Industrial Water Distribution Network Design and Analysis: A Case Study

Nikita Dhake
PG Student (Environmental Engineering)
Ssbt's College of Engineering and Technology, Bambhori, Jalgaon - 425001 (MS) India

Mr. Farooq I. Chavan
Assistant Professor
Ssbt's College of Engineering and Technology, Bambhori, Jalgaon - 425001 (MS) India

Dr. Mujahid Husain
Professor & Head of Civil Department
Ssbt's College of Engineering and Technology, Bambhori, Jalgaon - 425001 (MS) India

Abstract

This paper concerns for the design of industrial water supply distribution system in India. India is developing country and it has started developing Industrial parks to grow industries on local level and to attract foreign investments. Water is basic need of human being and it directly effects human health. Indian government has decided to provide safe, regular and adequate water to the community at their residence. Until now there is no standards specifications available for supply of water in industrial area.

This paper will be helpful to water supply engineers who are facing the problems in designing new distribution network in separate isolated industrial area.

For designing of best economical water distribution system Bentely Vi8 version is used in this case study. Design procedure satisfies all constraints. The constraints include nodal pressure, velocity of flow in pipe, pipe material, reservoir level, peak factor and available commercial pipe diameters.

In addition to the simulation tool, optimization techniques to identify the least cost design of distribution systems, while achieving the most equitable distribution of water have been developed.

Keywords- Water Distribution Network Design, Industrial Park, Bentely, optimization

I. INTRODUCTION

Safe and adequate water is basic need of human.

The World Health Organization, (WHO Study Group, 1987), defines:

i. safe water as "water that does not contain harmful chemical substances or micro-organisms in concentrations that cause illness in any form";

ii. and adequate waters supply as " one that provides safe water in quantities sufficient for drinking, and for culinary, domestic, and other household purposes so as to make possible the personal hygiene of members of the household. A sufficient quantity should be available on a reliable, year-round basis near to, or within the household where the water is to be used"

Many Standards and norms are developed until now on water supply standards and norms. But for industrial water supply there are no any firm standard guidelines developed.

Industrial development is need of the era. A basic necessity of industrial development is adequate availability of water. The industrial sector is the second highest user of water after agriculture. Estimates by the Ministry of Water Resources (MoWR) indicate that water used for industry in India is around 7-8 per cent of the total freshwater withdrawal in the country. In the next two decades water consumption will triple current levels. Meeting this unprecedented demand for water with limited availability is the biggest challenge. Water conservation will be definitely the solution for it. Water conservation is defined as any action that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces the loss or waste of water, improves the efficiency of water use, increases recycling and reuse of water, or prevents the pollution of water. All the industrial process do not required potable water. Processed/recycled water can also be used. Fresh Water Consumption can be reduced through Process Improvement and Recycle/ Reuse of Process Water.

II. DESIGN CRITERIA FOR WATER DISTRIBUTION NETWORK

A. Supply of water

i. Water Supply for residential area varies from 70 lpcd to 250 lpcd.

ii. Commercial area – depends on type

iii. Industrial area- varies with type of industry

B. Pressure

Adequate pressure should be available in distribution mains at all points located even at the remotest spots.
The following pressures are considered satisfactory:

i. Residential Area
   a. Single Story- 7 m of water column
   b. Double story- 12 m of water column
ii. Three Story Building- 17 m water column
iii. Commercial Area- 12 m of water column
iv. Industrial Area- 5 to 10 m of water column

Distribution system should not ordinarily be designed for residual pressures exceeding 22 meters. Multistoried buildings needing higher pressure should be provided with boosters.

C. Minimum Velocity

Minimum velocity of 0.6 m/s is required. The adequate range of design velocity in water supply network in 0.6m/sec to 1.5m/sec.

D. Minimum pipe sizes

The recommended minimum pipe sizes:

i. Town with population up to 50000: 100mm dia.
ii. Town with population above 50000: 150 mm dia.

For the dead end, less than 100 mm can be considered. For hilly area the minimum diameter can be decreased upto 80 mm.

E. Peak factors

The manual on water supply has recommended the following value of the peak factor, depending upon the population:

i. Population up to 50,000 : 3.0
ii. Population between 50,001 -2,00,000 : 2.5
iii. Population above 2 lakh : 2.0

For Industrial Area it can be kept as low as 1.1, as industrial process continue process. If the industrial park is of mixed land use and has residential and commercial area as well then the considered factor should be calculated.

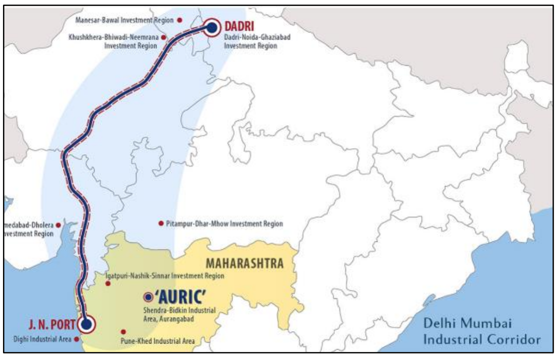
F. Head loss in network

The maximum headless can be considered upto 10m/km.

III. A STUDY AREA

Delhi - Mumbai Industrial Corridor (DMIC) is India's most ambitious infrastructure programme aiming to develop new industrial cities as "Smart Cities" and converging next generation technologies across infrastructure sectors.
The objective is to expand India's Manufacturing & Services base and develop DMIC as a "Global Manufacturing and Trading Hub". The programme will provide a major impetus to planned urbanization in India with manufacturing as the key driver. In addition to new Industrial Cities, the programme envisages development of infrastructure linkages like power plants, assured water supply, high capacity transportation and logistics facilities
as well as softer interventions like skill development programme for employment of the local populace. In the first phase eight new industrial cities are being developed. The programme has been conceptualized in partnership and collaboration of Government of Japan. Under it the Shendra Bidkin Industrial Area is getting developed in Aurangabad.
The SBIA is envisioned as a very large-scale industrial cluster including abundant land provisions for high growth industries with wide-ranging infrastructure services, convenient access and provisions to handle environmental waste with minimum impacts. Proximity to the existing industrial areas, Aurangabad city and existing airport and railways, gives strong support for export-oriented businesses. SBIA is located at a distance of approximately 15 km from downtown Aurangabad and is 8 km east of the Aurangabad Airport. It is planned as a new industrial corridor extending from the existing Maharashtra Industrial Development Corporation's (MIDC) Shendra Industrial Park to the town of Bidkin.
The total area of SBIA admeasuring 84.17 sq kms has been divided into two parts viz. Part-I and Part-II. The Part-I consisting of area of 41.42 sqkm, which is further divided into two parts, viz. Phase-I and Phase-II. The Phase-I covers an area of 8.39 sqkm located north of Jalna Road adjoining existing MIDC Shendra Industrial Park. Phase-II includes the remaining area of 32.03 sqkm located near Bidkin.
The development of the Part-II of SBIA consisting of total area of 42.75 sqkm will be taken up at the later stage.

Various categories of internal roads have been proposed within the Phase-I with Right of Way (RoW) varying from 15 m to 60 m.



DMIC corridor and location of Auric

Master Plan of SBIA phase I

IV. DESIGN OF WATER DISTRIBUTION NETWORK BY USING BENTLEY Vi8 WATER CAD SIMULATION MODEL

Bentely is software developing company established in 1984. It has developed the software like Bentely water CAD, Bentley Sewer CAD and Betely Strom CAD, Water Gems etc. These are user friendly wet utility design software.

The Water CAD uses Hazen William's formula which is most widely used formula to calculate headloss due to friction-

V= 0.849 CR^0.63 S ^0.54

Where V= mean velocity of flow in pipe (m/s)

R= hydraulic radius (mean depth) (m)

S= hydraulic gradient

C= coefficient of roughness of pipe

The following steps are followed

Design of a distribution network involves selection of an appropriate pipe diameter for every pipe, so that the water can be transported without violating specified hydraulic constraints and the desired minimum pressures maintained at nodes. Options for the location and capacity of source nodes are normally relatively few and are hence prefixed. The usual process is one of trial and error, where the engineer attempts a set of pipe sizes and checks the hydraulic conditions to see if they are adequate. If not the engineer changes the pipe sizes heuristically (or changes the pump locations and capacities if possible) to arrive at a workable alternative. It seems at first that the computer programs could directly solve the network for the required pipe sizes.

A. Data Collection- The following data was collected
   i. Geometric data- The elevations along all the proposed road are collected through total station survey.
   ii. Hydraulic data- Average water demands at all the relevant nodes, Pipe resistance coefficient in terms of Hazen William's expression, Source data
   iii. Proposed road elevations and cross section.

B. Inputs to the software-
   a. Pipe and Nodes- Pipes and drawn along the proposed roads. Nodes are given at junction points and at out late points near each plot.
   b. Demand- Demand is calculated for each type of plot per ha. The total water demand for the area is 38 MLD. This large amount of water requirement is bifurcated in to two type fresh potable water and reused water. Only 20 percent water requirement for industries are fulfilled by fresh water the remaining 80 percent was fulfilled by reused water treated in zero discharge ETP plant. The plantation requirement and street sweeping requirement are also proposed to fulfil by reused water. The other demands like residential, commercial, and industrial workforce demand will be fulfilled by Fresh Potable water. This calculated demand is given as input to software

V. RESULT

   a. After carrying out trial and error method, the minimum velocity and minimum pressure criteria has been achieved. The minimum pressure was achieved as 5 m of water column. The minimum diameter of pipe is proposed as 110 mm.
   b. The required valves and water meters are proposed at various locations.

VI. CONCLUSIONS

There is need of developing the standard guidelines for Industrial Parks. These will be helpful for water conservation. It will also helpful in calculating the demand of industrial parks. The disposal of water kept zero so that the water pollution will be under control. Water requirement of fresh water will also be under control.

REFERENCES

1. http://dmicdc.com
2. http://www.auric.city
3. CPHEEO Manual on Water Supply and Treatment 1999
4. Design, Construction, Testing, Commissioning and Operation & Maintenance of Infrastructure Works for Roads, Drains, Culverts, Minor and Major Bridges, Water Supply, Sewerage, Power systems Including Sewage and Common Effluent Treatment Plants for Sector A, Phase – II in AURIC Bidkin Industrial Area, Aurangabad, Maharashtra on EPC Basis (Package – I) Tender Document Mission DMIC: Phase-I at Shendra to be ready for occupancy in 2016
5. Mission DMIC: Phase-I at Shendra to be ready for occupancy in 2016https://timesofindia.indiatimes.com/city/aurangabad/Mission-DMIC-Phase-I-at-Shendra-to-be-ready-for-occupancy-in-2016/articleshow/48596627.cms
6. Water Supply Engineering: Environmental Engineering - Vol. I by Santosh Kumar Garg