Evaluation the effects of some parameters on the operational efficiency of the main water pipe in Karbala city

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Abstract. This study analyzes the results obtained from field measurements to one of the main water pipe operating with the dead end system in Karbala city (located in the middle of Iraq is located 105 kilometers south of the capital Baghdad) utilizing Water CAD software. Moreover, the study is conduct to evaluate the existing mainline supply water from AL-khairat area where is the location of the pumping station to improve existing water main line efficiency. The field readings at different junctions’ locations is take and which branch out the mainline at seasons in summer, autumn, winter, and different times by using an ultrasonic device. The collected data then simulated in WaterCAD software using an extended period scenario to determine future network defects. Based on the results, The hydraulic analysis demonstrates the extra flow is required to increase pressure and velocity in junctions. The existing pumping, that is a design amount of about 1200 m3/hr is not sufficient to deliver water to the end zones of the line, since the produced quantity of the pumps in the mainline does not exceed 950 m3/hr which was less than the design capacity as shown by field readings, because damaged many parts of which, It needs to increase the design capacity of not less than 2000m3/hr and this conclusion was made based on analysis of the obtained data. In addition, it is necessary to replace the old pumps with new ones in order to provide adequate flow that achieves the pressure and water velocity required.

Keywords. Efficiency pipe, Hydraulic analysis, WaterCAD, Some parameters, Karbala city

1. Introduction

The water supply system is one of the most important hydraulic infrastructure systems, including several parts that work together to supply treated water facilities. These parts are pipes, pumps, valves, tanks, reservoirs, and required fitting. The water distribution networks formed with different shapes to deliver water, such as branched and looped systems. The modern technique is widely desirable since it is equipped with a sufficient valving system that reflects a higher level of reliability. Additionally, the maintenance of defective pipes will be easier in the looped system and reflect no severe impact on the consumers, unlike the branched system. Service cannot be provided with such a matter until completing network issues.

Systems configured with looped shapes provide more than one path to connect the facility and reflect higher capacity[1]. Networks supply water for general use directly effects human beings' modern life and play an essential role in the public communities such important facilities may facing sudden failure due to an external or internal effect resulting in the input of the network out of the service, In addition the economic and environmental issues. Hence, continuous maintenance and inspection should ensure that the system works with perfect status[2].

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The pipeline configuration component varies from a complicated to a simple one. It may working as a single component to convey water between two reservoirs or may work as an interconnected element in the distribution network. The pipeline component may include one or several types of booster pumps distributed interiorly or at the ends and may convey water from or to the reservoir. The network system may include one or more than one sub-networks separated by pressure level or differential energy line to deliver water to the neighborhood regions having different elevations. Further, some having elevated tanks to keep the pumps away from being working continuously. It is highly recommended to control the network pressure levels to keep their components safe and away from server operating conditions using various value control devices. Hence, these systems will achieve their required functions.

Surge control devices need to be installed and integrated to protect the system's physical integrity from unexpected damages and balance water pressure. Such surge control devices are tanks, relief, and air vacuum valves placed at different system locations. The hydraulic mainline may consist of one large pipe or server of various pipe types configured in various ways, called the main or the barrel. The mainline includes a node or junction that the small pipes relatively connect with and allow water flows through them.

One characteristic of the mainline is the presence of many junctions or ports, usually relatively closely spaced but not so close that the flow at adjacent ports interacts[3]. The transmission mains connect the source and the storage tanks while passing through the service area with a relatively bigger diameter the distribution pipes distribute the water to the consumers[4].

At present, there is a focus from developed countries on rehabilitating on infrastructure system, especially water networks, as they cannot meet the water requirements in light of the user's needs as they are becoming obsolete. The water demand is increasing, so it became necessary to improve their services to accommodate and rehabilitate them to achieve the desired purpose[5].

The objective of this study is to evaluate the existing mainline's hydraulic performance, which has a dead-end system that located in a region of Karbala Governorate in Iraq. Finding the best ways and appropriate solutions to operate this deficit through an analytical study of the mainline evaluation, the Bentley WaterCAD is use to simulate the hydraulic analysis of the main pipeline. The operation performance is observe under peak consumption and with extended period simulation of 24 hours. The performance was evaluated based on existing hydraulic conditions. As mentioned previously the hydraulic performance showed that the amount of water flow that is pumping into the mainline is insufficient, and the main hydraulic parameters that have study in the water mainline are the pressure and the flow rate other relevant design factors are the pipe diameters, velocities, it has also been studied The present study contributes to help the water directorate to increase the capability and to improve the hydraulic performance of the main pipe.

2. Case study

This research will highlight on the evaluation of the efficiency of one of the main water lines in the Karbala governorate, which is one of the most important religious cities in Iraq and witnessed a significant number of visitors annually. Karbala city is located 105 kilometers south of the capital Baghdad and contains of three districts namely: City Center, Al-Hur and Al-Husayniyeh, and two sub-districts which are Al-Khairat and the Al-Jdwel Algarby the city is subjected to development of an extensive urban infrastructure, as it attracts visitors especially in annual religious events, which give additional financial source of the Iraqi government and also to the people who benefit from these activities. The location of water pumping station is shown in Figure (1).

One of the main aims of the present study is to highlight water main pipe that supplies water from the Al-Sijlah and Al-Feada complexes which are located in the Al-Khairat area, where is the location of the pumping station, which located at (x=432998&y=358611), as can be seen in Fig.2. The pumping station draws water directly from the Euphrates River. It is discharge into pressed steel pipe from which feeds two pumps. The design capacity of each pump is 600 m³ / hour that meaning that the total of water pumped into the conveyance pipe is 1200 m³ / hr.
Figure 1. General location Description of the studied area

Figure 2. mainline start and endpoints connection
After the water is pumped to the main pipeline, which has a diameter of 800 mm of ductile iron pipe the main pipe is passing through the villages and countryside that existed on the side of the road, and reaching the AL- Najaf road, where it runs along AL- Husseiniyat which is located on the road to the holy city of Karbala. The water compacts pump is located in Al-Khairat, specifically in the AL- Silja area. This conveyance line was established in 2017 and is considered one of the governorate main conveyance lines because it contains a branch to supply water to Karbala International Airport site. It is one of the important infrastructure projects contributing to the Visitors' movement after completing of its. The Karbala water directorate wants to increase the main line's design capacity to supply all areas that takes water from it.

3. Existing water conveyance system

The pipes components are working as links of conveying water from one location to another in the network. Water flowing from the compact water treatment unit is 34 Km away from the pipe. Several hydraulic components are required for the water conveying system's design; they are node location, pipes diameters and lengths, roughness coefficient, and valve status. The computed outputs for pipes included head loss, velocity, and flow.

The main water pipe's working system can be classified as the dead ends system or the so-called tree branches, as this system consists of the main pipe conveying water and branching from its secondary pipes in points called nodes. One of the disadvantages of this water system is that the flow is in one direction, and this causes losses in the water feeding. The dead ends points as well as to assurance of the phenomenon of sedimentation and this causes interaction with the pipe material and changes the taste and smell of the produced water as well if there is a cut in any part of the pipe, all of the serviced area supplied will be outside. In addition to the fact that this water system(dead end) is considered insufficient towards urban expansion, as it leads to a decrease in expenses in other additional lines. On the other hand, it is considered easy and simple because it does not require complex design processes. The diameters used in the branch pipes are somewhat economical, and there is flexibility in setting them according to the population and nature of the area.

Nodes are the sites where pipes connected. Two types of nodes exist in a pipe network system, (1) static nodes and (2) junction nodes. Static nodes are nodes whose Hydraulic Grade Line (HGL) are defined. For example, tanks and storage tanks are considered static nodes because their HGL at the beginning is defined. Junction nodes are nodes whose HGL are not yet determined and calculated when the pipe network analysis. The junction node may be connected to more than one pipe. The elevation of a node can sometimes be obtained from system maps or drawings[6]. There are eight positions for the branching points of the water pipeline, seven of which are 225 mm in diameter to a PVC plastic pipe, and the last tie has a diameter of 160 mm. These pipes are as follows:

- The first link at a distance of 2000 meters from the pump station
- The second link is 7952 meters from the pump station
- The third link is 9402 meters from the pump station
- The fourth link is 12002 meters from the pump station
- The fifth link is 19252 meters from the pump station
- The sixth link is 21452 meters from the pump station
- The seventh link is 27352 meters from the pump station
- The eighth link is 29652 meters from the pump station

Because of those above that the zones at the end of the line do not fully filled with water, a field study is conduct on the operation process, and an ultrasonic device measure the number of discharges coming out of the measuring ultrasonic device at the node sites and at different times during the summer, autumn and winter seasons. At different times of the day, the analysis process is carried out by using Watercad program, and it was noticed that the areas near the pumping station
have high consumption due to their low level below the station level, in addition to being absence of meters or valve to control daily consumption for water.

4. Methodology

Flow measurements (Ultrasonic device) are used at specific points of the network called junctions to monitor the network performance and build up the model and water consumption calculations. There are many types of flow meters where the ultrasonic device was used, as mentioned previously, and at different times to achieve more accurate information about the amount of water consumption. There is a great need to collect and prepare data to complete the analysis of the water network or the main pipeline. These data are: the length and diameter of the pipeline, the roughness of the pipeline wall, and the elevation of the water with drawl point. The target parameter is to estimate the discharge quantity of the pipeline. Since the discharge of the pipeline is unknown, the problem is classified as an analysis case, and the design problem of the network system requires the needs of nodes distributed in the network. The hydraulic gradient line (HGL) is one or more locations between two point. The discharge will be the target solution for pipeline, elevation, and node pressure[3].

5. Watercad Program

Bentley company had released several software and packages dealing with water distribution problems, one of them is the Watercad package. The software requires several data to be input. To build a model and perform analysis, the following must be done:

- The base demands and elevation of each junction (node).
- The pipe length, diameter, and roughness coefficient. By default, The software takes pipe properties as ductile Iron pipe type with a Hazen-William roughness coefficient of about 130.
- The pump operation curve and elevations, which are very important to define.
- The reservoir's elevations.

After defining all required data and run the analysis, various parameters can be obtained, such as flow value at any point of the system, pipe velocity, and pressure. Moreover, evaluating the hydraulics parameters for different demands at a single node with varying time patterns[7].

6. Results for using WaterCAD to the existing mainline

6.1 The Analysis of Main pipe line During Augest of 2020

| Nodes       | Elevation(m) | Pressure(bars) | Pressure(bars) | Demand (m3/hr) in ductile pipe | Demand (m3/hr) in pvc pipe |
|-------------|--------------|----------------|----------------|--------------------------------|--------------------------|
| Junction(1) | 25           | -13            | -16            | 942                           | 212                      |
| Junction(2) | 28.5         | -16            | -17            | 730                           | 178                      |
| Junction(3) | 27.5         | -17            | -17            | 552                           | 122                      |
| Junction(4) | 24.27        | -17            | -18            | 430                           | 153                      |
| Junction(5) | 25.67        | -18            | -18            | 277                           | 127                      |
| Junction(6) | 26.94        | -18            | -18            | 150                           | 83                       |
| Junction(7) | 24.37        | -18            | -18            | 67                            | 36                       |
| Junction(8) | 25           | -13            | -15            | 31                            | 31                       |
Table 2. Extended period state at the morning for piping

| Link ID | length(m) | Diameter (mm) Ductile pipe | Diameter (mm) Pvc pipe | Flow (m3/hr) Ductile | Flow (m3/hr) Pvc | Velocity (m/s) Ductile pipe | Velocity (m/s) Pvc pipe |
|---------|-----------|-----------------------------|------------------------|----------------------|----------------|-----------------------------|------------------------|
| pipe(1-2) | 2000 | 800 | 225 | 4121 | 212 | 2.28 | 1.48 |
| pipe(2-3) | 7952 | 800 | 225 | 2967 | 178 | 1.64 | 1.24 |
| pipe(3-4) | 9402 | 800 | 225 | 2059 | 122 | 1.14 | 0.85 |
| pipe(4-5) | 12002 | 800 | 225 | 1385 | 153 | 0.77 | 1.07 |
| pipe(5-6) | 19252 | 800 | 225 | 802 | 127 | 0.44 | 0.89 |
| pipe(6-7) | 21452 | 800 | 225 | 398 | 83 | 0.22 | 0.58 |
| pipe(7-8) | 27352 | 800 | 225 | 165 | 36 | 0.09 | 0.25 |
| pipe(8-9) | 29652 | 800 | 160 | 62 | 31 | 0.03 | 0.43 |

Figure 3. The results of model verification during August at morning

Table 2. Extended period state afternoon for junctions

| Nodes | Elev.(m) | Pressure(bars) in ductile pipe | Pressure(bars) in pvc pipe | Demand (m3/hr) in ductile pipe | Demand (m3/hr) in pvc pipe |
|-------|----------|--------------------------------|-----------------------------|--------------------------------|-----------------------------|
| Junction(1) | 25 | -17 | -17 | 931 | 197 |
| Junction(2) | 28.5 | -18 | -18 | 752 | 179 |
| Junction(3) | 27.5 | -19 | -19 | 555 | 108 |
| Junction(4) | 24.27 | -19 | -19 | 447 | 147 |
| Junction(5) | 25.67 | -20 | -20 | 300 | 122 |
| Junction(6) | 26.94 | -20 | -20 | 178 | 79 |
| Junction(7) | 24.37 | -20 | -20 | 99 | 58 |
| Junction(8) | 25 | -14 | -17 | 41 | 41 |
Table 4. Extended period state afternoon for piping

| Link ID | length(m) | Diameter (mm) Ductile pipe | Diameter (mm) PVC pipe | Flow (m³/hr.) Ductile pipe | Flow (m³/hr.) PVC pipe | Velocity (m/s) Ductile pipe | Velocity (m/s) PVC pipe |
|---------|-----------|---------------------------|------------------------|---------------------------|------------------------|---------------------------|------------------------|
| pipe(1-2) | 2000     | 800                       | 225                    | 4234                     | 197                    | 2.34                      | 1.38                   |
| pipe(2-3) | 7952     | 800                       | 225                    | 3106                     | 179                    | 1.72                      | 1.25                   |
| pipe(3-4) | 9402     | 800                       | 225                    | 2175                     | 108                    | 1.2                       | 0.75                   |
| pipe(4-5) | 12002    | 800                       | 225                    | 1512                     | 147                    | 0.84                      | 1.03                   |
| pipe(5-6) | 19252    | 800                       | 225                    | 918                      | 122                    | 0.51                      | 0.85                   |
| pipe(6-7) | 21452    | 800                       | 225                    | 496                      | 79                     | 0.27                      | 0.55                   |
| pipe(7-8) | 27352    | 800                       | 225                    | 239                      | 58                     | 0.13                      | 0.41                   |
| pipe(8-9) | 29652    | 800                       | 160                    | 82                       | 41                     | 0.05                      | 0.57                   |

Figure 4. The results of model verification during August at afternoon

Table 5. Extended period state at the evening for junctions

| Nodes   | Elevation(m) | Pressure(bars) in ductile pipe | Pressure(bars) in PVC pipe | Demand (m³/hr) in ductile pipe | Demand (m³/hr) in PVC pipe |
|---------|--------------|--------------------------------|-----------------------------|--------------------------------|-----------------------------|
| Junction(1) | 25           | -17                             | -17                         | 940                            | 202                         |
| Junction(2) | 28.5         | -18                             | -18                         | 738                            | 178                         |
| Junction(3) | 27.5         | -18                             | -18                         | 560                            | 113                         |
| Junction(4) | 24.27        | -19                             | -19                         | 447                            | 152                         |
| Junction(5) | 25.67        | -19                             | -19                         | 295                            | 127                         |
| Junction(6) | 26.94        | -19                             | -19                         | 168                            | 79                          |
| Junction(7) | 24.37        | -19                             | -19                         | 89                             | 53                          |
| Junction(8) | 25           | -14                             | -17                         | 36                             | 36                          |
Table 6. Extended period state for piping evening

| Link ID | length(m) | Diameter (mm) Ductile pipe | Diameter (mm) Pvc pipe | Flow (m³/hr) Ductile pipe | Flow (m³/hr) Pvc pipe | Velocity (m/s) Ductile pipe | Velocity (m/s) Pvc pipe |
|---------|-----------|-----------------------------|------------------------|---------------------------|----------------------|-----------------------------|------------------------|
| pipe(1-2) | 2000 | 800 | 225 | 4213 | 202 | 2.33 | 1.41 |
| pipe(2-3) | 7952 | 800 | 225 | 3071 | 178 | 1.7 | 1.24 |
| pipe(3-4) | 9402 | 800 | 225 | 2155 | 113 | 1.19 | 0.79 |
| pipe(4-5) | 12002 | 800 | 225 | 1482 | 152 | 0.82 | 1.06 |
| pipe(5-6) | 19252 | 800 | 225 | 883 | 127 | 0.49 | 0.89 |
| pipe(6-7) | 21452 | 800 | 225 | 461 | 79 | 0.25 | 0.55 |
| pipe(7-8) | 27352 | 800 | 225 | 214 | 53 | 0.12 | 0.37 |
| pipe(8-9) | 29652 | 800 | 160 | 72 | 36 | 0.04 | 0.5 |

Figure 5. The results of model verification during Augest at evening.

6.2 Evaluation of Hydraulic parameters Model Performance of Existing Main Pipe using WaterCAD program

To ensure that the water supply system has good technical performance, it is necessary to evaluate the system behaviour globally, including different scenarios that restrict the use of operating conditions for each component[8]. In addition to the research location of this, The importance of the present study comes from that includes on-site inspection method, which is performed by ultrasonic equipment at three seasons of the year and at different times of the day to obtain an extended simulation time, representing a hydraulic model, and know The actual consumption of residents is shown in the above table (1,2,3,4,5,and 6) and figure (1,2,and3).

1. The water flowed from the pumping station and pumped into the extend able trunk line of 800 mm diameter and did not reach the station's design capacity of 1200 m³/hr. As shown by the on-site reading. The ultrasonic equipment way used because the pump is not new, and some parts are damaged. In addition, there are high and low water levels in the stamped steel tank drawn from the pump, which is not as good as the analysis results under any circumstances. As shown, for consumption, at least 4000 cubic meters/hour of water needs to be pumped after any analysis by results shown.
2. The area close to the pumping station has a lower low elevation than the pumping station's elevation, which leads to take and consume more water. In contrast, the area which far from the pumping station and is located at the end of the mainline reaches the level of drinking water.

3. To manage or to adjust the total demand and provide an equal distribution of available water, intermittent water supplies with reduced system pressures are often introduced[2]. Keeping the pressure as low as possible within the system while only meeting the service standards required by the customer (adequate supply and sufficient pressure) will generally reduce pumping costs and reduce leakage. Additional savings can be achieved by lowering leakage to postpone the capital expenditure required for actual demand increases. However, the risk of crossing the pressure boundary increases (for example, pipeline rupture or abnormal demand). For real-time control of WDS, the goal is to optimize the entire operation process, including improving performance and reducing operating costs. As demand continues to fluctuate over time, it is often necessary to adjust control equipment[9]. The value of pressure in water distribution systems is of great importance in improving the level of service. And since there are factors that affect it, including different operating conditions, mechanical equipment, pumps, and the increase in demand for some areas. This makes the modeling of an unstable flow water distribution system important in hydraulic analysis. Of course, well-pressurized pipes are more reliable and safe at operating floating conditions change[8].

4. Measuring the nodal pressures within a system can be directly affected utilizing pressure gauges installed at selected nodes, or it can be indirectly achieved with mathematical modelling or hydraulic simulations. The first is simple but expensive, while the latter is complicated and cheaper but needs more sophistication[9]. The pressures in all the junction regions are negative or almost non-negligible. The pressure inside the station did not exceed one bar in all the seasons, as mentioned previously. After all, the pumps used are old and do not forget that the station level is higher than all the withdrawal junctions.

5. When the pump starts work or stops suddenly, or one of the valves is opened or closed, the velocity of water in the pipe will change. Furthermore, when flow accelerates or decelerates in a pipe, all of the water in that pipe does not change velocity directly. It takes time for the water at one end of a pipe to rush to the other side, the effect of a force applied some distance away from the pipe[10].

However, the method will not work if the source makes up a small part of the water balance or when the data have high uncertainty[7]. The program calibrated the field readings of the flow from the junction sites on the mainline with the flow resulting from the simulation process. The value of the regression coefficient was very good. The relationship was linear, which means that the hydraulic model's representation was near the required reality, as shown in Tables (1,2) & Figures (1,2) below.

6.3 The new scenario for Hydraulic prameter Modeling after increasing capacity and modify of some nodes diameters for One Case (Augest)

| Nodes     | Elevation(m) | Pressure(bars) in ductile pipe | Pressure(bars) in pvc pipe | Demand (m³/hr) in ductile pipe | Demand (m³/hr) in pvc pipe |
|-----------|--------------|--------------------------------|-----------------------------|--------------------------------|-----------------------------|
| Junction(1) | 25           | 3                              | 3                           | 942                            | 212                         |
| Junction(2) | 28.5         | 1                              | 1                           | 730                            | 178                         |
| Junction(3) | 27.5         | 1                              | 1                           | 552                            | 122                         |
| Junction(4) | 24.27        | 1                              | 1                           | 430                            | 153                         |
Table 8. Extended period state for piping

| Link ID | length(m) | Diameter | Diameter | Flow | Flow | Velocity | Velocity |
|---------|-----------|----------|----------|------|------|----------|----------|
|         |           | Ductile pipe | PVC pipe | Ductile pipe | PVC pipe | Ductile pipe | PVC pipe |
| pipe(1-2) | 2000 | 800 | 225 | 4121 | 212 | 2.28 | 1.48 |
| pipe(2-3) | 7952 | 800 | 225 | 2967 | 178 | 1.64 | 1.24 |
| pipe(3-4) | 9402 | 800 | 160 | 2059 | 122 | 1.14 | 1.69 |
| pipe(4-5) | 12002 | 800 | 225 | 1385 | 153 | 0.77 | 1.07 |
| pipe(5-6) | 19252 | 800 | 160 | 802 | 127 | 0.44 | 1.75 |
| pipe(6-7) | 21452 | 800 | 160 | 398 | 83 | 0.22 | 1.15 |
| pipe(7-8) | 27352 | 800 | 110 | 165 | 36 | 0.09 | 1.05 |
| pipe(8-9) | 29652 | 800 | 110 | 62 | 31 | 0.03 | 0.91 |

Figure 6. The results of model verification during August after increasing discharge
Figure 7. The results of model verification during August after increasing discharge

6.4 Evaluate parameter of Scenario Choice by software After Increasing Discharge

The result might have a chance . In every intersection or node from the system; also, these can be used to figure the stream rates discharge in every pipe of the system[11].

6.4.1 Pressure

Hydraulic simulation is a straightforward and flexible approach for evaluating pressures and flows under a wide range of demand patterns; however, it entails simplifications that may significantly influence results. When deficit pressures arise, the system can be upgraded by increasing pipe sizes, substituting material, relining conduits to reduce roughness, and altering other physical characteristics until the required nodal pressures are met. However, during pump failure, pipe break, or an exaggerated demand episode such as firefighting, the system may experience deficit pressure in several nodes. However, since these are temporary, system modification may not be an obvious response.

System behavior during such episodes should be considered part of the reliability analysis. It is better to consider both nodal pressure heads and outflows simultaneously for hydraulic performance assessment.[9]. The nodal discharges are dependent on the nodal pressure. It is, therefore, necessary to consider nodal demands and nodal heads simultaneously to obtain the flow at a node[12]. In this analysis model, pressures were treated acceptably at the junction sites, and negative values were eliminated as previously presented. They are somewhat acceptable and can reach users either by domestic pumps or by gravity if there are no high altitudes, also abooster station can be used after the fifth junction with a capacity 400 m3/hr in case you want to increase the pressure more than that.

6.4.2 Flow rate in the pipe

Continuous supply with continuous delivery (CSCD) considers as a typical regime in the developed countries. Such a method assumes water is supplied directly and delivered continuously to consumers tanks to water availability at the source and adequate facilities for transport and distribution[13]. So that through the hydraulic analysis of the model and the simulation, the adequacy of pumping the product was shown with the current realistic requirements, where a single case of the readings was worked out. The case was similar to the remaining readings. It needed the same amount of water and consumption as the field readings showed real consumption during different periods.

6.4.3 Velocity in junctions

Maintaining the water velocity in pipes is an important matter to avoid issues of breakage or damage to operating equipment and continuous maintenance if it is high and affects the quality of water if it is low[8]. Velocity range can also be adopted as a design criterion. Low velocities are not preferred for hygienic reasons, while too high velocities cause exceptional headloss [14].

In the simulation model that was chosen, the speed at the connection sites was within acceptable limits, with full coverage of water for all areas, for 24 hours shown in table No.2 in the new scenario.

Conclusions

From studying the properties of the existing mainline operating with the dead end system and monitoring the operating performance of the pumping station for different seasons of the year and at different times of the day to get extended period simulation, the following conclusions were reached:

First the purpose of present study is to evaluate the hydraulic performance of the existing mainline. Second the main hydraulic parameters in the water mainline are the pressure and the flow rate other relevant design factors are the pipe diameters, and velocities, its modified in the new scenario. Third the proposed plan increased comprehensive flow and pressure. Therefore, we note that the amount of water supply required when conducting the analysis and before the increase is 4121 m3 / hour, for example as in Table No. 2, 4234 m3 / hour in Table No.4, 4213 m3 / hour in Table No.6, and in order
to reach it through the analysis, 2000 m³ / hour was added in addition to the existing design capacity and the water velocity in the contract as in Table 2 when analyzing before the addition with note. Some connections' diameters were modified, according to which the velocity was modified, as shown in Table 2 in best scenario, after adding the new capacity. This was for the August and it is similar to the analysis and addition process if it was conducted for the of October and December, where field surveys were conducted for them.

Fourthly the relationship between the field data and resulting from the simulation was very strong with a regression coefficient of (0.984,0.985, and 0.985) as in figures (3,4, and 5) respectively and before adding the new capacity and it became (0.972 for the discharge) and (0.889 for the pressure) as in figures 6 and 7 after adding the new capacity.

Finally delivering the water to all zones with sufficient pressure and removing the negative pressure before using the scenario in which was also noted that the area was fully water supply for 24 hours, and the water problem in anchor points between the branch line and the mainline was been removed it.

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