Bulgarian Chemical Communications, Volume 48, Special Issue D (pp. 274 – 279) 2016

Vertical flow constructed wetland on the slightly polluted water denitrification and phosphorus removal test parameters optimization research

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Received June 18, 2016, Revised September 10, 2016

The test is mainly aimed at ceramsite matrix vertical flow constructed wetland for slightly polluted water denitrification and phosphorus removal test parameters optimization research. According to reed, canna, water bamboo, water celery several hygrophilous plant of slightly polluted water treatment, examining the best treatment effect advantage as artificial wetland plants; Then examines the several key factors influencing the artificial wetland, such as plant density, height of filling and HRT, through the determination of NH_3-N in water, NO_3^--N, TN, TP, pH value, analysis the relationship between them to determine the optimal parameters. Screening tests of the plant: discovery of canna in denitrification and dephosphorization has obvious superiority than other several plants, so choose canna as the test plant. Parameter optimization experiment: artificial wetland system of HRT for 12h, the density of canna for 6 strains, haydite filling height of 40 cm when the optimal parameters, remove the best effect.

Keywords: Slightly polluted water, ceramsite matrix vertical flow constructed wetland, hygrophilous plant, nitrogen and phosphorus, parameters optimization.

INTRODUCTION

At present, with the rapid development of industrialization, the growing strength of the use of water resources, river pollution is increasingly serious. According to the survey, 50% of the river channel in our country and more than 80% of the pollution of lake, river and lake eutrophication problem on a nationwide scale appear constantly, causing damage to the original benign cycle [1]. As a result, the river water quality purification and restoration in the spotlight. River restoration is the purpose of river ecosystem restoration leads to a more natural state, make the river ecosystem sustainability [2], at present, the main pollution of river restoration methods are physical method, chemical method and biological method, has made some progress in both the three [3]. One of the most widely used, the most advantage is biological method, constructed wetland is one of the commonly used method.

It is the mechanism of sewage flows through long plant medium, resulting in a filtration, sedimentation, adsorption, such as physics, chemistry and pollutants and various kinds of biochemical reaction matrix [4]. Artificial wetland treatment process has: investment and maintenance cost is low; Low energy consumption; Suitable for non-point source pollution control and management. Wetlands can store surface runoff; they have the advantages of landscape function [5-6], and therefore they are widely used. Artificial wetland by category and three classes of surface flow, undercurrent, vertical flow. The vertical flow constructed wetland of denitrification and phosphorus removal in the first two effect is more outstanding. So the experiment selected vertical flow constructed wetland. Ceramsite filler selection. Choose wet raw edge species reed, canna, water celery, water bamboo compared after the screening.

Test apparatus and materials

This test USES vertical flow constructed wetland, ceramsite matrix hygrophilous plant plants in rivers investigation advantage of reed, canna, water celery, water bamboo, the above several selected plants separately for a period of training, for all kinds of plants grow after normal, then the transplanting 40*60*60cm of the experiment in the organic glass box.

Planting density of each plant reference actual planting density, such as reed, canna, water bamboo plants / 5 barrels, water celery plants / 10 barrels, with no plants to control (CK), a total of 5 groups, each group to deal with 3 replications. Plant after transplanting, injection test the water volume of 30 l a barrel. The experimental set repeat 3 times. Immediately after experimental period for 63 days, the water samples were determined, measurement indicators include: NH_3-N and NO_3^--N, TN and TP.

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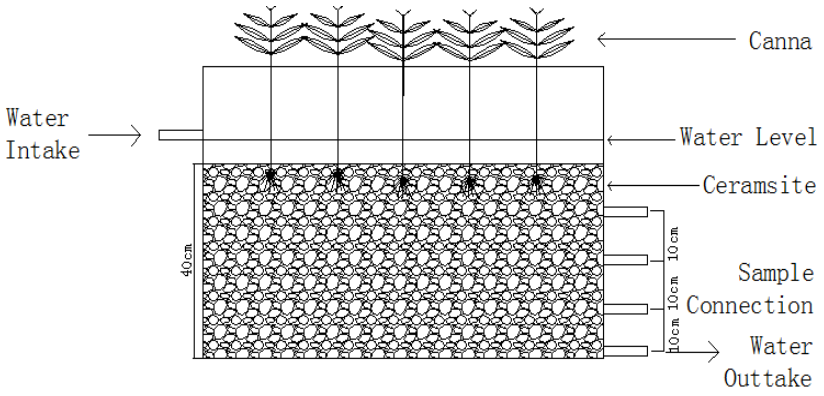

Fig. 1. Test unit.

Table 1. The water quality indicators.

Analyze project	NH_3-N	NO_3^--N	TN	TP	pH
Unit	mg/L	mg/L	mg/L	mg/L	-
The average value	2.13	1.76	5.36	0.48	6.87-7.45

NH_3-N AND TP REMOVAL EFFICIENCY ANALYSIS

In addition to water bamboo, other plants maximum removal rate of NH_3-N in 3 days, with canna removal effect is best, removal rate reached 84.3%, followed by water celery, reed. So it can be seen that canna advantages in terms of NH_3-N removal.

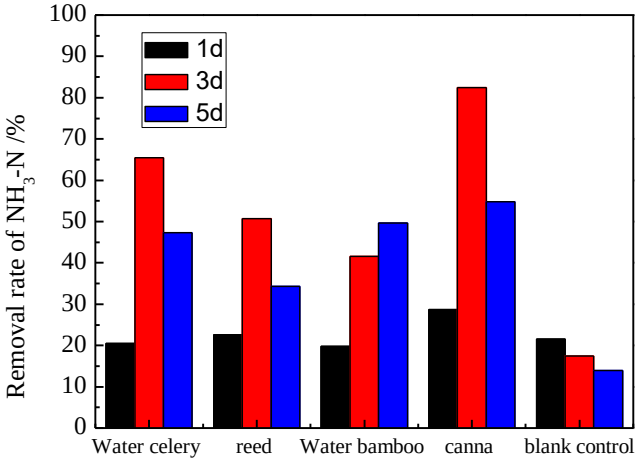

Fig. 2. Different wetland plants on the removal rate of NH_3-N contrast effect.

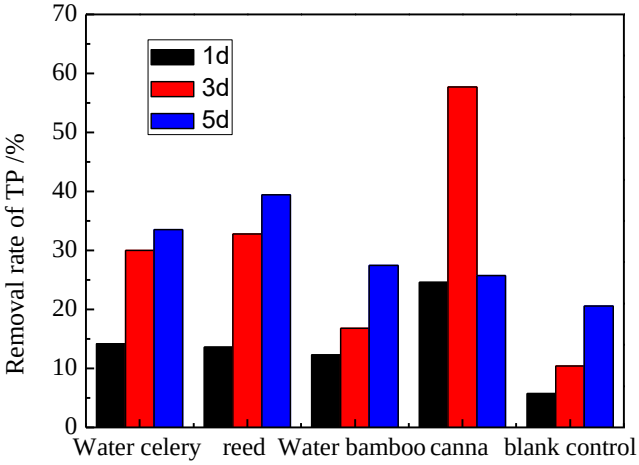

Fig.3. Different wetland plants on the removal rate of TP contrast effect.

The Figure 2 shows that all kinds of plants are certain removal effect of TP, besides canna, other plants on the removal rate of TP with increased with the extension of time, the removal efficiency of the control group was 22%, phosphorus content is higher, shows that particle state deposits play an important role, and canna removal rate reduced to 28.5% in the third day, that may be its the second release of phosphorus in the body effect is stronger, result in higher effluent total phosphorus content, therefore, adjust good hydraulic retention time for the p removal is very important.

Found in the process of screening plant cannas has more advantage in removing nitrogen and phosphorus, NH_3-N and TP removal rate is better than that of reeds, water celery, water bamboo. Canna has strong vitality and adapt better on the surrounding environment, so canna was chosen as the test plant.

Artificial wetland system of jointly by packing, plants and microbes, and in these three aspects in the operation of the system became conditions to limit its role, so to study the best conditions for system operation. Optimize the influence the effect of vertical flow constructed wetland to remove nitrogen and phosphorus several limiting factors, mainly including packing height, plant density and hydraulic retention time. The following parameter optimization was studied respectively.

PARAMETER OPTIMIZATION TEST

Height of packing

Another limiting factor of artificial wetland system, i.e., height of packing, so this experiment device based on the size of the set up three kinds of packing height, 25 cm and 35 cm, 45 cm haydite filling height, plant planting density of 6 strains canna, hydraulic retention time for 24 hours, the run of five cycles, experimental determination of NH_3-N in and out of the water, NO_3^--N, TN, TP of several indicators.

By Figure 4 and Figure 6, three different packing height of vertical flow constructed wetland

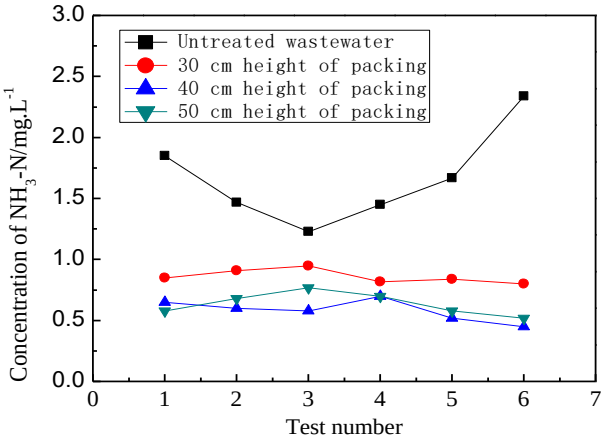

Figure 4 packing height on the influence of NH_3-N

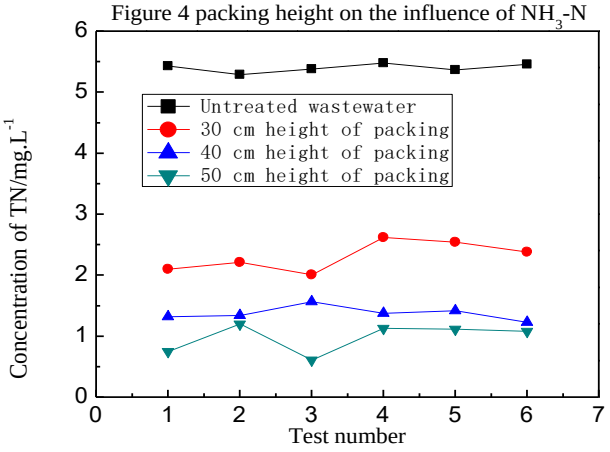

Figure 6 packing height on the influence of TN

The Figure 5 shows that when the haydite filling height of 30 cm, unstable system water NO_3^--N concentrations. The system packing height is low, in the digestion of microbes cannot provide stable anaerobic environment, should be appropriate to improve packing height; And when the filling height of 40 cm and 50 cm, stable effluent NO_3^--N concentrations of the two systems, two system NO_3^--N average removal rate of 35. 8% and 49. 2%, in terms of nitrogen removal effect, 40 cm of height of packing is good.

Canna vertical flow constructed wetland system of total phosphorus in water to remove significant correlation, the higher the packing, the removal rate of system, the better, that in addition to the plant absorption, the change of phosphorus content in the water, the adsorption of packing and interception effect is also one of the important influencing factors, when the filler height of 30 cm, 40 cm, 50 cm, the system average removal rate of total phosphorus were 32. 6% and 65. 5% and 78. 3%. 40 cm and 50 cm packing height on the wetland system of TP removal efficiency is affected.

Considering all factors, choose 40 cm of height of packing as best highly artificial wetland system.

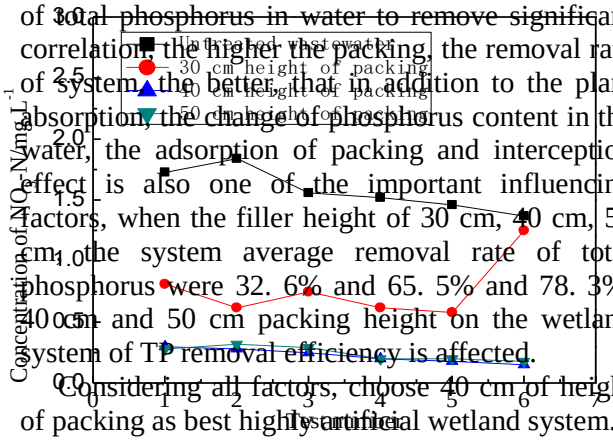

Figure 5 packing height on the influence of NO_3^--N

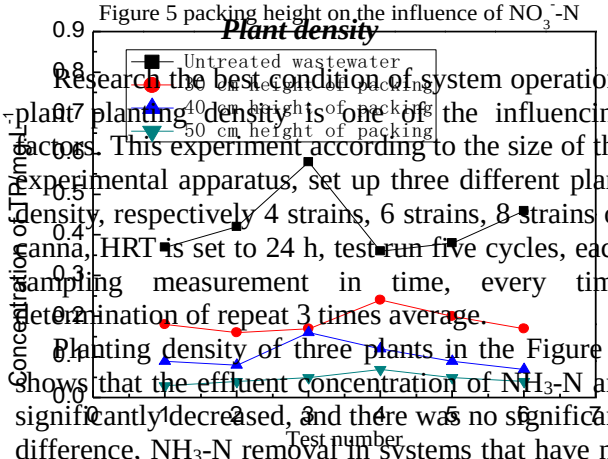

Figure 7 packing height on the influence of TP

Research the best condition of system operation, plant planting density is one of the influencing factors. This experiment according to the size of the experimental apparatus, set up three different plant density, respectively 4 strains, 6 strains, 8 strains of canna, HRT is set to 24 h, test run five cycles, each sampling measurement in time, every time determination of repeat 3 times average.

Planting density of three plants in the Figure 8 shows that the effluent concentration of NH_3-N are significantly decreased, and there was no significant difference, NH_3-N removal in systems that have no obvious correlation with plant, mainly is the packing of adsorption and microbiological nitrification, the main means of NH_3-N removal are nitration is transformed into NO_3^--N, so the system of NO_3^--N concentration increase, NH_3-N others rely on ammonia volatilization removal, the removal rate of NH_3-N in the system are higher, respectively, 70.5%, 78.1% and 82. 6%, among them 6 strains and 8 plant density of artificial wetland system of NH_3-N removal rate.

The Figure 9 shows that three kinds of plant density of artificial wetland system of NO_3^--N were not removed, instead, three kinds of NO_3^--N concentrations in the water system had increased,

but the three system water NO_3^--N concentrations 4 seedlings > 6 strains,> 8 strains, which may indicate NO_3^--N concentrations is associated with canna plant number, the more number of plants, the more conducive to denitrification.

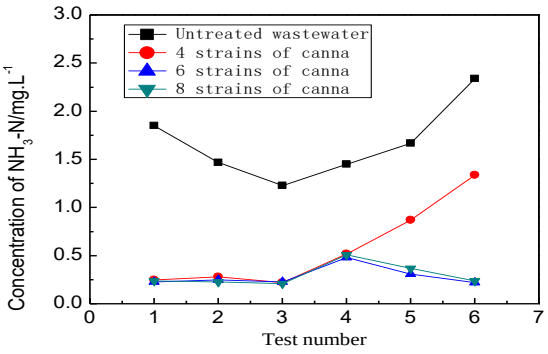

Figure 8 plant density on the influence of NH_3-N

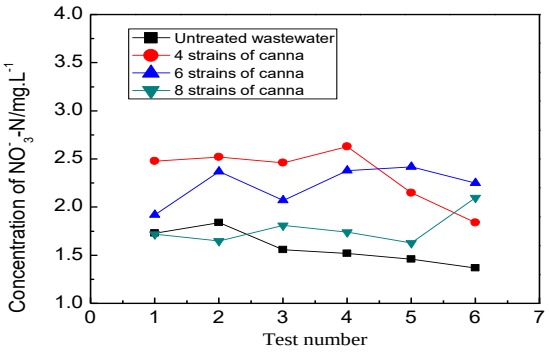

Figure 9 plant density on the influence of NO_3^--N

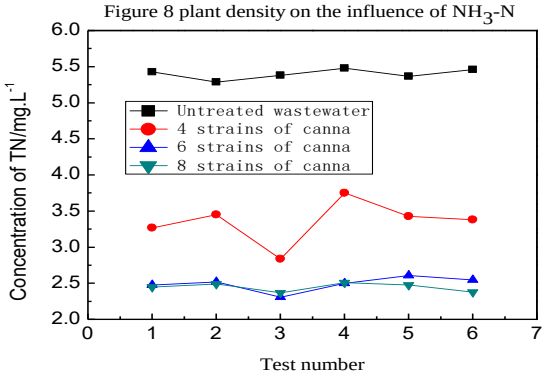

Figure 10 plant density on the influence of TN

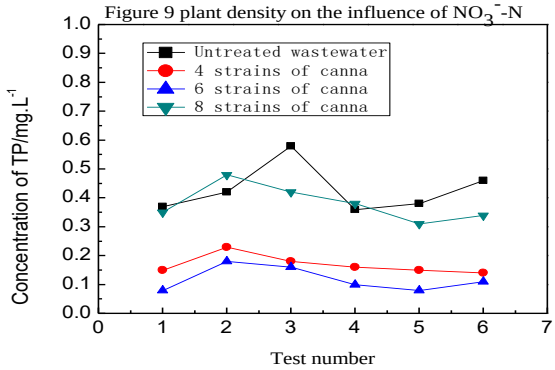

Figure 11 plant density on the influence of TP

The Figure 10 shows that present the lower effluent TN content of three kinds of system state, including plant a total of 4 canna plant effluent TN removal rate to an average of 24. 2%, and 6 cases and 8 strains of canna effluent TN removal rate to an average of 39. 5% and 41. 3%, thus can draw, 6 strains and 8 strains of canna device is superior to the 4 strains of canna device, it could be a canna in removing other forms of nitrogen removal has played a role.

By Figure 11 shows, 4 strains and 6 strains of canna two plants density of vertical flow constructed wetland system of the water from raw water TP concentrations were significantly lower, and the five test cycle, plant a total of eight canna TP water-quality wetland system of raw water was increased, the average TP is higher than that of original water 47. 6%, which can be judged, 8 strains of canna planting density is too high, can lead to canna plant competition for nutrients, thus some canna, death happened in the process, the second release of phosphorus, which can lead to system effluent is higher than that of raw water quality, plant a total of 6 canna vertical flow constructed wetland system with the minimum of TP concentration, removing effect is good, the average removal rate reaching 51. 1%.

In conclusion, can choose 6 strains for parameters of the system plant density.

HRT

Study found that HRT could theoretically use geometry average flow, system operation, such as water level, the initial porosity to estimate, because of the influence of geographical factors such as the application of artificial wetland technology in various areas in need of operation parameters. The appropriate extension of HRT can improve the removal rate of organic matter in wetland system. Visible, choose different HRT parameters in the artificial wetland can directly affect the efficiency of the artificial wetland.

Device select early screening advantage plant cannas, in the process of the test set different HRT, respectively is 12 hours, 24 hours, 36 hours, 48 hours, a total of four different residence time to determine water quality.

The Figure 12 shows that water of artificial wetland system in HRT for 12 h, the removal rate of NH_3-N concentration has reached 72. 4%, during the water removal rate of NH_3-N is stable, and with the HRT increases, the removal rate of NH_3-N revealed a general trend, first the lowered after the removal rate of NH_3-N best in HRT for 48 h, during the water removal rate of NH_3-N the highest reached 93. 5%, than high removal rate of HRT for 12 h best 21. 1%, and the cycle time is 4 times as much, so the analysis by NH_3-N removal efficiency, HRT for this system, the optimal time of 12 h.

The Figure 13 shows that the system effluent NO_3^--N concentrations in HRT for 12 - within 48 h, were higher than water NO_3^--N concentrations, system within 48 h, is superior to the nitrification and denitrification effect, because denitrification need anaerobic conditions, but with the extension of time, the concentration of NH_3-N can reduce water, nitrification will gradually weaken, denitrifying bacteria play a major role at this time, start lower NO_3^--N concentrations.

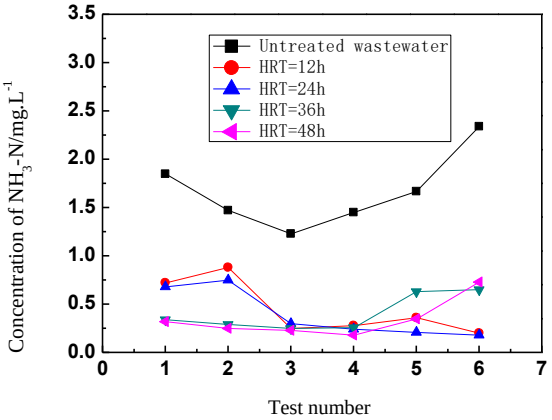

Figure 12 The influence HRT of NH_3-N

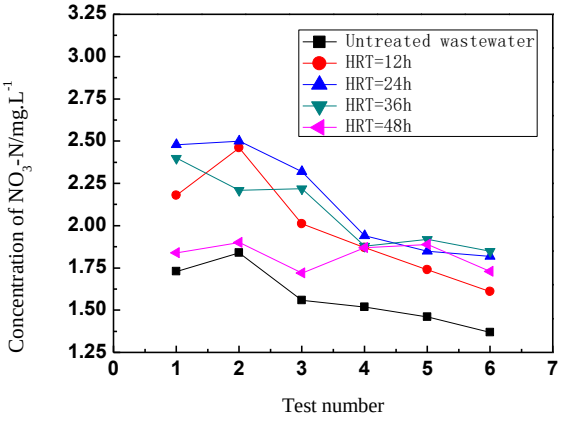

Figure 13 The influence of HRT of NO_3^--N

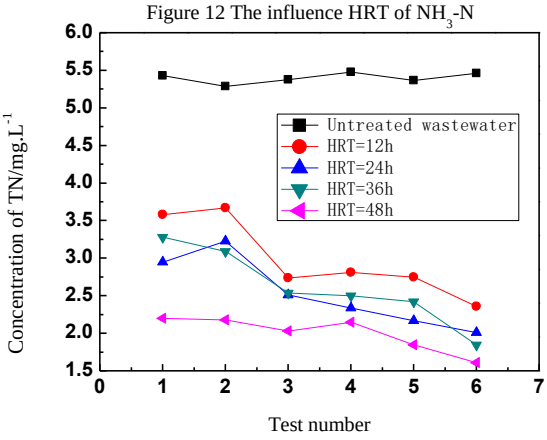

Figure 14 HRT effect on TN

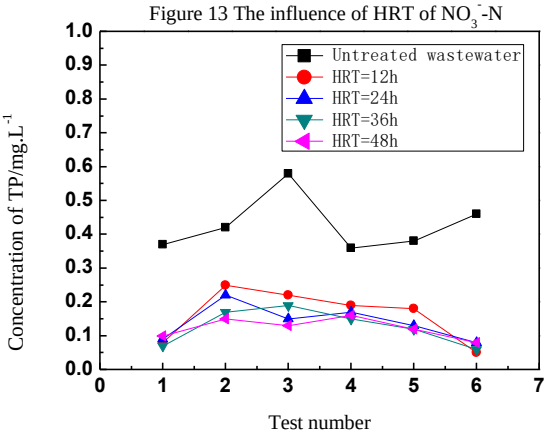

Figure 15 The influence of HRT of TP

By Figure 14, the TN concentration in the system under the condition of different hydraulic retention time, out of the water have significant changes in concentrations of TN, TN removal rate with the increase of time, gradually increases, when the HRT for 48 h, TN removal effect is best, removal rate reached 62. 4%.

By Figure 12 shows, in different HRT system effluent TP is lower than the water concentration, and with a continuation of the time, the concentration of the two measures are, in turn, reduce the water, namely in the experiment of six different HRT, 48 h effluent TP concentration, the lowest average removal rate of up to 63. 5%. And when HRT is 12 h, the system average removal rate of TP water has reached 48.7%, while a quarter of their time only for 48 h, so you can determine the optimal hydraulic retention time of artificial wetland system for 12 hours.

Taken together, determine the optimal hydraulic retention time of artificial wetland system for 12 h.

CONCLUSION

(1) the test in the process of screening plant found that canna has advantage in removing nitrogen and phosphorus, total nitrogen, total phosphorus removal rate is respectively 84.5% and 57.3%, respectively, better than the reeds, water celery, water bamboo, canna strong vitality and adapt better, on the surrounding environment in the whole process of plant selection, canna nitrogen and phosphorus removal is more significant in the lake, so choose canna as the test plant.

(2) the canna vertical flow constructed wetland plants in total nitrogen removal is mainly due to the system in the process of growth need nutrients supply, ceramsite filler on nitrogen removal efficiency of phosphorus removal effect is better than, slightly polluted water during the trial run period, a little change of nitrogen and phosphorus concentration in the artificial wetland in the purification effect is stable. Canna artificial wetland system on phosphorus removal effect is remarkable, the main reason in the period of system stable

operation, including canna root absorption ability is good, plant growth condition is good, the plants need to grow and phosphorus absorbed by plant roots in great quantities, which is transformation in plants and thus out of the water concentration is low.

(3) according to the economic benefit and nitrogen and phosphorus removal effect analysis of artificial wetland system of HRT = 12 h, plant density of 6 strains of canna and 40 cm ceramsite filler height as the optimal parameters.

Acknowledgements: *The authors wish to thank the China Fund program: National Science and Technology Major Project for the Control and Treatment of Water Pollution (2014ZX07202-011).*

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