A REVIEW PAPER ON DESIGN AND ANALYSIS OF WATER DISTRIBUTION SYSTEM OF ADYPU CAMPUS

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Abstract - *Water supply system is a system of engineered hydrologic and hydraulic components which provide water supply. Water is one of the basic necessities of every living being in the world. Water demand is increasing day by day. Water distribution network play vital role in preserving and providing desirable life quality to the public, of which reliability of supply is the major component. To solve this problem, design of new or up-gradation of existing water distribution network is necessary. Such type of problem can be solved manually as well as by using different computation technologies like LOOP 4.0, MIKENET, STANET and EPANET 2.0 software. This study is based on assessment of existing water distribution network using EPANET 2.0 software. The pipe network and junction network system is simulated to understand its behavior for different inputs using EPANET 2.0. Simulation has been carried out for hydraulic parameters such as head, pressure and flow rate. The results obtained verify that the pressures at all junctions and the flows with their velocities at all pipes are feasible enough to provide adequate water by the network of the study area.*

Key Words: EPANET, Economic Efficiency, Water Supply System.

1. INTRODUCTION:

Water distribution system, a hydraulic infrastructure consisting of elements such as pipes, tanks, reservoirs, pumps and valve etc., is crucial to provide water to the consumers. Effective water supply system is of paramount importance in designing a new water distribution network or expanding the existing one. Pipe water system is one of the best systems to supply water safely, adequately and continuously.

Distribution networks are also an essential part of all water supply systems. Distribution system costs within any water supply scheme may be equal to or greater than 60 % of the entire cost of the project. Design and analysis of pipe networks are important, because availability of water is an important economic development parameter.

Water distribution system, hydraulic infrastructure consisting of elements such as pipes, tanks, reservoirs, pumps and valves etc. is crucial to provide water to the consumers. Elements of a distribution system include distribution mains, arterial mains, storage reservoirs and system accessories (valves, hydrants, mainline meters, service connections, and backflow preventers). Distribution mains are the pipelines that make up the distribution system. Their function is to carry water from the water source or treatment works to users.

1.1 AIM OF STUDY

To analyse the existing water distribution system and to suggest some measures if present network does not fulfil the future demand.

1.2 OBJECTIVE OF STUDY

- To study the existing water supply network of ADYPU campus Lohegaon, Pune.
- To collect pipe report and junction report of existing network.
- To analyze the data by using EPANET software.
- To check the discharge & pressure head in existing network

1.3 STUDY AREA

The study area opted is our AJEENKYA D Y PATIL UNIVERSITY CAMPUS, situated at Charholi (Bk), which is 07 km away from the PUNE Airport. And consists of 13 blocks.

Photo no 1 Study Area of Campus

1.4 Overview of EPANET software:

EPANET was developed by the water supply and water resources division (formerly the drinking water research division) of the U.S Environmental protection agency's national risk management research laboratory. It is public domain software that may be freely copied and distributed. EPANET is a computer program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps. In addition to chemical species, water age and source tracing can also be simulated. Running under windows, EPANET provides an integrated environment for editing network input data, running hydraulic and water quality simulations, and viewing the results in a variety of formats. These include color-coded network maps, data tables, time series graphs, and contour plots.

2. LITERATURE STUDY:

1. **Jacob (1991)**, proposed a technique for simulation of water distribution system in developing countries, where supply is less than demand i.e., intermittent supply.
2. **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 abalance between cost minimization and net benefits (benefit minus costs) (ii) Reliability of the water distribution networksshould not be reduced for the sake of cost reduction.
3. **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.
4. **Vicki L. Van Blaricum and Vincent F. Hock (2007)** This paper describes the demonstration and validation of multi-parameter water quality sensors and corrosion rate sensors that were permanently installed at a U. S. Army installation to detect corrosion problems and fine-tune the chemical treatment program. The use of water quality and corrosion rate sensors has been demonstrated and validated in the field.
5. **Andrea Bolognesi, Cristiana Bragalli, Angela Marchi,SandroArtina DISTART, (2009)** This paper proposes a newmodel named Genetic Heritage Evolution by Stochastic Transmission GHEST, a multipopulation evolutionary strategy like algorithm applied to the design of water distribution networks

3. DESIGN CRITERIA:

Following are the design limitations required to get the most efficient and economical water distribution network. The design criteria for water distribution system can be divided in non-hydraulic and hydraulic design consideration.one of the non-hydraulic criteria can be the ability to isolate part of the system especially during emergency operation. Hydraulic design criteria are primarily related to the flow and pressure in the network. Moreover, criteria for minimum and maximum pipe capacities, flow velocities, pressure fluctuations and pressure gradients are relevant factors.

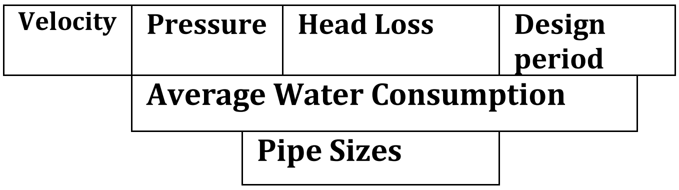

Fig no 1 Factors for Design Purpose

1. **Block wise water demand:**

The water demand was calculated on the basis of IS code 1172:1993. In this code, the water consumption of each person in each building is mentioned.

1)Hostel=135 l/h/d
2)College=45 l/h/d
3)Office =45 l/h/d
4)Auditorium =15 l/h/d
5)Hospital=450 l/h/d

4. METHODOLOGY:

1. **Selection of study area** i.e ADYPU Campus Charoli(bk),Pune.

2. **Collection of Data** .These data include: (i) The population data (Students Affairs, Housing and Academics Affairs Units) (ii) Water Supply Records (Maintainance Dept) (iii) General layout map of the University (Maintainance and Planning Department) (iv) Existing water distribution layout map (Maintainance and Planning Department) (iv) Elevations of water distribution nodal points (Maintainance and Planning Department) and (v) Direct sample head counts of the various sectors to determine the water demand at each node in the distribution network.

3. **Data Analysis**
   Nodal Demand Estimations

Population Demand*:* In order to estimate the demand at each node, the population for each node is used to multiply the per capita demand of the node. The daily demand is further translated into liters per second (lps) for consistency with EPANET specifications.

Fire Demand*:* During a fire break out, large quantity of water is required to extinguish it, therefore provision is made in the water work to supply sufficient quantity of water or keep as reserve in the water mains for this purpose. In the analysis for the total water demand, it is expected that provision of about 10% be made for fire demand. In this case 10% of the population demand is added as fire demand (Lingkungan, 2012).

Minor Losses*:* A provision of 5% is made for minor losses. This is to take care of losses at fittings, valves and bends.

4. **Skeletonization of the Network** The next step in using EPANET was to skeletonize the network and assign node numbers to the nodal points.

5. **Assigning Distribution Network Parameters** After the skeletonization of the network on EPANET platform, the next step was to assign network parameters. The networks parameters include: pipe lengths, pipe diameters, roughness coefficients (Hazen-Williams or Darcy-Welsbach), Nodes numbers, and Nodal elevations. These are basic network parameters on which future simulation will be based depending on the flow to be simulated.

6. **EPANET Analysis of the Distribution Network** The main principle of EPANET network analysis is based on the continuity equation and conservation of energy theory. The continuity equation implies that the algebraic sum of the flow rates in the pipes meeting at a node together with any external flows is zero. This is illustrated in Figure 1 and Equations 1 and Equation 2.

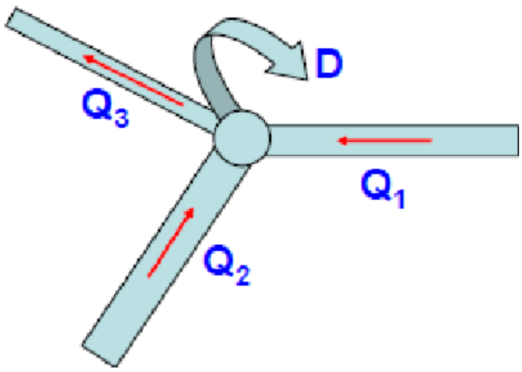

Fig no 2 Distribution Network

$$Q_1 + Q_2 = Q_3 + D \qquad (1)$$
$$D = Q_1 + Q_2 - Q_3 \qquad (2)$$

Where Q = Flow in or out of the node and D = Demand at the node or nodal demand.

The conservation of energy condition implies that, for all paths around closed loops and between fixed grade nodes, the accumulated energy loss including minor losses minus any energy gain or heads generated must be zero. This is illustrated by Figure 2 and Equation 3.

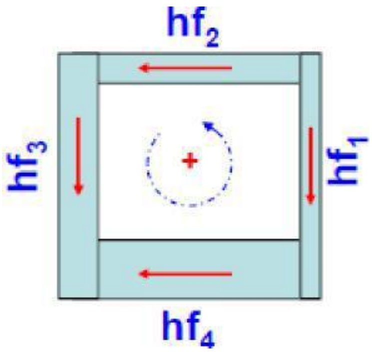

Fig no 3 Conservation System

Given total head loss for each link (pipe) as hf and assuming counterclockwise flow direction to be positive, then:

-hf1 - hf4 + hf3 + hf2 = 0 (3)

The Hazen-Williams head loss equation is given by Wurbs, R. A. and James, W. P. (2010) in Equation.

where; hf = head loss (m),
L = pipe length (m)
, D = pipe diameter (m),
Q = flow rate in the pipe (m3/s), and
CHW = Hazen-William Coefficient

The algorithm used in EPANET software to solve the flow continuity and head loss equations that characterize the hydraulic state of the pipe network is based on Newton-Raphson iteration method for solving the simultaneous equations which are derived from the flow and head loss in the network. This is achieved in very efficient manner through the computer-based software.

5. CONCLUSIONS

The main view of this research is:

1) To analyze the water distribution network and to lookout the deficiencies (if any) in the analysis, establishment and its usage.

2) At the end of the analysis 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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