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A research on application of water treatment technology for reclaimed water irrigation

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ARTICLE INFO

Article history:

Received 30 March 2016

Accepted 4 May 2016

Available online 20 June 2016

Keywords:

Reclaimed water irrigation
Water quality standards
Water treatment technology
Membrane bio-reactor
Management requirement

ABSTRACT

Water, taken as the source of life, is one of the most important constituent parts of the global ecological system. The water resources problem is becoming more and more severe as a result of the acceleration of the process of urbanization in China and an increased population since reform and opening up. Therefore, reclaimed water irrigation is one of the effective measures to deal with the scarcity of water resources. In line with the necessity and urgency of reclaimed water reuse at present, brief analyses are made on the determination of both the reclaimed water treatment and the relevant irrigation technology, and then explanations and studies are made from such perspectives as the construction purpose, the water quality standards and the technological process. Finally the relevant new technologies and technical requirements for the reclaimed water treatment are put forward for the reclaimed water irrigation from such aspects as the techniques and technologies related to sewage treatment, the technical requirements and standards for reclaimed water irrigation, and the management and monitoring of reclaimed water irrigation.

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Introduction

Water, taken as the source of life, is one of the most important constituent parts of the global ecological system. The water resources problem is becoming more and more severe as a result of the accelerated process of urbanization in China, industrial and agricultural development and an increased population since reform and opening up. China would begin to enter into a period of severe water scarcity since 2010, with

the water resources situation being especially severe in the northern region, according to a survey in *Water Supply And Demand in China in the 21st Century* from the Ministry of Water Resources. Therefore, it is extremely urgent to alleviate the water scarcity by strengthening studies on water recycling while improving efficiency in water utilization [1–3].

Recycling reclaimed water is one of the effective ways to reduce sources of pollution and solve the issue of water scarcity, and irrigation is one of the important measures to recycle the reclaimed water. As an effective method of saving

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<http://dx.doi.org/10.1016/j.ijhydene.2016.05.020>

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water resources, reclaimed water has been widely adopted by developed countries to irrigate farms in lieu of drinking water. The traditional irrigation mode not only causes huge waste of water resources, but is unable to meet the irrigation requirements, as agricultural crops have various varieties, and different requirements for irrigation water volumes, locations, irrigating methods. Therefore, it is of paramount importance to explore the technologies and modes of reclaimed water irrigation on farm [4,5]. It would be best to adopt a combination of technologies for disposal and reuse of domestic wastewater as well as for irrigation with respect to reclaimed water irrigation in order to achieve the purposes of transforming the sewage into resources and improving water utilization ratio and labor productivity while saving water. The effluent from the sewage treatment device for irrigation application features stable and reliable volume and quality, which is not only capable of reducing discharge of pollutants and relieving shortage of water resources, but can even be used as a reliable alternative source of water and fertilizer. Thus, study of technological mode for treatment of reclaimed water, recycling of reclaimed water in farm irrigation, as well as nationwide development and promotion will be of great strategic significance [6,7].

Water quality standards of reclaimed water irrigation

In china, water shall be divided into water for agriculture, forestry, animal husbandry and fishery industry, water for urban miscellaneous use, industrial water, water for environment and water for supplementing source of water according to the purposes of wastewater treatment and reuse in *The Reuse of Urban Recycling Water—Classified Standard* (GB/T 18919–2002). At present, there are uniform national standards with respect to each of farm irrigation, urban miscellaneous use, industrial water, water for environment and groundwater recharge [8,9].

Water quality standards of reclaimed water irrigation for urban green land

Limits for the physiochemical indexes and hygienic indexes of the reclaimed water for irrigation of urban green land shall conform to the provisions in [Table 1](#).

Table 1 – Water quality standards of reclaimed water for irrigation of urban green land.

	Index	Limit
1	BOD ₅ /(mg/L)	≤20
2	COD _{Cr} /(mg/L)	≤100
3	SS/(mg/L)	≤30
4	LAS/(mg/L)	≤1
5	Fecal coliform/(MPN/100 mL)	≤200
6	TN/(mg/L)	≤30
7	TP/(mg/L)	≤30
8	Total residual nitrogen/(mg/L)	≤2
9	pH	6–9

Water quality standards of agricultural reclaimed water irrigation

The basic control items of quality of reclaimed water for agricultural irrigation are shown in [Table 2](#).

Reclaimed water treatment and irrigation technologies

Introduction to treatment method of water for reclaimed water irrigation

The optimization and grouping shall be implemented by selecting rational treatment technology units according to properties and characteristics of sewage, purpose of water recycled, physiographic conditions, project investment, operation costs, because a certain single water treatment process is difficult to meet the requirement for quality of water recycled. At present, the urban sewage treatment process in China mainly includes such conventional processes as coagulation, sedimentation, filtering, sterilization and so on; there are also many other methods for advanced treatment, including coagulation and clarifying filtration, absorptive filtering with activated carbons, ultrafiltration, semi-permeable membrane, ionic exchange, reverse osmosis, biological method, micro-flocculation, contact mechanism of oxidation and filtration, ozonation, etc [10,11]. See [Table 3](#) for corresponding treatment method. Moreover, the requirements for the quality of agricultural irrigation water continue to be improved, and further requirements are being put forward from more aspects including color, turbidity, pathogenic bacteria, etc. along with the progress in water treatment technologies and social development.

Application and study of MBR in reclaimed water irrigation

In recent years, the MBR has been applied to sewage reclamation and reuse on a wider and wider scale, and has brought about obvious economical benefits, considerable environmental benefits and social benefits [12–14].

The research group has established relevant test base and demonstration village in Yingzi Village, Saiwudang Administration, Maojian District, Shiyan, Hubei Province, wherein the design scale of the recycling project of reclaimed water is 5 m³/d; and the raw water refers to rural domestic sewage. Twater quality of the same is shown in [Table 4](#).

The sewage treatment system adopts the combined process system in which full-automatic membrane bio-reactor (MBR) is combined with the advanced oxidation process (AOP). Moreover, the procedure of the sewage treatment process is as follows: domestic sewage—pretreatment tank—anaerobic/aerobic membrane tank—reclaimed water ([Fig. 1](#)).

The combined process in which the membrane bio-reactor (MBR) is combined with the advanced oxidation process (AOP) may be implemented for treatment of sewage of any quality [15,16]. The MBR treatment process has the advantages of both the membrane separation technique and the bio-treatment technology; and the all-in-one MBR reactor integrates

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