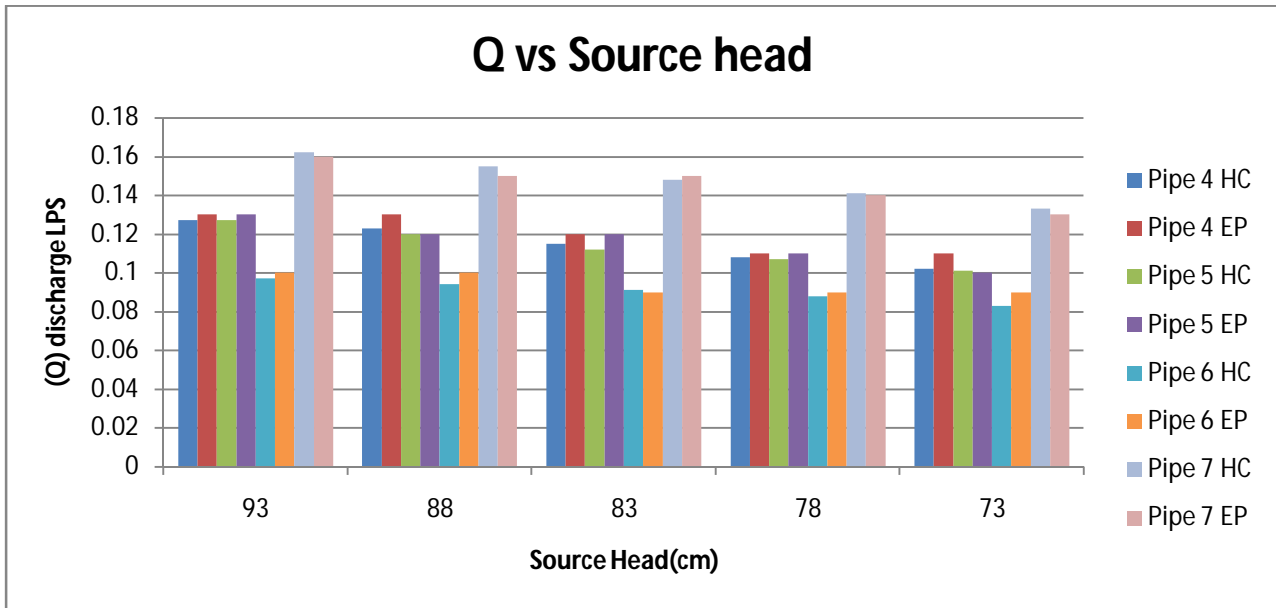
Graph no 2 shows the comparison of discharges for remaining pipes.

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Graph no 2: comparison of discharges

The discharge through each pipe decreases as the source head decreases.. The flow through pipe 1 is maximum in each case. Discharge through pipe 2 is minimum

The following tables show the comparison of pressure at each node observed experimentally and that from EPANET results

Table no 3: Comparison of pressure

Sr no	Source head (cm)	Node1 (cm)		Node 2 (cm)		Node 3 (cm)	
		EXP	EP	EXP	EP	EXP	EP
1	93	72	72	69.5	70	67	67
2	88	47.5	47	45.5	45	42.5	42
3	83	40.5	40	38	38	36.5	36
4	78	30.5	30	29	29	26.5	26
5	73	24	24	23	23	20.5	20

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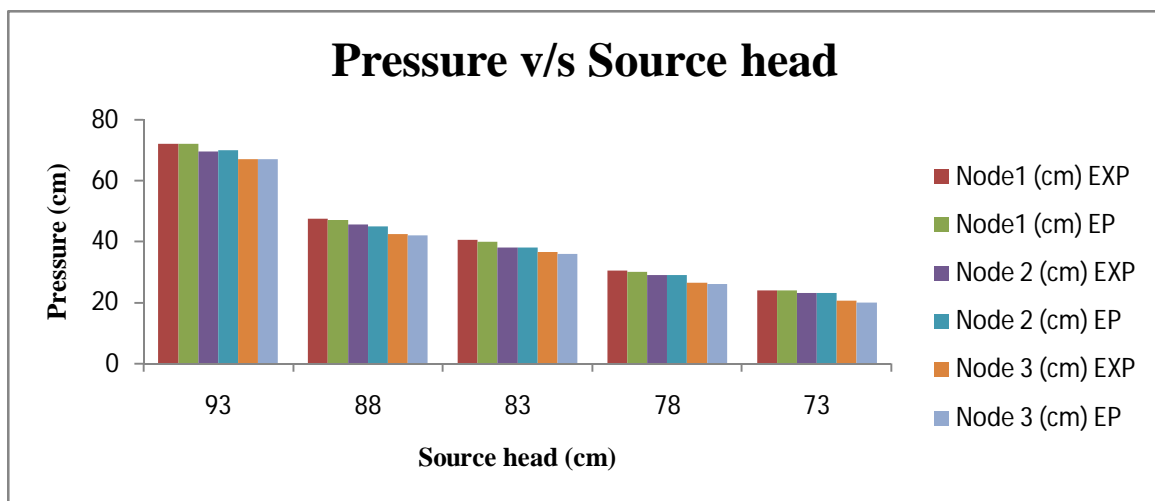
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Table no 4: comparison of pressure

Sr no	Source head (cm)	Node 4 (cm)		Node 5 (cm)		Node 6 (cm)	
		EXP	EP	EXP	EP	EXP	EP
1	93	64.5	65	66	66	68	68
2	88	40	40	41.5	41	43	43
3	83	34	34	35	35	37.5	37
4	78	24	24	26	26	27	27
5	73	19	19	20.5	20	21	21

Graph no 3 and 4 show the comparison of pressures at each node observed experimentally and that from EPANET results.



Graph no 3: comparison of node pressure

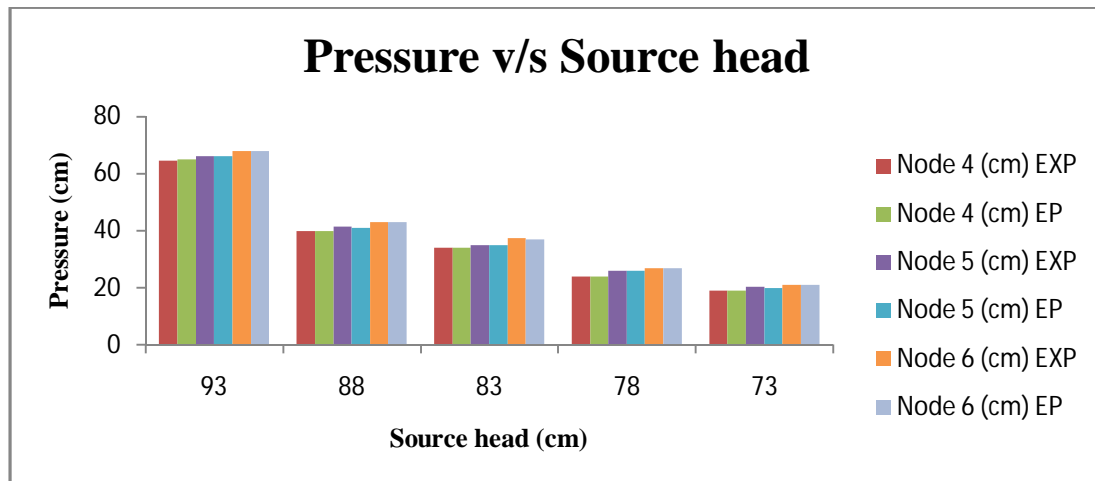
The following graph shows the comparison of pressure at various nodes observed experimentally and that from the EPANET results.

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Graph no 4: comparison of pressure

The pressure at each node goes on decreasing as the source head decreases. As observed from the graph there is abrupt drop in pressure after the source head changes from 93cm to 88cm

### VII. CONCLUSIONS

- Results from experimental analysis by Hardy Cross method are similar for five cases of different source head.
- The discharge through pipes decreases by 19 % as the source head decreases by 22%.
- The pressure at each node decreases by 67 % as the source head decreases by 22%

### VIII. FUTURE SCOPE

- Variation of pressure at demand nodes can be studied for various discharges for constant source head.
- Thus a relation can be established between pressure and discharge.
- Analysing the network on small scale and applying it on larger network i.e. practical network would be beneficial.

### ACKNOWLEDGMENT

First and foremost, I would like to thank my Project guide, Mrs D. R. Vaidya for her guidance and support. I will forever remain grateful for the constant support and guidance extended by my guide. Through our many discussions, he helped me to form and solidify ideas. The invaluable discussions I had with him, the penetrating questions he has put to me and the constant motivation, has all led to the development of the ideas presented in this paper. The authors would like to thank the publishers, researchers for making their resources available and teachers for their guidance. I would also thank the college authorities for providing the required infrastructure and support. Also, I would like to thank my parents for their continual encouragement and the positive support. I would also like to thank my friends for listening my ideas, asking questions and providing feedback and suggestions for improving my ideas.

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