Research and Application of GIS Information System of Pipeline Network of Oil Field Water

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Abstract

Pipeline network of oil field water is established on the basis of GIS geographic information and SCADA platform, and monitor the running state of water supply system in oil field mining area in real time through data acquisition, instrument measurement and control, wireless network, water quantity, water pressure and other on-line monitoring equipment. The water supply system is formed, and the information of mass water supply system is analyzed and processed in a timely manner. The system manages the entire production, management and service processes of the water supply system in a dynamic manner in order to ensure water supply safety management, and realize the modernization, intelligence and information mode operation of the water supply system in the mining area.

Keywords: GIS, SCADA, implementation monitoring, information analysis and processing, dynamic control, water supply system, intelligence, informatization

1. Introduction

Water is the source of life, water supply system is an important infrastructure of the city, in the city's economic development plays an important role. With the accelerated process of urbanization, the construction of the community and the expansion of the road reconstruction project has been gradually advancing, and the water supply system is constantly changing and innovating. Therefore, how to use modern computer network technology to build water supply pipe network management information system, to achieve the city water supply industry to achieve the "two increase, three reduction" requirements, is the key step in the process of modernization. Set up the data analysis system of water supply pipe network in oil field mining area, to realize the dynamic simulation and calculation of water supply network. Through the water supply system under different conditions of water supply and demand situation of calculation, analysis and control of network real-time operating state formulated reasonable dispatching plan and the dispatching scheme, reasonable scheduling of pump station operation, under the premise of user of water service quality guarantee and improve and maintain optimization of pipe network of water and water pressure distribution, scientific and reduce energy consumption of water supply and water cost. Research and application of Oilfield Mining Area water supply pipe network GIS information system implementation, thus accurate judgment and Decision Sciences, rapid implementation and energy saving the basic purpose and operation analysis of oil field water supply system entered the intelligent, informatization and digitization.

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2. Main research contents

(1) The establishment of pressure data acquisition and monitoring SCADA system. According to the actual situation of water supply in oil field, the pressure and flow data acquisition terminals are installed in the key nodes of the pipe network and the water supply station.

(2) Establishment of modeling and analysis system for water supply network in Oilfield Mining area. According to the actual situation of water supply in oil field, the current situation of water supply model and the model of South to North Water Transfer in oil field are set up. The model of South to north water transfer is divided into: 1 access point of water diversion project, 2 access point of the south to North Water Diversion Project, the current situation of water supply of the south to North Water Transfer and 4 sets of long-term water demand of the south to north water transfer. The calculation and analysis of flow and pressure are carried out according to different models and different schemes.

(3) Determination of inner diameter of pipeline.

(4) Determination of no water metering.
Calculating formula: 
\[ \sum_{i=1}^{96} q_{wi} = \sum_{i=1}^{96} q_{si} - \sum_{i=1}^{96} q_{pi} \] 

(5) Node water allocation. According to the oil field mining area water supply pipe network system supply, water supply network, water total 75 node 6 months of water statistics, calculate a variety of different water supply model, different model scheme of water, in accordance with the operation of the water supply pipe network analysis system established format set up supply and water content file.

(6) Data entry. The water system pipe network data, data of the valve, pipeline hydraulic friction coefficient data, node volume data, the inlet pressure and the flow of data, data of elevation point pressure, pipe network pressure and flow data in accordance with the model established format entry model, and the overall accuracy check, the establishment of the operation of the water supply pipe network analysis model.

(7) No metering water distribution. In order to make without metering water allocation more reasonable, combined with differences in the user actual water, water properties of user nodes are classified and water balance analysis is carried out on the water, in view of the nature of the different water nodes formulate corresponding without water metering mode curve, and in accordance with the ratio flow without the allocation of water metering.

(8) Pattern curve formulation. According to the nature of the different water users, users of the similarity to the actual water laws are classified, for each node, water supply and demand analysis, ultimately determine the model is divided into 8 hours of production units, 24 hours of production units, and other common user 11 kinds of patterns of water use. To collect the water consumption data of 10 days every 15 minutes for typical users of various water patterns, the average mode curve of each model is calculated, which is used as the model curve of the system.
3. Effect analysis

Oilfield mining operation of the water supply pipe network analysis system, improve the pressure SCADA system, install the pressure and flow data acquisition and remote terminal, online collection water pressure data and real-time remote data to the dispatching command center, the collected data through the SCADA system were analyzed and the performance in the form of charts. Staff can monitor the pressure of the water supply network in the dispatch command center, the flow of important nodes. Staff can according to need, time transfer pressure data, analysis, calculation results, pressure pipe network to grasp the situation, reasonable dispatch station and water source well pump start and stop, and ensuring the water pressure balance, to achieve the water supply system of online real-time simulation and optimization of scheduling.

The water pressure method is used to make the adjustment of pipe network, and the water pressure method is a method to calculate the net flow of the water head loss. The basic equations of the system are as follows.

Continuity equation: \( \sum_{j} q_{ij} + Q_i = 0 \). Where \( q_{ij} \) is pipe flow, \( Q_i \) is nodal flow.

Calculation formula of head loss: \( h_{ij} = s_{ij} q_{ij}^n \). Where \( h_{ij} \) is head loss, \( s_{ij} \) is friction, \( q_{ij} \) is pipe flow, and \( n \) is index.

Water damage formula: \( q_{ij} = s_{ij}^{\frac{u}{n}} (H_i - H_j)^{\frac{u}{n}} \).

When the calculation of the flow of nodes in the pipe network is selected automatically, the calculation of the flow rate of the nodes in the water supply system is based on the principle of specific flow distribution. Specific flow rate is \( q_i = \frac{Q - \sum q}{\sum l} \), and flow distribution of node \( i \) is \( Q_i = \frac{\sum q_i l_i}{2} \).

These coefficients form a water pipeline mode curve, or weight coefficient curve, each type of user can be calculated their water mode curve, combined with the average flow of all types of users, are the nodal flow calculation, combined with other parameters in the network, simulation calculation of water supply network system delay.

4. Dynamic simulation model under different conditions: To build the network model requires, first of all, the topological structure of the model is established. In the operation of water supply network modeling analysis system map rendering pipeline, and model of nodes and pipe section, equipment and other property data to improve, under various conditions of pipe network model of topological relations are determined.

Production application effect

(1) Application prospect of operation analysis system of water supply pipe network

Water supply system operation scheme also changes in the non-stop, water supply pipe network
model only with the change, may simulate the real water supply system water flow. Therefore, analysis of the operation of water supply pipe network system maintenance work is very important. The maintenance of water supply network operation analysis system mainly includes the following aspects:

1. Update the structure of the network model and the corresponding data: water supply facilities (pipelines, valves, pumps, reservoirs, etc.), add, delete, add the corresponding attribute data and spatial data, etc.

2. Update the nodal flow: users increase or decrease in the number and position of dynamic adjustment; the second is the nature of the water users to dynamically adjust the, content a significant change in the corresponding adjustment to the remote meter installation point; the third is water of different types of users to dynamic test, the establishment of perfect periodic patterns of water use database.

3. Update the operating plan: modify the state of the valve switch, modify the pump switch status, etc.

5. Economic benefit analysis

Water leakage of water supply pipe network, and the high and low pressure of the pipe network has a direct relationship. Now the international model of the relationship between pressure and Water Leakage general: relationship between water loss and Q pressure P N times square. Through the water pump start and stop scheduling, to achieve the regulation of pipe network pressure, on the one hand, saving water energy consumption, on the other hand, reducing the leakage of water supply network leakage. Specific analysis is as follows:

(1) Through the adjustment of the pressure, the motor power of the centrifugal pump is reduced, the energy consumption of the water supply is reduced, and the water supply cost is saved. According to the relationship between power, speed and pressure, it can be known:

\[
\frac{W}{W_i} = \left( \frac{n}{n_i} \right)^3
\]

\[
\frac{P}{P_i} = \left( \frac{n}{n_i} \right)^2
\]

\[
\frac{W}{W_i}^2 = \left( \frac{P}{P_i} \right)^3, \text{ thus, } W = \sqrt[3]{\frac{P}{P_i}^3} \times W_i^2.
\]

(2) Through flow adjustment, reasonable starting and stopping water wells, reduce water consumption. The water supply system of oil field mining area is in the water source well. Adjust the flow through the night, shutting down the reasonable water wells, reduce water consumption, water saving electricity.

(3) To reduce the pipeline pressure reducing water leakage. According to the relationship between
pressure and flow: $Q = (P)^n$, we can know that pressure adjusted leakage loss is $Q_i = \left(\frac{P_i^n}{P^n}\right) \times Q$, and

$$Q_i = \left(\frac{P_i^n}{P^n}\right) \times Q = \left(\frac{10^{1.1}}{17.5^{1.1}}\right) \times Q \text{ m}^3.$$  

6. Conclusion

In this paper, we introduce the research and applications of GIS information system of pipeline network of oil field water, and this information system is based on GIS geographic information and SCADA platform. Due to water is the source of life, so that water supply system is an important infrastructure of the city which plays an important role in the city's economic development. In order to help urban water supply industry to achieve the planning requirements, we use modern computer network technology to build water supply network management information system.

References


