Integration of Geographic Information System (GIS) Web-based and the intelligent pressure control system in water distribution network in the city of Hamadan in order to optimal management of the distribution network pressure

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Abstract

In order to consumption management and reduction of non-revenue water in Hamadan, pressure controllers system of water distribution network and geographic information systems (GIS) in Hamadan province ABFA widely have been used and significant results have been achieved. On the other hand, how to calculate the output pressure of the pressure reducers to achieve the ideal pressure in the covered zone while distribution network pressure become minimum and minimum required customers pressure is provided are constant challenges in output pressure controller of pressure reducers. In Water and wastewater Hamadan province company by integration of web-based GIS and pressure controllers system as well as GIS analysis, efficient, fast and practical approach to estimate suitable pressure of pressure reducers was successfully operated that in this essay, practical way and results are presented.

Introduction

Population growth, increasing per capita water consumption and decreasing annual precipitation have made water crisis of HAMEDAN very remarkable. In Water and wastewater Hamadan province company by integration of web-based GIS and pressure controllers system as well as GIS analysis, efficient, fast and practical approach to estimate suitable pressure of pressure reducers was successfully operated that in this essay, practical way and results are presented. In Water and wastewater Hamadan province company by integration of web-based GIS and pressure controllers system as well as GIS analysis, efficient, fast and practical approach to estimate suitable pressure of pressure reducers was successfully operated that in this essay, practical way and results are presented.

General research

An overview of water resources and demands in HAMEDAN

This city can produce 1.4 cubic meters per second water averagely

Intelligent pressure management system and its advantages

Intelligent pressure management system includes controlling operation and pressure adjusting to achieve optimum pressure of water distribution network. Adjusting pressure of distribution network has a lot of advantages such as:

1. minimizing water losses
2. minimizing the Minimum Night Flow
3. minimizing accidents and pipe collapses
4. minimizing water consumption
5. extending useful life of the distribution network and other facilities
6. increase the volume of overnight storage reservoirs

Reducing the pressure must be such that the system reliability remains in an acceptable range, this means that reducing required pressure rate will be done in consumption nodes that consumption demand at all times will be fulfilled. Ideal situation occurs when the pressure amount on all nodes be in a way that precisely fulfil the demand rate in consumption node. In general, the optimal settings calculations of valves relatively is a complex task that requires the consideration of many factors such as topography of area, material and subordinate network diameters and communication of distribution network with each other, estimating consumption amount based on the number of subscribers within the desired areas.

pressure management methods

First, pressure swing causes must be recognized. one of the common causes of the pressure swing is the existence of several ups and downs through the distribution network. These networks are designed to deliver water with acceptable pressure to users which are located at the highest level, so the users with the lower level will receive water with higher pressure. Another reason of pressure swing is the time difference between uses. Distribution networks are design for the worstcase scenario which in all users are available at the pick hours. So at the non-peak hours network pressure is higher than required pressure. So pressure management methods should be able to regulate pressure in the optimum rage. These methods are as follow:[2]

1. Maneuver valves
2. the use of reservoir with different heights
3. The use of variable speed pumps
4. The use of parallel tubes
5. The use of intelligent pressure valves

HAMEDAN Authorities have decided to use number 1 and 5. By installing intelligentcontrolsystempressure,we are able to perfume pressure management over ourdistribution networks.

Pressure control devices

In order to regulate distribution network pressure, pressure valves are generally used. These valves mechanical mechanism is based on the pressure difference between outlet and inlet of the valve. A pilot is installed on these valves to regulate outlet pressure. After pilot regulated the outlet pressure it would try tomaintain it on the regulated pressure. Will required network pressure is not constant. For example , in the evening hours when consumption is low subscribers can reduce network pressure.Pressure control devices are able to provide appropriate pressure for users at all hours of the day by regulating valves outlet pressure automatically.

Some of the pressure control devices advantages are:

1) Adjustable outlet to the desired time of day
2) Ability to communicate with GIS system online
3) allows you to send commands from the control valve to the outlet pressure

Intelligent Control System of Water Pressure, Water and Waste water Company in Hamadan

During 2012-2013 Hamadan was faced with a 44% percent of precipitation reduction, which caused available level of water underground resources has been lost. Due to the population growth process and rising per capita consumption on the one hand and on the other hand to become adverse atmospheric conditions in Hamadan (decrease of precipitation) problem of water shortage was quietly understandable. Another troubling issue is the high percentage of water loss in this city. water real losses in Hamadan is about 17percent. Generally due to the lack of attention to the fundamentals of hydraulic water flow in pipes (pressure control) and erosion of water distribution networks, we are witnessing increasing incidents and bursting pipes as well as big and small leaks in water distribution networks that finally, a high percentage of the provided water volume which generated with a high cost will be wasted. So, the most basic and most urgent effective action is improving the quality monitor use through using modern intelligence control systems. One of the presented solutions to tackle the water crisis and the reduction of non-revenue water in Hamadan is pressure management. Pressure management in water supply networks is one of the practical ways of water demand management and reducing the amount of water without income. [2]

For this reason, 59 number of pressure reducing valves valve has been installed on the water distribution network of Hamadan that of which by the end of the year 93, 32 systems are equipped to intelligence pressure controller. All information of pressure reducing valves and controllers have been recorded in the GIS system.

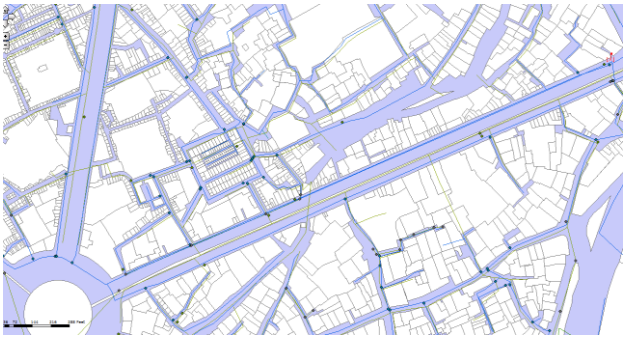
Geographic Information System (GIS) of Water and Waste water Company in Hamadan

According to the third volume of matched instructions mapping, geographic information systems (GIS), is an organized collection of hardware, software, data, procedures and human resources for collecting, preparing, structuring, storing, updating, processing, display and analysis (analysis) of data space. The aim in these systems is reference space information management to make optimal decisions. Specifically in the water and waste water companies this system is used to manage the descriptive and local information of the subscribers, device procurement, transmission and distribution of water as well as the collection facilities, transport and treatment of wastewater. The features of this system are as follows:

1) The ability to implement in the context of an intranet or the internet
2) The ability of connectivity to other systems such as subscribers system , events, intelligence pressure breakers controllers
3) The possibility to set access level for different users
4) Use of existed processing and analysis in the GIS system in order to obtain the required spatial and descriptive information

For this reason, the use of Geographical Information Systems (GIS) as one of the most sophisticated science and technologies of obtaining and optimal management of reference place information, is necessary for modeling and management water distribution networks and any substantial investment in the preparation and implementation of such systems is quite justified and necessary.

According to Figure (1) Geographic Information System of Hamadan which is defined in the context of the company's internal computer network contains information about the subscribers, water and sewer lines, and distribution network reinforcing steels, tanks and etc.



Fig(1)A view of a Geographic Information system of hamadan

2.7. The Combination Manner of GIS System and the Intelligent Pressure Control System in Distribution Network

The optimal output pressure of pressure breakers is function of zone topography, pipe diameter and connectivity manner of subordinate network and consumption rate at different nodes of the network. The exact calculation of pressure distribution network in different nodes of the distribution network is practically impossible due to worn out of network and hidden leakage and lack of complete understanding of network. Only two factors of the topography and the number of covered subscribers in detail in each area are measurable. Therefore, in this study for the convenience and avoid the complex calculations, the two mentioned factors have been used to estimate pressure in various parts of the network. So that the steps is as follows:

Determining the Covered Area of Pressure Breakers and the Number of Subscribers

Based on the GIS distribution network maps, for example in the Figure (2) pressure breaker covered area of (aa) area of Hamadan is shown based on the existing maps and local navigation.

Determining the Minimum and Maximum Height of Area and Height of the Installation place of Pressure pressure reducing valves Device

According to the existed DEM information (Digital Terrain Model) in GIS system the minimum and maximum height of area and height of the installation place of pressure breaker device is extracted. According to Figure (2) the minimum height of area is 1910 meters, the maximum height of area is 1930 meters and height of installation place of pressure breaker device is 1918 meters.

Determining Critical Points of Pressure Zone

Considering the number of each residential complex floors that is extracted from existed descriptive information on GIS and help of existed DEM in the GIS system, DSM (Digital Surface Model) of area is prepared. According to Standard (Publication No. 117-3) the maximum number of floors of each residential complex that its pressure must be provided by water network distribution, is 4 floors annexed with parking. Therefore, with this method, high residential complexes in the region (the critical points) is obtained which the standard pressure must be supplied in.

Determining the Lowest Output Pressure of Pressure Breaker Device at Night (Time Period of Lowest Consumption Amount by Subscribers)

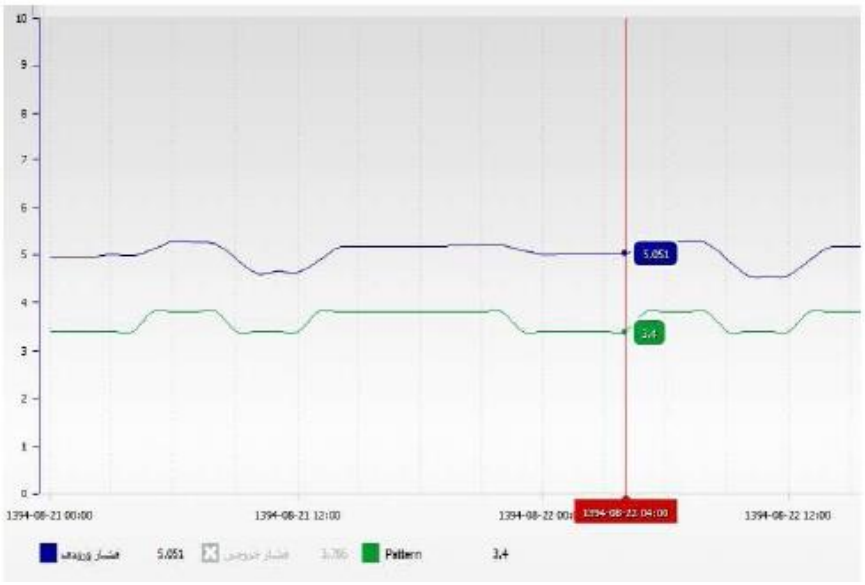
The lowest output pressure rate of pressure breakers should be adjusted in a way which based on the Standard Publication No. 117-3 the minimum pressure of 1/4 times on the ground floor and for each additional floor 0.4 times added in a way to 4 floors will be added to input pressure of apartment (the maximum permissible pressure based on the Standard is 2, 6 times for four-floored apartments). According to the referred conditions and extracting the highest point of the range that is the critical point and based on the DSM area model, minimum output pressure of pressure breakers in static state at night when consumption is minimized will be calculated and applied to the pressure breakers output.

Determining the Lowest Output Pressure of Pressure Breaker Device of Day (Time Period of Consumption Peak by Subscribers)

To determine the output pressure of the pressure breaker device in consumption peak, at first the local pressuring gauge at the critical point and in the consumption peak will be measured, and output pressure of pressure breakers will be regulated in a way that the minimum pressure at the critical point will be provided at peak consumption time.

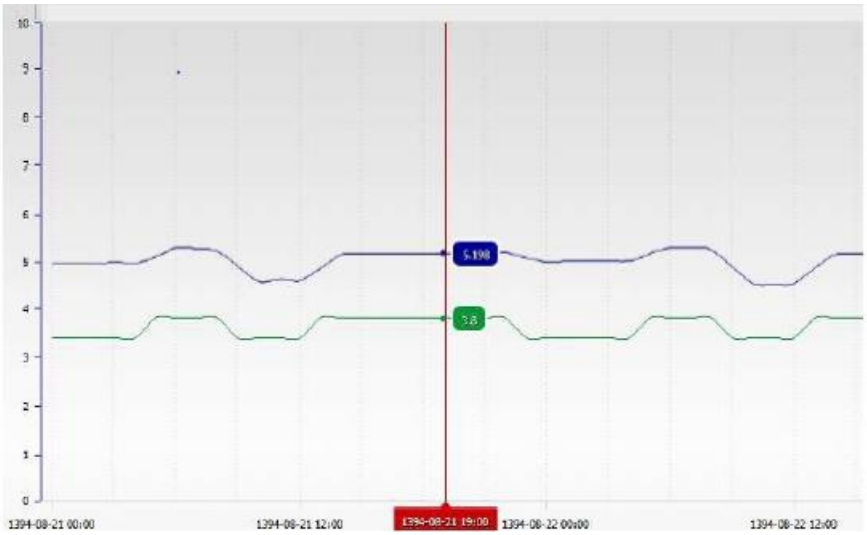
Fig(2) pressure reducing valve area coverage of (A) in Hamadan

For example, according to the DSM studied area, critical point A with the maximum height is 3 floors and should be provided according to standard of 2.2 times on the ground floor. That due to the difference in height of 12 m (equivalent to 1.2 times) pressure breakers with critical point, the minimum output pressure of pressure breakers will be adjusted 3.4 times according to figure (3).



Fig(3) minimum out put pressure of pressure reducing valve at night

At the time of consumption peak, and according to field observations if the output pressure of pressure breakers will be set 3.4 times, pressure on the ground floor of critical point was measured 1/ 8times that its reason is consumption of subscribers. Therefore, in order to provide the minimum pressure at the critical point (2.2 times) output pressure of pressure breakers according to Figure (4) will be adjusted 3.8 times.
The other advantages of integrating two systems of spatial information and intelligent management of water distribution network is the ability to estimate pressure in different parts of the network according to output pressure of pressure breakers and the height difference of pressure breakers and the considered point.



Fig(4) minimum out put pressure of pressure reducing valve at peak hours

3. Conclusion

Pressure management in water distribution network is a complex task that in which different elements such as shape and pipe diameter of distribution network, zone topography, consumption amount, etc. are involved. On the other hand, complex calculations of estimating the pressure in different parts of network did not take advantage of the above relations practically.this study have been used to the combination if geographic information systems and controls system of pressure along with the field observations to management of pressure in water distribution network.with intelligent management of pressure in the distribution network of 2011 achieved the following results:

1. minimizing water consumption
2. minimizing accidents and pipe collapses
3. extending useful life of the distribution network and other facilities
4. minimizing the Minimum Night Flow
5. minimizing the real water losses
6. increase the volume of overnight storage reservoirs

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