Study on the Domestic Sewage Treatment by ABR-CW Method

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***Abstract*—Based on the status quo and requirements of domestic sewage treatment, the ABR and widespread constructed wetland (CW) methods are used to treatment domestic sewage in rural area. By the ABR and CW treatment processes, the size and organic loading are designed on the basis of the sewage quality and quantity. The COD, TN, TP and NH_4^+-N are analysized by monitoring methods and its changed are analysized. The processing results are discussed and some conclusions are used to select to treat the domestic sewage in rural area.**

Keywords- domestic sewage, ABR, CW, monitoring methods

I. INTRODUCTION

With the economic development and people's living standards improve, the resulting serious environmental pollution problems have become increasingly attentions. In the past, the environmental protection is focus on cities, while ignoring the larger area of the countryside. Thereby, the environmental problems are worsening in rural areas, especially the water pollution. Domestic sewage treatment in rural areas rise with rives and lakes aggravated pollution, but the sewage treatment engineering is less in rural areas, and many treatment technologies is only in demonstration research stage[1,2]**.** So, the low energy consumption, low running costs, low maintenance and management techniques are the main method to solve the sewage pollution problems in rural areas[3].

From the 1950s, the world in different countries and regions began to try to carry out wetland to purify sewage[4]. After half a century, the use of constructed wetland (CW) technology is gradually accepted and become more sophisticated[6]. Various countries had gradually established the sewage treatment system by CW method[7-8]. In treating the domestic sewage with a relatively small degree of pollution (CODcr<1000 mg.L^{-1}), which its removal is better, is a treatment technology using physical, chemical, biological of microbial and plant and its synergy action[9-10]. The thesis uses the CW and ABR methods to treat the domestic sewage of Beijing city.

II. EXPERIMENTAL APPARATUS AND METHOD

A. *Experimental apparatus*

The test water is the Beijing changping district domestic sewage. For personal change, the fluctuations of waste water quality change. So, anaerobic pretreatment unit (ABR) apparatus is used before the artificial constructed wetland (CW) to balance water quality and reduce impact loading. The parameters of ABR and CW apparatus are shown in table 1 and table 2.

TABLE I. DESIGN PARAMETERS OF ABR

Index	**Size L*D*H**	**Volume**	**Area**	**Hydraulic loading**	**HRT**	**Filling**
	m	m^3	m^2	$m^3/m^2{\cdot}d$	d	
Value	1.2*0.5*0.8	0.45	0.6	0.25	1.28	Fiber ball

TABLE II. DESIGN PARAMETERS OF CW

Index	**CW 1**	**CW 2**
Size (L*D*H, m)	1.2*0.5*0.8	
Volume (m^3)	0.45	
Area (m^2)	0.6	
Filling (style & number)	Up→Down: zeolite, bio-ceramic,anthracite. Effective height of each floor is 20cm	Up→Down: zeolite, bio-ceramic, anthracite. Effective height of each floor is 20cm
Hydraulic loading ($m^3/m^2{\cdot}d$)	0.09	
HRT (d)	3.5	
Flow direction	Upstream	Downstream

Anaerobic treatment is often used as a pre-treatment unit, which combined with aerobic treatment, can achieve good results. In this study, pretreatment technology is ABR method that jointly researched by Pro.Mccarty in 1982[13], with low energy consumption, long contact time between microorganism and domestic sewage, stable operation, good treatment effect, etc.

B. *Experimental methods*

The domestic sewage is taken in Beijng Changping district. The experiment is carried out during the day, and each sample is taken two parallel samples. "ABR+CW" method has two apparatuses, each unit takes three points and each sample number is 24. Septic tank effluent through the pump into the ABR reactor, which has pollutant removal efficiency and can reduce fluctuations in water quality after preprocessed. The domestic sewage is taken into sump after treating by ABR, and pumped into CW apparatus. The device runs 10h, from 8:00 to 18:00, and the total water inflow is 150L.d^{-1}. The indexes of domestic sewage, CODcr, TN, TP, NH_4^+-N, are measured every 5d. The measurement method is dichromate method, alkaline potassium persulfate digestion-UV spectrophotometric method, ammonium molybdate spectrophotometric method, and Nessler's reagent spectrophotometry method, respectively to CODcr, TN, TP and NH_4^+-N.

C. Raw Water quality

The index of water quality is 100-500mg.L^{-1} (CODcr), 10-50mg.L^{-1} (TN), 1-5mg.L^{-1}(TP), 4-16mg.L^{-1}(NH_4^+-N), respectively. By measurement, the effluent index is 50-230mg.L^{-1} (CODcr), 10-66mg.L^{-1} (TN), 0.2-0.3mg.L^{-1}(TP), 1.3-17.5mg.L^{-1}(NH_4^+-N) using ABR technology. So, the main effects of ABR are controlling water quality and reduce impact loading.

III. RESULTS AND DISCUSSION

A. The change Law of CODcr

The results of CODcr are shown in Figure 1 and Figure 2.

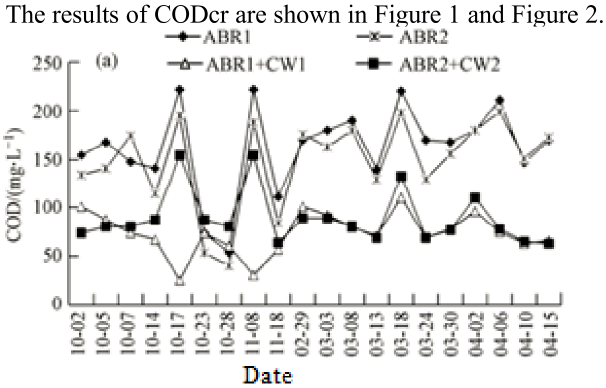

Figure 1. The value of CODcr before and after CW treatment

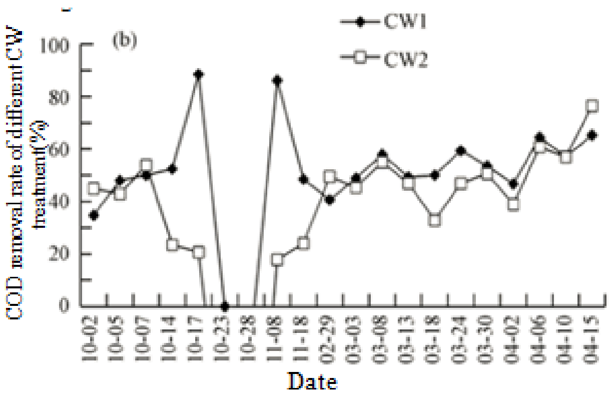

Figure 2. The CODcr removal rate of different CW treatment method

The Figure 1 and Figure 2 show that: the concentration of CODcr is 50-230mg.L^{-1} and 20-150 mg.L^{-1}, before CW treatment and after CW treatment, respectively. The mean value is 73.9 mg.L^{-1} after CW treatment, which reached the two standard of urban sewage treatment plant pollution discharge standard. From the Figure 1, "ABR1+CW1" and "ABR1+CW2" are two different ways of flow constructed wetland methods. CW1 is up flow, and CW2 is down flow. Figure 1 shows that the water quality by "ABR1+CW1" is better than "ABR1+CW2".

The reason is that the water impact loading is between in the pollution loading of wetland microbial-Matrix-Plants, which can adsorb and degrade. The impact loading is not reach saturation. The rate of discharge by CW1 method is 40%-90%, the mean value is 60%; The rate of discharge by CW2 method is 30%-80%, the mean value is 50%.

Figure 2 shows that the decontamination effect of up flow is better than down flow by constructed wetland method. The reason is that the water flow type can influence the hydraulic characteristics and water conduction, resulting different distribution layer of matrix aerobic and anaerobic, and different organic matter distribution. Compared to downstream, upstream is more evenly distributed of organic matter in CW1. After intercept and adsorption of underlying matrix, the underlying anaerobic or facultative microorganisms begin to initial degrade, and complex organic is compounded into simple organic by microorganisms. At the same time, as the water from the down to up, the simple organic is intercepted and absorbed by upper matrix, which upper aerobic microorganisms fully pay the role of degrading organic matter. By the together function of the matrix, anaerobic or facultative microorganisms, and aerobic microorganisms, the circulatory system of organic matter degradation forms from down to upper.

B. The change Law of TN

The results of TN are shown in Figure.3 and Figure.4

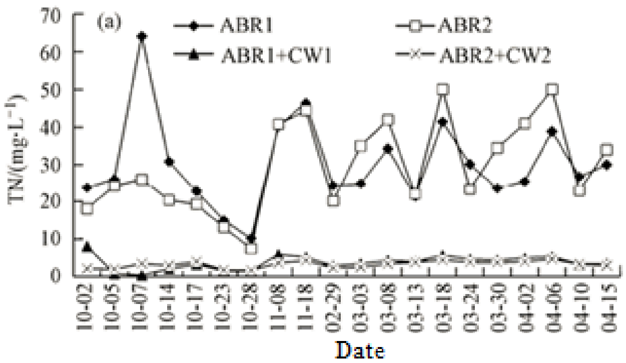

Figure 3. The value of TN before and after CW treatment

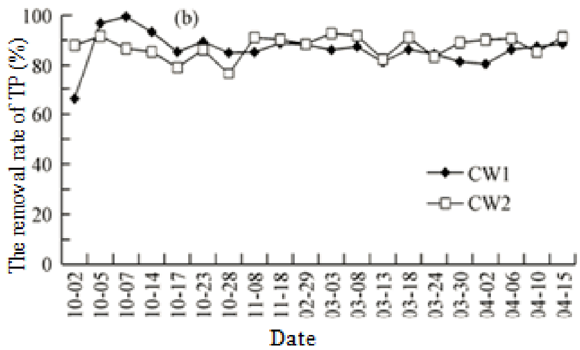

Figure 4. The TN removal rate of different CW treatment method

The values of TP before and after constructed wetland treatment are shown in Figure 3 and Figure 4.

From the Figure 3, TN content of water before CW treatment has large fluctuations, the concentration of TN is 13-65 $mg.L^{-1}$, the mean value is 40 $mg.L^{-1}$. After CW treatment, the TN concentration of water is 0-9 $mg.L^{-1}$, the mean value is 3.8$mg.L^{-1}$, which the TN value is stable. The total mean value is 4.0$mg.L^{-1}$. There is a similar concentration after CW1 and CW2 treatment methods, which reached to the A standard of pollutant emission standards of urban sewage treatment plant.

The Figure 4 shows that the removal rate of TN by "ABR+CW" treatment method is 65%-95%, the mean is 85%. The water quality is better after CW treatment. There are many influence factors of TN removal. The ABR1 and CW method forms a circulation system of TN, which the TN is in the form of ammonia, nitrate, nitrite nitrogen and organic nitrogen. This is a complex process of nitrogen conversion. Through the intercept and absorption functions of the zeolite, anthracite, bio-ceramic, et al, which haves a good removing effect, then through the jointing function of the nitrifying bacteria and denitrifying bacteria by constructed wetland treatment method, the water can reach a good effect of nitrogen removal.

C. The change Law of TP

The results of TP removal are shown in Figure 5 and Figure 6.

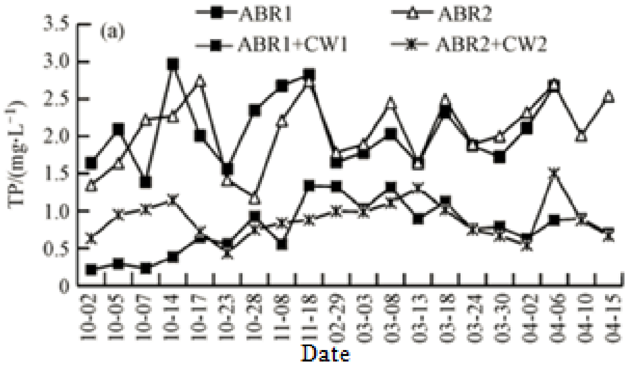

Figure 5. The value of TP before and after CW treatment

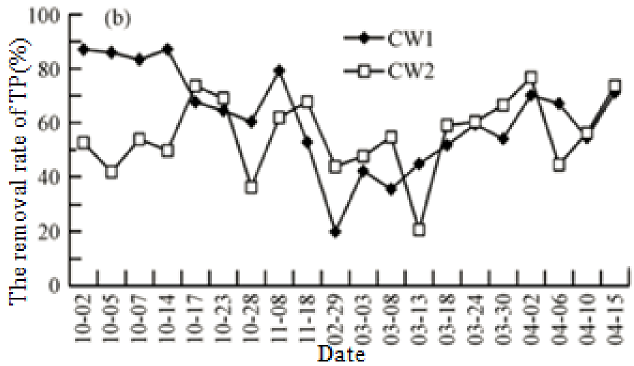

Figure 6. The removal rate of TP by different CW treatment method

The statistical results of TP concentrations by CW treatment method are shown in Figure 5 and Figure 6.

The Figure 5 shows that TP concentrations before and after CW treatment is 1.2-3.0$mg.L^{-1}$ and 0.2-1.4$mg.L^{-1}$, respectively, the mean concentration after treatment is 0.78$mg.L^{-1}$.

The Figure 6 shows that the removal rate of TP is 20%-89% by CW1 treatment method, then the removal rate of TP is 20%-80% by CW2 method. So, the water quality by CW1 method is better than CW2. At the same time, the Figure 6 shows that seasonal changes are not the important factors to "ABR+CW" treatment effect.

D. The change Law of NH_4^+-N

The results of NH_4^+-N removal are shown in Figure 7 and Figure 8.

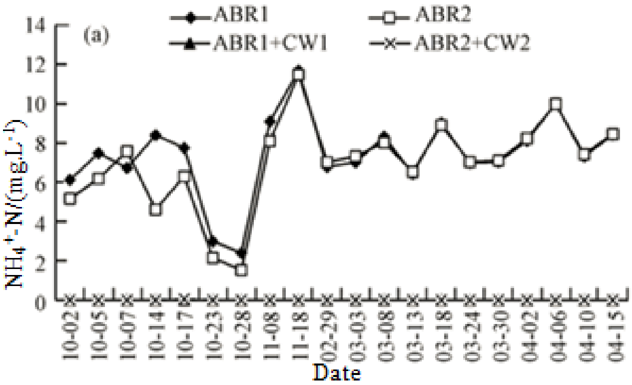

Figure 7. The value of NH_4^+-N before and after CW treatment

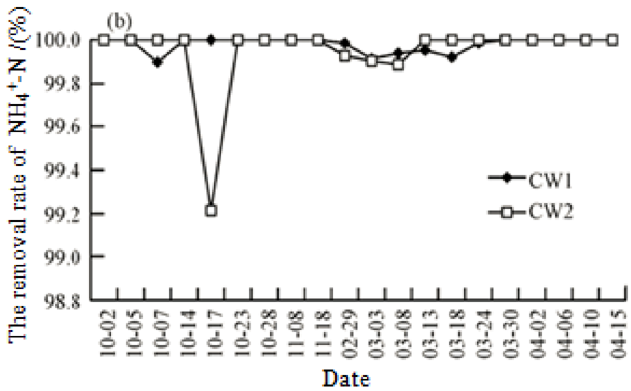

Figure 8. The removal rate of NH_4^+-N by different CW treatment method

The statistical results of NH_4^+-N concentration and removal rate are shown in Figure 7 and Figure 8.

The Figure 7 shows that NH_4^+-N concentration has large fluctuations between 1.3$mg.L^{-1}$ and 11.8$mg.L^{-1}$ before constructed wetland treatment method. The concentration is almost to 0 after constructed wetland treatment method. The removal rate is reached to 99%, and the treatment effect is very well shown in Figure 8. From Figure 8, we can also see that CW1 and CW2 have the same effect, in addition to CW2 has a special value. The reason is that there is adequate oxygen content within in the matrix of constructed wetland method, which makes ensure the smooth progress of nitrification and make the N-transfer circulation system can be orderly.

IV. SUMMARY

On the basis of the study on domestic sewage by ABR1 and CW treatment methods, some conclusions are shown that:

(1) The water quality is better by "ABR+CW" method than ABR method. CODcr, TN,TP and NH_4^+-N can reach the two standard, one standard(A), one standard(B) and one standard(A) of pollutant discharge standard of urban sewage treatment, respectively.

(2) Form the removal rate index, the removal rate of CODcr, TN, TP and NH_4^+-N is 50%-60%, 85%, 80-90%, and 99%, respectively. So, the removal rate of domestic sewage is very well.

(3) The treatment effect is less impacted as temperature varies, but is positively correlated with fluctuations in raw water quality. It is because of the pollution loading has not reached to saturation sake.

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