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Vertical flow constructed wetland nitrogen concentration vertical distribution in the simulation system

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ABSTRACT

The research under different working conditions,the vertical flow constructed wetland simulation system packing various forms of nitrogen in the vertical distribution of concentration,by measuring the depth of denitrification effect,to determine the effective height of packing. Use with zeolite ceramsite and packing,willow food for wetland plant four units of vertical flow constructed wetland system. 1#:ceramsite,growing plants,aeration; 2#:zeolite,no plant,no aeration; 3#:zeolite,plant,no aeration; 4#:zeolite,a plant,aeration. Four devices were separately measured the depth of oxygen,nitrogen concentration and conversion rate. Four units in the depth of the packing for 20 to 30 cm DO drops rapidly, to DO to achieve the minimum 50 cm, respectively is 1.55 mg/L,0.71 mg/L, 0.68 mg/L,5.39 mg/L.1#,4# processing unit average removal rate of TN were 27.9%,25.3%,35.1%,19.6%. The four processing unit of NH_4^+-N average conversion rate were 87%,89%,89.8%,91.6%;Of NO_3^--N in the system did not decrease,accumulation. The simulation system,the working condition of 3# for nitrogen removal effect is best.3# unit transformation of NH_4^+-N and TN removal at a depth of 30 cm maximum,so are made valid by means of the zeolite packing of artificial wetland are 30 cm deep. NO_3^-–N concentrations in the four units is higher,the main reason is lack of carbon source,the denitrification reaction is weak,cause the accumulation of NO_3^-–N,appropriate supplementary carbon source for denitrification reaction.

KEYWORDS

Vertical flow constructed wetland; Simulation system; Nitrogen vertical; Zeolite; Distribution; Nitrogen removal.

INTRODUCTION

With the rapid development of social economy development and the city development,a large number of sewage produced,most of them are not standard treatment on the direct emissions,resulting in the deterioration of water environment. According to the survey,in the 200 Rivers National seven rivers and inland river water quality assessment,section ratio of IV class-V and class V water quality deterioration at 24.2%and 20.8%.1/3 above the river are subject to different degrees of pollution,more than 90%of the city water pollution,urban water source on nearly 50%does not meet the drinking water standard,has serious harm to human health. Therefore,constructing the safety of water environment has become an urgent task facing. Nitrogen is the key index caused by the pollution,so the control of eutrophication must focus on nitrogen removal.

Artificial wetland is an integrated ecosystem,has good economic benefit and ecological benefit,has low investment,high efficiency,good effluent quality,strong anti impact force,improve and beautify the environment,maintenance and operation has the advantages of low cost[1-2]. Suitable for the national conditions of our country,especially for the rural areas,sewage treatment of small and medium-sized city,with the prospect of application of[3]wide.

The artificial wetland is the surface flow constructed wetland,horizontal flow constructed wetland and vertical flow constructed wetland is three[5]. The vertical flow constructed wetland in three in the denitrification effect relative prominence. Filling is an important group of artificial wetland system, its adsorption function can greatly improve the wetland treatment effect of[6]. The research results show,zeolite and ceramic adsorption effect of NH_4+-N good. The comparison study of nitrogen at the same conditions of vertical distribution. Remove the path of vertical flow wetland nitrogen mainly for nitrification denitrification reaction[7-8]. Study on vertical flow constructed wetland using zeolite and ceramic filler,Lythrum salicaria as nitrogen vertical system of wetland plants to the distribution of concentration and proportion,in order to explore the effective depth of filler,effect of DO concentration on the reaction of microbial nitrification and denitrification. Improve the nitrogen removal efficiency and investment economy,the more efficient removal of sewage nitrogen has practical significance is worthy of popularization.

MATERIAL AND METHODS

Experimental design

(a) Experimental materials

Ceramic, zeolite, air pump,water tank(made of organic glass,divided into 4 units,filling test filler. Each cell are arranged perpendicular to the 5 sampling port. The unit size is 80cmx50cmx70cm).

(b)Test conditions

This device uses a continuous operation mode,the parallel operation of HRT unit,2d,hydraulic loading is $7.24\times10^{-3}m^3/m^2.h$. Control of aeration unit 4 in the 100ml/min,the intermittent aeration mode,aeration 1h,suspended 5h. The room temperature is 25˚C, humidity 70%, carbon dioxide concentration is 385ppm, daytime light intensity was 1000-5000 lux. Set the S1-S5 five sample level,before the start of the experiment, the first collection of plants on the experimentation area domesticated l0d, then transplanted into the test device.

(c)Setting

The water tank is arranged in the device above the water,the system is controlled by a valve velocity evenly to each unit. Flow from top to bottom vertical flow into the bottom,bottom of the device and a water outlet overflow pipe. Research on simulation system for vertical to the water quality change along,ceramsite filler No.1 unit,diameter and height of 20mm(50cm);No.2-4 units are packed with zeolite filler,zeolite particle size and height of 35mm(0-20cm),20mm(20-30cm),30mm(30-50cm). Each unit filling the total height is 50cm,three units selected No.2 for the control group,no plants,no treatment,other units are plant Lythrum salicaria,while No.4 unit increase in artificial aeration conditions,by connecting the gas meter to control ventilation.

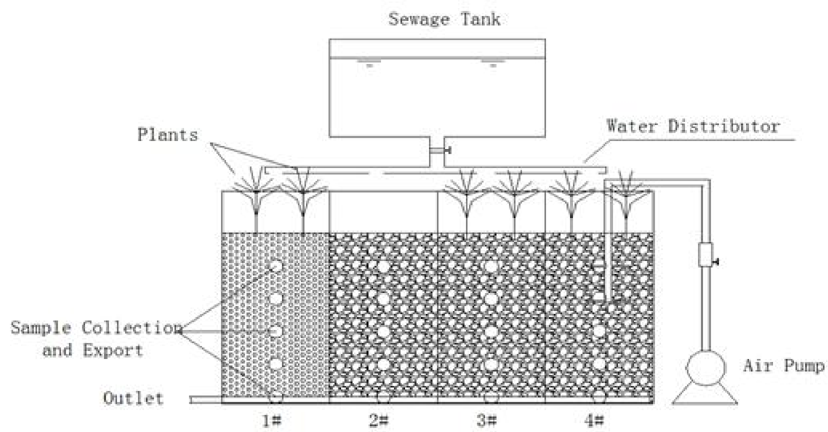

Figure 1 : Device unit

Water index

The device from a water inlet Hunhe River mouth,the main quality index table.

TABLE 2 : Water quality indicators

Water Index	DO（mg/L）	TN（mg/L）	NH_4^+-N（mg/L）	NO_3^--N（mg/L）	NO_2^--N（mg/L）	pH
Mean±standard deviation	2.54±1.42	13.37±1.84	5.92±0.81	6.77±0.7	0.32±0.14	7.5±0.3

Sample Collection and Analysis Method

Each sample in the morning 8 points, the siphon method of collecting water samples, water samples in plastic sample bottles, volume 500mL. After the acquisition, placed in 4°C refrigerator to be determined.

TABLE 3 : Monitoring indicators and analytical methods

Water Index	Analysis Method
TN	Alkaline potassium persulfate digestion UV spectrophotometric method
NH_4^+-N	Nessler'sreagent spectrophotometric method
NO_3^--N	Phenol two sulfonic acid spectrophotometry N-(1-naphthyl)ethylenediamine dihydrochloride
NO_2^--N	spectrophotometric method
DO	Membrane method
pH	The glass electrode method

RESULTS AND ANALYSIS

DO vertical distribution

Each processing unit of vertical distribution of DO is shown in figure 2.4 processing unit due to the increase of the aeration device, so the highest concentration of DO, concentration of DO filler bottom still reached 4.89mg/L. The filler height at 10cm DO was the highest, reached 7.32mg/L, followed by the 1 processing unit, the content of DO decreased from 6.56mg/L to 1.39mg/L,DO distribution of No.3 and No.2 processing unit is the most close, filling the depth 50cm,basically reach the anoxic condition.

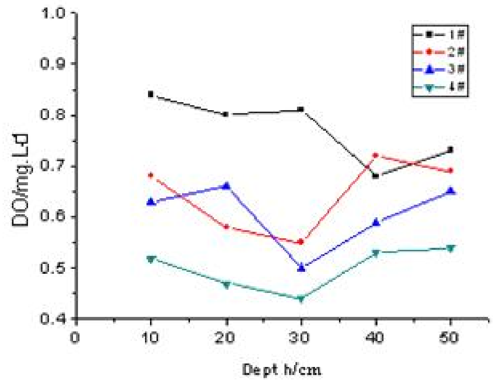

Figure 2 : Vertical flow constructed wetland system Simulation of vertical DO distribution curve

Different Forms of Nitrogen Concentration and The Vertical Distribution

Below are NH_4+-N,NO_3^--N,NO_2^--N concentration vertical distribution map. We can see from Figure 3,four processing units in the packing depth is 10cm when the NH_4+-Nconcentration is composed of a water inlet NH_4^+-N average concentration of 5.90mg/L to 0.45-0.90mg/L, NH_4^+-N.1-4 removal rate reached 87.80%,respectively,88.47%,89.32%,91.19%. Visible in the filling depth of about 10cm when the processing unit NH_4+-N has most been removed, depth is reached the lowest level in the lowest concentration of No.2-4 processing unit of the 30cm,then increased to a certain extent,No.1 unit in the packing depth is 40cm when NH_4+-N concentration reached to the lowest level.

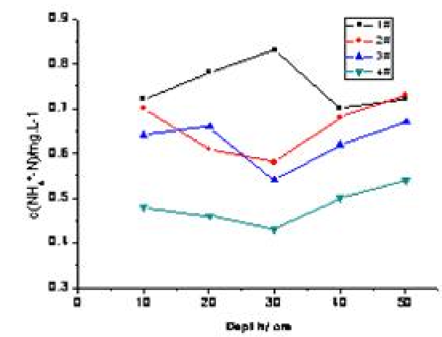

Figure 3 : Vertical flow constructed wetland system simulation Curve changes to the NH_4+-N concentration

We can see from Figure 4,No.1-3 processing unit,in the filling depth is 10cm,the concentration of NO_2^--N decreased from 0.32mg/L to 0.07mg/L-0.3mg/L,removal rate. The No.1 unit of NO_2^--N have not been removed,but there is a certain degree of accumulation. In the filling depth is 40cm,the concentration of NO_2^--N reached the maximum. Then dropped to 0.28mg/L,which may be due to the ceramic filler 1 processing unit filling contains more CaO to make the surrounding water environment is alkaline,influence microbial activity,made from NO_2^--N to NO_3^--N transformation has certain difficulty,leading to the accumulation of NO_2^--N.

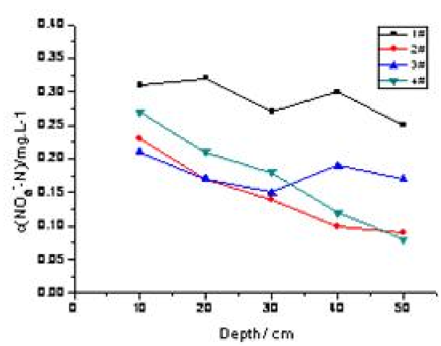

Figure 4 : Vertical flow constructed wetland system simulation Curve changes to the NO_2^--N concentration

We can see from Figure 5,the four processing unit of NO_3^--N vertical distribution is basically the same,in the filling depth is 10cm,No.1-4 unit on the NO_3^--N removal rate is larger,filling depth is more than 10cm after NO_3^--N began to accumulate.

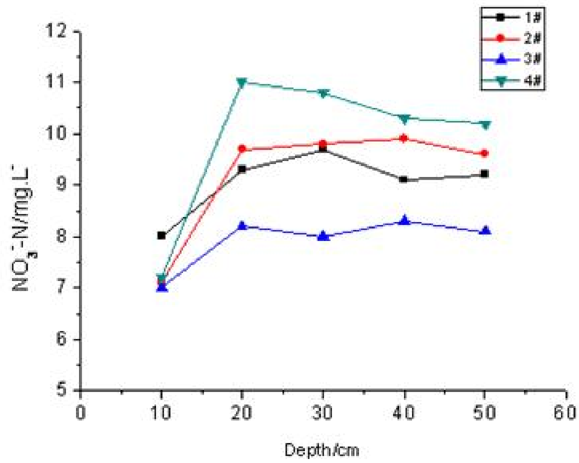

Figure 5 : Vertical flow constructed wetland system simulation Curve changes to the NO_3^--N concentration

Different Ratios of Nitrogen Vertical Distribution

From the figure,No.1-4 processing unit nitrogen vertical distribution situation as shown below. The water content of NH_4^+-N four processing units accounted for 46.66%,NO_3^--N accounted for 52.23%,NO_2^--N accounted for 1.11%,packing depth at about 10cm most of NH_4^+-N was converted to NO_3^--N,there are a small part of NO_2^--N. The four processing unit along the NO3--N content reached more than 90%,and the 1 processing unit of NO_2^--N also appeared to accumulate. The whole system is not the denitrification process obviously,the main reason is lack of carbon source,especially the 1 processing unit increased aeration device,can not achieve the hypoxic environment at the bottom,so the number 1 processing unit of the NO_3^--N account for the largest proportion.

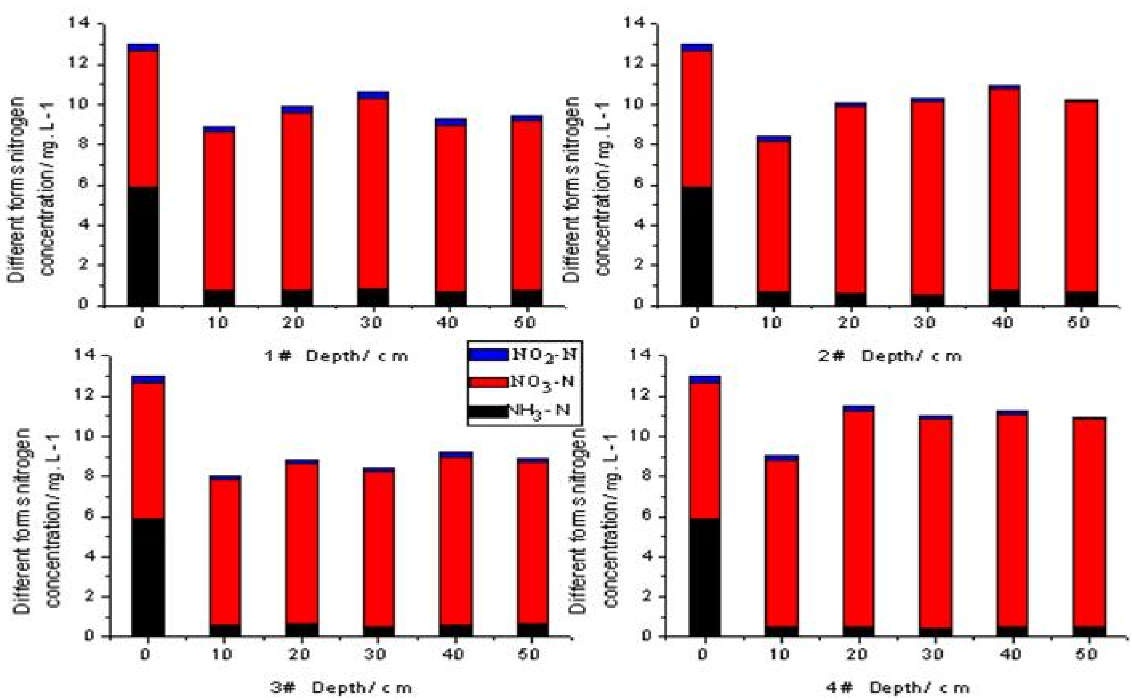

Figure 6 : Units at different vertical depth of the nitrogen distribution ratio diagram

CONCLUSION

4 processing unit of the system on the NH_4^+-N conversion is higher,the average conversion rate were 87.80%,88.47%,89.32%,91.19%,but NO_3^--N accumulation. No.1-4 processing unit and the average removal rates of TN were 27.9%,25.3%,35.1%,19.6%.1#-4#processing unit in the packing depth is 20-30cm DO decreased rapidly,to 50cm when the DO reaches the minimum, respectively 1.55mg/L, 0.71mg/L, 0.68mg/L, 5.39mg/L. System in the packing depth is 10cm most of NH_4+-N into NO_3^--N,NO_3^--N denitrification produces weak, accumulate in the system. Mainly because of the lack of carbon source,can not meet the denitrification reaction conditions,so the removal efficiency of TN system is not ideal.

1#and 4#comparison,1#average removal rate of TN is lower than that of 4#. Under the same conditions,the adsorption effect of zeolite,microbial nitrification and denitrification reaction is better than ceramic;2#,3#contrast,planting more conducive to the removal of pollutants;3#,4#,aeration can make the conversion of NH_4^+-N was slightly higher than that of natural conditions,but the removal efficiency of TN don't like 3#.

In general,using zeolite as substrates in constructed wetland,the best nitrogen removal efficiency for 3#,suggest that under natural conditions on the conversion of most microbial nitrogen and removal can achieve good status. Comprehensive comparison,in the 3#unit operating conditions,transformation and NO_3^--N,NH_4^+-N removal in the depth reached the maximum at 30cm,the effective depth of the filler for 30cm. In the surface 10-20cm range appropriate to increase the dissolved oxygen can accelerate the nitrification of microorganisms,but the increase of dissolved oxygen and inhibit denitrification, is not conducive to the removal of TN.

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REFERENCES

[1] G.Fu, et al.; Construction of wetland clogging, Journal of research of Environmental Sciences, **25(3)**, 144-149 **(2004)**.

[2] C.C.Tanner ,et al; Relationship between loading rates and pollutant removal during maturation of gravel-bed constructed wetlands treating farm dairy wasterwater, Journal of Environmental Quality, **7(2)**, 304-310 **(1998)**.

[3] P.Feng, et al; The research progress of constructed wetland and its mechanism, Journal of Ecologic Science, **21(3)**, 264-268 **(2002)**.

[4] Z.Nie, et al; The environmental science of 3 type artificial wetland treatment in eutrophic water, Journal of Comparative Study, **28**, 8,1675-1680 **(2007)**.

[5] W.Mo, et al; ammonia nitrogen and phosphorus on three kinds of artificial wetland fillers on the adsorption kinetics, Journal of chemistry, **1**, 21-23 **(2012)**.

[6] R.M.Gerberg, B.V.Elkins, S.R.Lyons, C.R.Goldman, Role of Aquatic Plants in Wastewater Treatment by Artificial WetIands, Water Research , **20,** 363-367 **(1985)**.

[7] S.C.Reed, E.J.Middlebrooks, R.W.Crites, Natural Systems for Waste Management & Treatment, McGraw Hi11, New York, NY **(1988)**.