Water Resources Survey and Urban recycled water reuse of Handan

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Abstract: - The profile of water resources in the city of Handan is introduced in this paper. According to the water resources crisis, overfulfill groundwater problems and so on, this paper points out a method reusing reclaimed wastewater to improve the current situation of water resources utilization. And through the feasibility analysing of reuse of reclaimed wastewater to clarify its foreground in the future development. And the development of the reclaimed wastewater reuse method is affirmed. So graded-based water supply method will take an important part in Handan water supply. This will contribute to alleviate the water resources crisis caused by deteriorating water environment and water shortage. At the same time the problem of overfulfill groundwater and water pollute will be alleviated or solved. So many fresh water can be saved to cycle in the nature that contributes to the formation of a good circulation among the economy, society and nature.

Key-words: - Water Resources; Reclaimed Wastewater; WastewaterReuse; Graded-based Water Supply

1 Introduction

Water is a natural resource, which is involved in a cyclical movement among the land, rivers, oceans and atmosphere, and is an important source of wealth for human beings. Only under the condition that observe this cyclical cycle law and by taking corresponding measures to maintain a healthy cycle can it be utilized permanently by humankind. As a branch of the water cycle, urban recycled water reuse is a junction of the natural water cycle and social water cycle, and is a bridge leading to the health of the water cycle. The practical experience of the restoration and regeneration of the water environment at home and abroad shows that all actual progress made in the effective use of reclaimed water is a contribution to the global environment and human progress. The way of promoting wastewater treatment and advocating use of reclaimed water is indispensable for the harmony between nature and humankind, and the establishment of a good water environment and promotion of the development process of a recycling-oriented urban.

Handan city is located in the east of Taihang Mountains and south of Hebei province. The north latitude is from 36°04’ to 37°01’ and east longitude is from 113°28’ to 115°28’. The topography of the city is complicated, there are mountains, hills and plains, the terrain is generally high in the west and low in the east, high in the south and low in the north. The total land area of Handan is 12062km².

2 Overview of water resources in Handan

Handan City is located in a semi-arid, sub-humid, warm-temperate, continental monsoon climate zone, the multi-year average precipitation is 558.8mm. Because of the continental monsoon climate, the characteristic of precipitation changes acutely, and the spatial and temporal distribution is uneven. 75% of annual rainfall is concentrated in
the flood season around June to September, usually during this period disastrous rainstorms break out, and crops in spring do not get enough water nine out of ten years.

Handan is one of the cities which are seriously short of water. According to statistics: the multi-year average self-exploited water resources is 1.33 billion m$^3$, of which the volume of groundwater resources is 1,105,000,000 m$^3$, the repeated volume is 394,000,000m$^3$, and water resources per capita is only 157m$^3$, equivalent to 50.6% of the per capita water resources in Hebei province. This is less than one fifteenth of the national per capita water resources, and also far below the world recognized absolute poverty level of about 500m$^3$ per capita of water resources, are part of resource-based water shortages. In recent years, water shortage directly threatens the life of city residents, economic development and social progress. In order to meet the need of water for normal city life and industrial and agricultural production, the government is forced to take measures such as over-exploitation of groundwater and long-distance water diversion outside the basin. In addition, there is scarce rainfall in recent years and rivers dry up. The existing small amount of surface water has also been seriously polluted, leading to the formation of "Rivers are dry, and water are polluted everywhere" and continuous decline in groundwater level. At present, the area of over-exploitation in groundwater has reached 5184km$^2$, and formed a funnel area of 1569 km$^2$, in particular, most of the shallow and deep groundwater has been seriously over-exploited in eastern plains, and once the deep groundwater been exploited, it's really difficult to supply. Since the 1970s, the groundwater level in the eastern plain declines at the speed of 0.52m ~ 1.49m per year and four huge funnel areas like Dongyangzhunag in Yongnian county, or Tiantai Mountain in Feixiang appeared. The continuous decline in the groundwater level causes not only ground subsidence, the abandonment of wells and reduction of the yield of groundwater, but also may leads to other geological disasters.

3 Necessity of recycled water reuse

The problem of water pollution in Handan is a serious day to day issue, the ground water receives a certain degree of punctuate and regional pollution with the a tendency to aggravate year on year. Serious water pollution not only reduces the utilization of water resources, it also further intensifies the contradiction with the shortage of water resources, and also has a bad influence on the sustainable development policy which is being implemented at present, but also threatens the safety of residents regarding their own water use and people's health. There are many reason for this issue, the main reason is that industrial wastewater and urban sewage has not been treated effectively. Another reason is that lots of water is wasted easily and an awareness of conservation should be cultivated. As this is the fundamental measure of solving the water contradiction and the basic strategy to guarantee sustainable development policy of Handan, when faced with the crisis, recycled water reuse has its incomparable superiority compared with other strategies.

Firstly, the reuse of recycled water is a useful way to deal with serious water pollution, and it can also guarantee the sustainable use of fresh water resources in Handan. Recycled water takes sewage as the raw water. According to different use and function, as long as it has been treated suitably, the tailwater from a sewage treatment plant can be fully used and this makes it an important part of the original water resources of the city. In addition, the sewage water of Handan is stable and abundant. At present, the discharge quantity per day of Handan approximately is 420,000 m$^3$. There are two sewage treatment plants. The technology is mature and the expense is not high. The quantity of sewage which can be treated per day is 200,000 m$^3$, therefore there is still a massive amount of sewage which cannot be handled effectively. Reuse of recycled water has a
dual function, one is to develop sewage resources and the other is to reduce the pollution load by a large scale. This is a brilliant method to keep the health of the water cycle.

Secondly, the water resources of Handan is deficient at present; reuse of recycled water can provide a stable and reliable secondary water source.

The comprehensive development and utilization of water resources in Handan is not enough, so that it is especially vital to strengthen the management and comprehensive utilization of water resources. The quantity of sewage resources are huge, stable, and are not restrained by climatic conditions and other natural condition, so long as there is sewage, there would be a reliable regenerative water source.

As a very economical new water source, reuse of recycled water can meet the requirement of some industry, which is able to reduce the demand for fresh water resources in society, and can guarantee the supply of high quality drinking water and solve the shortage of water resources in Handan.

Thirdly, reuse of recycled water can supply different departments with minute natural water and reduce the cost greatly.

According to the different requirement of user and usage, minute nature water will be supplied. On the one hand, the water resources can be optimized, achieving sustainable development; on the other hand, the cost of recycled water is lower than the running water, having an obvious superiority of price which may reduce the user's expenditure and has splendid market prospect.

4 Feasibility analysis of recycled water reuse

4.1 Technical feasibility of recycled water reuse

The treatment technology at present may change the sewage into water which meets the required standard. Conventional advanced treatments are applied, such as material filtration, microfiltration, nanofiltration, reverse osmosis and so on. After pretreatment, the effluent water from the material filtration processing system can be used to wash, to water gardens, clean roads and in many other aspect of our life. The water from the microfiltration diaphragm processing system can be used in landscapes. The water from the reverse osmosis system is by far better than standard running water.

The elimination object of recycled water treatment technology and the main processing method fare related in table 1:

4.2 Economic feasibility of recycled water reuse

After being recycled, the sewage has the following advantages compared with other exploited water resources:

1) Recycled water is cheaper than long-distance water diversion. Its initial cost is only equal to drawn water 30 kilometers outside and the water resources distribution in Handan is unbalanced, with the water resources in the western part being more than the eastern region. The project drawing water from west to east is vast and the sailor is high.

2) Reuse of recycled water not only saves precious fresh water resources, but also saves expenditure on the discharge of pollution.

3) There is a broad future for the breakthrough of treatment technology for recycled water reuse. With the development of craft and innovation of equipment and materials, the security and reliability of supplying the recycled water will be gradually enhanced and the processing cost will be certainly reduced day by day.
## 5 Application prospects of recycled water reuse

(1) The scale of recycled water reuse can be big or small, which depends on the circumstances. Recycled water takes sewage as raw water, the treatment plant is the source area of recycled water. The scale of sewage recycling may be more flexible, depending on the sewage source and the water quality condition. The two sewage treatment plants should take on more tasks with the assistance of some special processing enterprises, and process sewage from different sources. Based on the process, the second project of the two plants should be continued and the utmost should be done to clean the local rivers and stimulate the reappearance of the beautiful natural environment of Handan.

(2) By disposing of the recycled water reasonably and mutually supplementing it with fresh water, we can guarantee the water supply in Handan. According to different usage, recycled water can be generalized in to the following criteria, including the agricultural water, the industrial water, the municipal miscellaneous water, living miscellaneous water, the ground water reinjection and so on. So long as the recycled water is disposed reasonably, the recycled water reuse cycle can be seen to bypass the social water cycle, maintaining the water cycle in nature and guarantee the

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### Table 1. Regeneration processing elimination object and technology

<table>
<thead>
<tr>
<th>Elimination object</th>
<th>Related target</th>
<th>Main processing technology used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended state</td>
<td>SS, VSS</td>
<td>Filtration, Coagulation precipitation</td>
</tr>
<tr>
<td>Dissolved state</td>
<td>BOD, COD, TOC, TOD</td>
<td>Coagulation precipitation, activated charcoal adsorption, ozone oxidation</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>T-N, NH3-N, NO2-N, NO3-N</td>
<td>Blows escapes, Oxidation break point, the biological denitrogenation</td>
</tr>
<tr>
<td>Vegetative nutrition salts</td>
<td>PO4-P, T-P</td>
<td>Metal salt coagulation precipitates, Lime coagulation to precipitate, crystal analyze law, the biological elimination of phosphorus</td>
</tr>
<tr>
<td>Micro ingredient</td>
<td>Conductivity, Na, Ca, Cl ion</td>
<td>Counter-seepage, electrodialysis, ionic exchange</td>
</tr>
<tr>
<td>Microorganism</td>
<td>Bacterium, virus</td>
<td>Ozone oxidation, disinfection (chlorine, sodium hypochlorite, ultraviolet ray)</td>
</tr>
</tbody>
</table>
influential role of the sustainable use about of water resources.

6 The social and environmental benefits of recycled water reuse

(1) The reuse of recycled water provides another water source, reduces the use of fresh water, alleviates the pressure and burden of water insufficiency and relieves the contradiction between supply and demand.

(2) The reuse of recycled water reduces the withdrawal of pollutants, on the one hand, it alleviates the water pollution and can renew a part of polluted water; on the other hand, it decreases the investment into environmental pollution treatment.

(3) The benefit of saving water is obvious, if the technology concerning water recycling is being promoted greatly, a massive quantity of water can be saved.

(4) Compared with long-distance water diversion, recycling of sewage has an incomparable social and environmental benefit, and taking consideration of the present technical level, the long-distance water diversion and ground water development also has certain insufficiency, which highlights the superiority of sewage recycling.

(5) As a demonstration project for environment protection, project of recycled water reuse may strengthen people's awareness of saving water and environment protection.

7 Example of the recycled water reuse project

The recycled water reuse project in Handan was started in the late1980s. In the last few years, along with the shortage of water resources and the aggravation of water pollution, this project is being taken seriously day by day. Let's take the eastern sewage treatment plant for example.

The eastern sewage treatment plant is the first second-level sewage treatment plant of Handan, which receives a grant aid from the Danish Government which introduces technology and equipment from Danmark. The volume of designed processing sewage per day is 100,000 m$^3$, the load in the processing sewage per day is about 13300kg, the sanitary sewage and the industrial sewage account for 50% respectively, the amount of planned service population is 730,000 and the catchment area is about 46km$^2$. The sewage treatment plant was built in November, 1990, the total area of the factory is about 54,000 m$^2$.

The eastern sewage factory has run for 18 years, the facility movement is normal and the processing effect is stable. At present the plant processes about 6000 ~ 7000m$^3$ sewage per day, the quality of leakage water is superior to the national second-level leakage of sewage standard. Besides the every yearly massive supply of agriculture irrigation water, Shui Yi takes the second water source and widely applies it into industry, afforestation, environmental sanitation and building construction.

The eastern sewage treatment plant is carrying on an overall transformation project, which will transform the facilities reasonably and renew the old equipment. This project will improve the working conditions and enhance the automatic management level. It is also helpful in energy conservation, and may promote the steady operation of the factory. At the same time, after this project has been finished, the overall quality of water resources in Handan will be improved greatly.

8 Conclusion

The deterioration of the environment and shortage of water resources compel us to develop a new water source, and the recycled water is a stable and reliable water resource. The comprehensive utilization of recycled water can not only alleviate the insufficient water resource situation, but also can improve the water environmental pollution condition gradually. In addition, this experience indicates that the reuse of recycled water is not only necessary, but also is feasible. At present the research results and the experience indicate that
second-level processing water leakage can be directly used in agriculture, and can be used as miscellaneous living water and municipal water after certain advanced treatment.

In summary, recycled water has an incomparable superiority compared with other water sources, and will definitely become a critical factor to solve the water crisis in Handan in the future.

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