A Study on the Monitoring System of the Recharge Water Treatment of Surface Water

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ABSTRACT: For the more rational exploitation and utilization of geothermal water resources, the underground heat reservoir must be recharged. Concerning the relatively small amount of the recharged geothermal tail-water, the proposal to make use of the surface water for recharging is advanced in this paper. Through this method, we can develop a ground water treatment procedure that can attend to the need of this recharge and establish a mathematical model in between the optimal dosage, the mud amount and the influent water turbidity. By testing sensors, PLC, frequency converter, metering pump and motorized valve online, we can collect data and information. Furthermore, combining those with the long-distance data communications and the configuration monitoring technology, we can design and develop the surface-water recharging water treatment monitoring system that suits the project. The monitoring system could cut the water treatment costs and improve the management and efficiency at the premise of guaranteeing the amount of processed water and the quality of effluent water.
KEYWORD: Recharging of ground water; Nano-filter technology; Automatic monitoring; Water treatment

1 INSTRUCTIONS

A geothermal resource, a clean and green energy source, plays an important part in resolving the current energy crisis. The artificial recharge is widely acknowledged by the academia as among the important measures to improve the utilization ratio of geothermal resources, prevent ground subsiding, reduce effluent water discharging and realize the sustainable utilization of geothermal resources[1]. To use the ground effluent water as recharging water has several disadvantages, such as small recharging amount, low recharging efficiency and that the year-by-year decrease of the underground heat reservoir pressure cannot be dramatically turned upwards[2]. Targeting at the problem, the authors of this paper cooperate with the institute in Tianjin to conduct a research on the relevant technologies involved in using ground water for recharging. The research purpose of the paper is to guarantee the quality of the treated water by formulating the ground-water treatment techniques and designing a certain monitoring system so as to meet the requirements for water quality. In 2005, Prof. Li Ni argued that the improving of the utilization ratio of ground water is a systematic project, the execution of which calls for plan perfecting and strict design review[3]. The design proposal in this paper is come up with after theoretical analyses and experimental demonstration, and thus it lives up to the design requirements. In 2000, Xiao Xianming and several others conducted a comparative analysis on the four water-treatment configuration technologies, and concluded taht the Nano-filter configuration technology performed better than others[4]. The water-treatment technique in this paper is centered at the Nano-filter technology. In 2005, Luo Dongpu revealed his set of online long-distance monitoring system based on INTERNET and WEB technologies. The set was applied to the quality-classification water-supply demonstration project in the Golf Garden Southern Part, Baiyun District, Guangzhou, and reaped outstanding application results[5]. In 2011, Guo Xiaoan integrated the monitoring system based on the industrial Ethernet into the project entity to make the system relatively more adaptable to the environment, real-time, secure and reliable[6]. His research is of great help for the research on the monitoring system in this project.

2 WATER TREATMENT TECHNOLOGY OF GROUND WATER

In order to meet the requirements for water quality, the Nano-filter technology is adopted to desalinate

the original water[7]. Since the recharge water has a relatively high requirement for the dissolved oxygen in water, the procedure of removing the dissolved oxygen in water is added to the treatment technology. When the influent water pass the spongy iron oxygen-extractor, the oxygen in water, combined with the spongy iron, will result in the chemical reaction as follows[8]:

$$2Fe+2H_2O+O_2 \text{---} 2Fe(OH)_2$$

$$2Fe(OH)_2+H_2O+2O_2 \text{---} 2Fe(OH)_3$$

In the hoisting and transporting of ground water, the antiseptic is added to the water to eradicate the microorganisms and bacteria in it. After that, the water will be transported to the coagulation tank. The coagulant should be added to separate part of the impurities in water. Then the water will be delivered to the sloping tube settling tank to carry out the slurry separation. After being filtered through the sand filtration tank, the water will enter the oxygen-extractor tank to dissolve the better part of dissolved oxygen. Moreover, the water will get in the polishing filter to remove further the impurities in water. After pressurized, the water will enter the Nano-filter system. Following this treatment and before the recharge, the water should be added with a small amount of alkali water and deoxidant to make the recharge water reach the requirements specified. The technological process of the ground water treatment is as shown in the Figure 1.

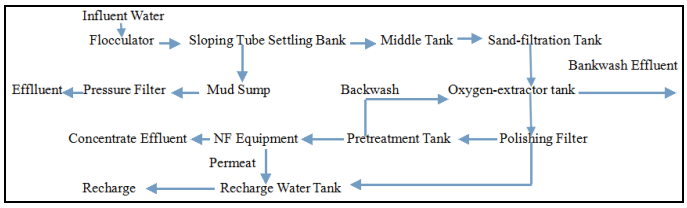


Figure 1.Technological Process of the Ground-water Treatment

The project chooses the water from the Dongli Lake as the original ground water to be processed. Under the influence of the pollution in the upper reach of the inlet waterway of the lake, the surrounding man-made pollution, and the water eutrophication, the original ground water sees a significant change in its quality. Others experiencing significant changes include the dosage of the coagulant needed in the purifying treatment and the amount of mud produced in the sedimentation unit. Therefore, the reliable coagulant addition and mud discharging control technology are needed to ensure the quality of the processed water satisfy the requirements for recharge water quality. The standards for the recharge water quality are shown in the following Table 1.

Table 1.Quality Standards for Recharge Water

Items	Control Requirements	Notes
Suspended Solid Content	＜5.0mg/l	
Median Value of the Suspended Particles' Diameter	＜3.5μm	
Average Corrosion Rate	＜0.076mm/a	Or non-corrosive water LI (Racine Index)＜0.5
Calcium Sulfate Scale Formation Judgment	RS1＜0	
Silicate Scale Formation Judgment	RS2＜ 1.0	
Ferro bacteria(FB)	＜n×104 /ml	
Sulfate Reducing Bacteria (SRB)	＜10 /ml	
Dissolved Oxygen in Water	＜0.01mg/l	
PH	7±0.5	In the recharge of the porous heat reservoir, the PH value could be slightly higher than 8.0
Total Iron Content in Water	＜0.3mg/l	
PO43-	＜0.05 mg/l	The Carbonate rock heat reservoir of the karst-fracture type in the bedrock can give rise to the slightly soluble phosphates that could block the fracture.

3 AUTOMATIC DOSING AND AUTOMATIC SOIL DISCHARGING SYSTEM

The ground recharge water treatment and monitoring system is composed of the power execution equipment and the online testing device. It adopts the idea of controlling in dispersion and administrating collectively, and adjusts the technique's operating parameters in a real-time manner. The water quality parameter could be controlled through adjusting the dosage. The amount of dose added could determine the cost for treating the original water and the quality of effluent water[9]. The mud resulting from the added dose, if not discharged promptly, could give birth to the phenomenon that the phenomenon that deposit

flocculation is once again taken away by the flowing water, which affects the water quality. If the mud removing is too frequent, the discharged mud will have low concentration and big mud volume, and the load of mud filter press system will be increased. Therefore, combined with the water treatment process, the system determines the concentration of suspended sediments and the correlation between the optimal dosage and the optimal mud volume in surface water; the mathematical model is established through the experiment; through the on-line detection of influent water turbidity in surface water, the system realize the automatic dosing and automatic mud discharging by using the PC-PLC, the frequency converter, the metering pump and the motorized valve. System structure diagram of automatic dosing and automatic mud discharging of ground recharge water treatment is shown in Figure 2.

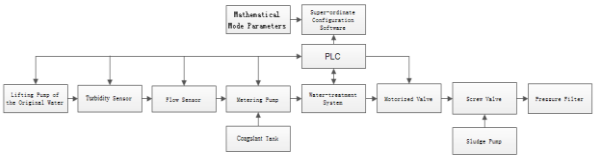


Figure 2.Structure Figure of Automatic Dosing and Automatic Mud Disposal System

The automatic dosing and automatic mud discharging systems are composed of the water-quality sampling unit, the turbidity sensor, the flow sensor, PLC, the configuration touch screen, the frequency converter, the metering pump, the liquid-level meter, the medicine pin, the stirring motor, the motorized valve, the analog display screen, the alarming instrument and the control component parts. The analog signals are collected through the sensor, and then transmitted to the sub-modules of the PLC. By utilizing the presetting of control modes and parameters, the PLC will transmit the control instructions to the electrical control units so as to execute the initiation upon instruction or stop the power equipment, thereby making the automatic control possible. Meanwhile, the information of the functioning status of the equipment will be back feed toward PLC, thus realizing the close-loop control. The control block figure of the automatic dosing and automatic mud discharging system is shown as the Figure 3.

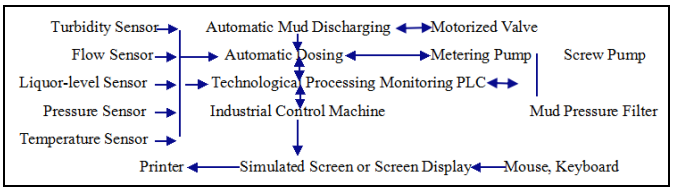


Figure 3.Control Block Figure of the Automatic Dosing and Automatic Mud Disposal System

4 MONITORING SYSTEM

The monitoring system comprises the monitor terminal, the system's central unit and its sub-units. The system's central unit is composed of the super-ordinate host, the data exchange device and the data transmission module. The sub-units include the sub-unit of transmission, promoting and monitoring and the sub-unit of ground water treatment monitoring. Of the two, the former is made up by the transmission and promoting PLC and the fiber-optical module. The latter is constituted by the industrial control machine, the technological process monitor PLC, the automatic dosing PLC, the automatic mud disposal PLC and the fiber-optical module. The monitoring system's structure block figure is as shown in the Figure 4.

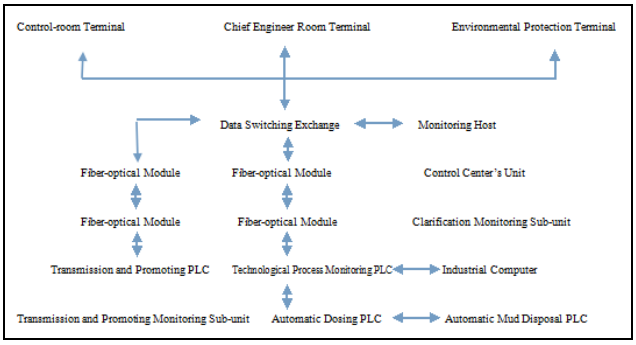


Figure 4.Monitoring System's Structure Block Figure

The function of monitor system includes:

Timely collect the surface water used for the reinjection of geo thermal to deal with process parameters like water turbidity, flow, level, pressure, pH, temperature, etc.

Achieve the purpose of letting geothermally recharged surface water deal with automatic dosing, automatic sludge, the detection and controlling of running condition of power operating equipment, and various fault alarming.

Make the panorama map of the treatment process of the geothermally recharged surface water and partial panorama, all equipment operating status, process parameter variations and changes in water quality parameters display in the upper dynamic host configuration monitoring software.

Serve to realize remote network monitoring, performance data processing, storage, and display the curves of history, record fault alarming, and the like.

According to the actual systematic condition, the upper dynamic host configuration monitoring software can be divided into seven interfaces: the main interface, partial interface, fault alarming, historical curve, report printing, parameter setting, and helping. Monitoring interface is mainly used for real-time display of each sampling point pressure, flow rate, solenoid valves running, pump, the start and stop of the pump. By monitoring interface, you

can master the working condition of the system. The monitor interface of the system is shown in Figure 5.

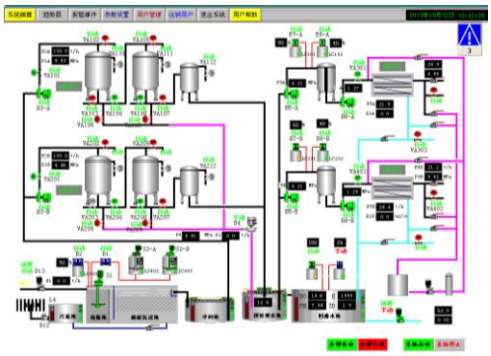
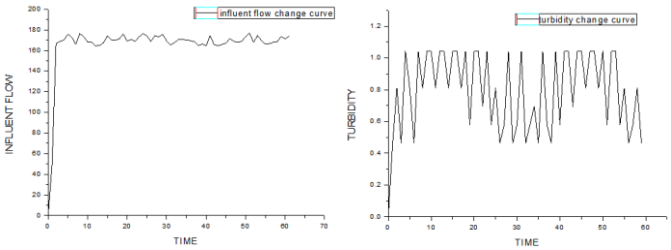


Figure 5.System Monitoring Interface

The sensors can collect the data on the project site, and display the data variation trend on the super-ordinate machine using the monitoring software. The historical data curve mainly shows the variation curve of data at different times. The user can observe the variation of turbidity flow and pressure over a certain time period on the monitoring system. Part of the data variation curve is as shown in the Figure 6.



a Turbidity Variation Curve; b Influent Flow Variation Curve

Figure 6.Curve of the Data's Historical Change

5 CONCLUSION

The suspended particle's content in the original ground water goes through a comparatively large change. On the basis of initial trial, the mathematical model between the optimal dosage, the mud amount and the influent water's turbidity is created. Through testing the sensors, PLC, frequency converter, metering pump and motorized valve online, we can realize the automatic dosing and soil discharging. The technological problem brought about by the ordinary sensor testing is thus resolved to guarantee the quality of the effluent water.

The monitoring on the technological process is realized. As a result, the technological problems, such as the low level of automation of the water-treatment monitoring system of the geothermal recharge water, dispersed control, and excessive labor strength for worker, can be effectively resolved. In a word, the level of the automatic monitoring technology of the water-treatment system could be improved.

The data is collected and processed through the monitoring host, the data exchange unit, the communications module and the industrial fiber-optical Ethernet. The monitoring platform shall be built through the configuration software in order to realize the long-distance networked monitoring, resolve the technological trick that the information between different units is relatively isolated and difficult to administrate, and improve the management level and work efficiency.

This project uses the ground water as the recharge water. And the monitoring system corresponding to it has already been put into application in a recharge well. The system is stable, and the water quality reaches the requirement for recharge, thus producing a relatively large amount of economic and social benefits.

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