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SPECIAL ISSUE

Tạp chí Môi trường Việt Nam

Proceedings of 2nd DAAD Alumni Workshop

Sustainable Management of Environment and Natural Resources in Vietnam

Hanoi, Vietnam
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Content

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Study on treatment of domestic wastewater of an area in Tu Liem district, Hanoi, by water hyacinth

Nghiên cứu xử lý nước thải sinh hoạt tại một khu dân cư thuộc quận Từ Liêm, Hà Nội, bằng Bèo lục bình

Research article

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Domestic wastewater is one of the most interested environmental issues in Vietnam, especially in big cities and suburban residential areas. Most of the wastewater was not treated in the right way before discharging to environment. In this research, the author used water hyacinth as a main aquatic plant in aquatic pond model to treat wastewater. The experiment was operated continuously in 1 year with hydraulic retention time (HRT) is 11 and 18 days. Hydraulic loading rate (HRL) is 300 and 500 m^3/ha/day, respectively. Treatment efficiency of the model for TSS is 90% (remaining 6 -12mg/l); COD, BOD_5 is 63 - 81% (remaining 10 - 48mg/l); TP is 48 – 50% (remaining 3.5 - 9.8mg/l); TKN is 63 - 75% (remaining 8 - 17mg/l). Polluted parameters in effluent were lower than A and B levels of Vietnam standard QCVN 14: 2008/BTNMT and QCVN 40: 2011/BTNMT. The doubling time of water hyacinth in summer is 18days, and in autumn and winter is 28.5 days. Experiment results showed that we can use water hyacinth in aquatic pond to treat domestic wastewater with medium scale. We can apply this natural treatment method for residential areas by utilizing existing natural ponds and abandoned agricultural land with capacity up to 500m^3/ha day. However, to get better efficiency we should combine with other aquatic plant species to treat wastewater and improve environmental landscape.

Nước thải – xử lý nước thải sinh hoạt hiện đang là một trong những vấn đề môi trường được quan tâm tại Việt Nam nhất là tại các thành phố lớn và các khu dân cư. Hầu hết lượng nước thải chưa được xử lý đúng cách trước khi thải ra môi trường. Trong nghiên cứu này, tác giả sử dụng mô hình hồ thủy sinh và sử dụng cây Bèo lục bình để xử lý nước thải sinh hoạt của một khu dân thuộc huyện Từ Liêm, tại khu vực này nước thải bị thải trực tiếp vào sông Nhuệ. Thực nghiệm đã được tiến hành trong khoảng thời gian một năm, trải qua các mùa của khu vực miền Bắc với hai chế độ vận hành HRT là 18 và 11 ngày, tương ứng với tải trọng thủy lực HRL là 300 và 500 m^3/ha/ngày. Kết quả cho thấy mô hình thủy sinh sử dụng cây bèo lục bình cho kết quả tốt, hiệu suất xử lý với các chất ô nhiễm đạt được như sau: chất rắn lơ lửng đạt 90%, COD, BOD_5 đạt 63 - 81%, Phốt pho tổng giảm tới 48 -50%, Nitơ tổng giảm tới 63 - 75%. Hàm lượng các chất ô nhiễm trong nước thải đầu ra của mô hình đều thấp hơn ngưỡng A và B của các tiêu chuẩn QCVN 14: 2008/BTNMT và QCVN 40: 2011/BTNMT. Bên cạnh đó tác giả cũng đã xác định định được tốc độ sinh trưởng của cây bèo tại khu vực miền Bắc là 18 ngày vào mùa hè và 28.5 ngày vào mùa thu đông. Kết quả nghiên cứu cho thấy có thể sử dụng bèo lục bình để xử lý nước thải sinh hoạt, với qui mô vừa và nhỏ và nên áp dụng cho các khu vực ven đô, nông thôn nơi có diện tích đất rộng hoặc tại các hồ sinh thái của các khu đô thị. Tuy nhiên, để hiệu quả tốt hơn ta cần kết hợp với nhiều loại thực vật thủy sinh khác để ngoài tác dụng xử lý nước thải mà còn tạo cảnh quan môi trường xung quanh.

Keywords: aquatic pond, BOD_5, COD, TP, TKN, TSS, wastewater, water hyacinth

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1. Introduction

In Vietnam, domestic wastewater of resident is not treated in the right way. It is only preliminarily treated, and the effluent quality does not meet the Vietnam Standard. This is the cause of the pollution and the epidemic spreads. Using aquatic plants to treat wastewater is one of the natural methods, known as a technology solution for wastewater treatment in natural condition. It is an environment friendly method and can achieve high performance efficiency with low operating costs. Other advantages of this method are to increase biodiversity value and improve landscape.

Water hyacinth - a kind of aquatic plants is very common and develops well in Vietnamese condition. It is grown and used with many purposes such as soil additives, fertilizer; their pulp and fiber are used for paper making, animal feed, biogas production and human food. Many studies in the world show that we can grow it in aquatic pond to treat wastewater. Our study is carried out in Northern Vietnam, where has two distinct seasons in the year, rainy and dry seasons. A continuous experiment to the time is still a new research direction, and result of this experiment can help us assess the actual capabilities of water hyacinth to treat pollutants such as SS, COD, BOD_5, TP, and TN.

2. Subjects and methodology

2.1. Subject

The authorsused water hyacinth (*Eichhornia crassipes*) to study its ability in treatment of pollutants in wastewater [2]. Research was carried out with real wastewater sample taken on wastewater ditch of a residential area near University of Mining and Geology before run into the Nhue River. (Figure 1)

2.2. Methodology

Calculate and establish aquatic pond model to treat wastewater

- Aquatic pond model is established with dimension as follow (Figure 2):

+ The ratio between length and width of the reactor is 3: 1; Length (L) = 1800mm; Width (R) = 600mm;
+ Height (H) = 600 mm (flooded height = 500mm);
+ Reactor area (S) = 1.08 m^2; Treatment volume (V) = 540 liters.

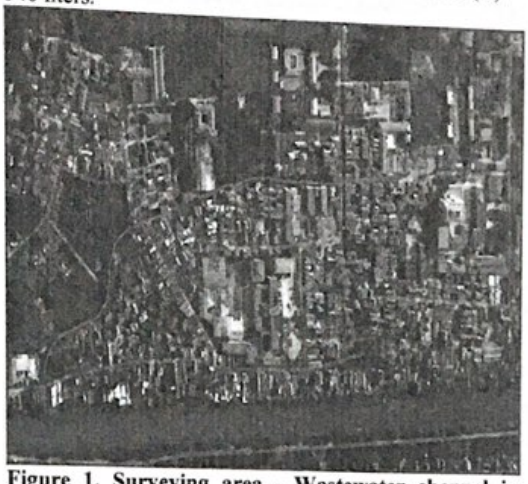

Figure 1. Surveying area - Wastewater channel in Dong Ngac Commune - Tu Liem district

- Determination of the operating parameters for aquatic pond model such as [3]

+ Hydraulic retention time - HRT;
+ Hydraulic loading rate - HLR;
+ Organic loading rate - OLR;
+ Flow

- Feeding water hyacinth and preparing experiment
- Analysing wastewater sample at influent and effluent with parametersSS, COD, BOD_5, TP, TN, NH_4^+, PO_4^{3-}
- Calculating growth rate of water hyacinth

Operating modes:

* Period 1- Feeding water hyacinth and Preparing experiment: during the time from 5/1/2012 to 5/3/2012. Water hyacinth is transported and fed in the reactor pond with real wastewater to develop and adapt with the artificial environment, and preparing experimental stage.
* Period 2- Running with continuous operation mode: during the time from 3/6/2012 to 16/7/2012. With operating parameters HLR = 300m^3/ha-day; Q = 30l/day; HRT = 18 days
* Period 3- Running with continuous operation mode: during the time from 17/7/2012 to 15/12/2012. With operating parameters HLR = 500m^3/ha-day; Q = 50l/day; HRT = 11 days.

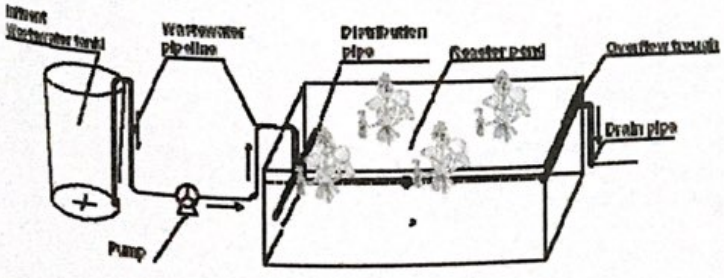

Figure 2. Reactor system (aquatic pond made by safety glass)

Table 1. Analysis results of pollution parameters in wastewater *(*QCVN 40:2011/BTNMT)*

No	Parameter	Analysis result	QCVN14:2008 QCVN40:2011*
1	pH	6.9 ÷ 7.3	5 ÷ 9
2	DO (mg/l)	1.2	-
3	BOD_5 (mg/l)	64 ÷ 95	30
4	COD(mg/l)	96 ÷ 135	75*
5	TSS (mg/l)	90 ÷ 140	50
6	NH_4^+ (mg/l)	12.6 ÷21.0	5
7	TNK (mg/l)	31 ÷ 37	20*
8	PO_4^{3-}(mg/l)	2.4 ÷ 7.3	6
9	TP (mg/l)	16 ÷ 32	4*
10	Coliforms(MPN/100ml)	≥ 9000	3000

3. Results and discussion

Analysis results showed that concentrations of almost pollution parameters in wastewater at studying area are higher than the allowed limitation given by Vietnam standard QCVN 14: 2008/BTNMT and QCVN 40: 2011/BTNMT (table 1).

3.1 TSS content

Concentrations of suspended solids (SS) in wastewater influent range from 90 ÷ 145 mg/l, which is 3 times higher than the A level of QCVN 14: 2008 standard.

In period 2, with HRT = 18days, TSS at effluent is from 6 to 12mg/l, average removal efficiency is 92%. And in period 3, with HRT = 11days, TSS at effluent is from 6 to 14mg/l, average removal efficiency is 93%.

Factors affecting treatment efficiency is retention time in reactor. When the retention time is long enough it helps solid particles deposit easily down to the bottom. The development of roots system can be considered as the filter layer having effect to reduce flow velocity and to filter out solid particles from wastewater.

3.2 COD, BOD_5

In period 1, after 10 days COD concentration in effluent meet A level of Vietnam standard, and the COD component in effluent is continuing to decrease.

In period 2, COD content at effluent is from 10 to 35mg/l, average removal efficiency 84%. OLR = 18 kg BOD_5/ha.day.

In period 3, COD content at effluent is from 20 ÷ 58mg/l, average removal efficiency 63%. OLR = 26 kg BOD_5/ha.day.

The doubling time of water hyacinth in summer is 18 days, and in autumn and winter is 28.5 days.

When we change wastewater flow from 30 to 50 l/day, treatment efficiency reduced from 81% to 63%. COD concentration in effluent increased after a number of water hyacinth is harvested. Harvesting process also made the reduction of micro biomass in aquatic pond. Factors affecting treatment efficiency is hydraulic retention time, wastewater flow and harvesting process.

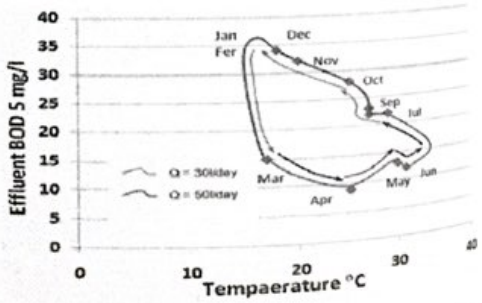

Figure 3. Relationship between BOD and temperature

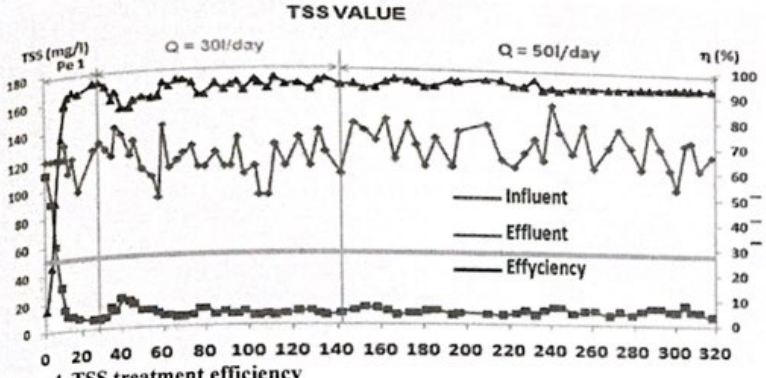

Figure 4. TSS treatment efficiency

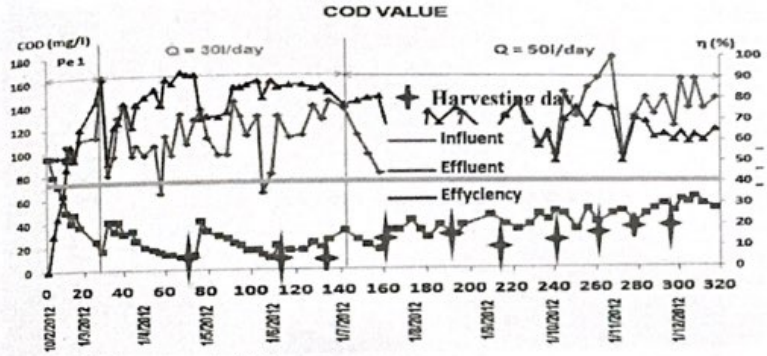

Figure 5. COD treatment efficiency

Table 2. Pollution parameters in influent and effluent

Period	Time		Parameter	Value	Average		Value	Average	η %
Period 1 (59 days)	5/1 - 6/3	influent	SS(mg/l)	97÷130	115.5±9.5	effluent	-	-	-
			COD (mg/l)	96÷110	105 ± 5		-	-	-
			TKN(mg/l)	-	-		-	-	-
			TP(mg/l)	-	-		-	-	-
Period 2 HRT = 18days (124days)	6/3 – 6/7	influent	SS(mg/l)	90÷140	116.9±11.0	effluent	6÷20	9.5±2.7	92%
			COD (mg/l)	64÷160	113±18		10÷ 40	21±7	81%
			TKN(mg/l)	24.2÷37.1	30.7± 3.5		10.1÷40.5	8.8±2.9	71%
			TP(mg/l)	11.1÷23.4	17.3± 2.8		3.5÷17.0	8.5±3.8	50%
Period 3 HRT = 11days (162 days)	6/7 – 15/12	influent	SS(mg/l)	96÷154	125.2±10.7	effluent	6÷14	9.0±1.6	93%
			COD (mg/l)	64÷178	121±22.8		16÷60	40± 9	67%
			TKN(mg/l)	22.3÷49.0	36.8± 5.1		8.0÷19.0	13.7± 2.3	63%
			TP(mg/l)	7.8÷19.0	13.9 ± 1.9		4.8÷9.8	7.1± 0.8	48%

3.3 TKN

In period 2, content of TKN in effluent is from 6 to 12 mg/l, average removal efficiency 75%. In Period 3, TKN content in effluent is from 8 to 17 mg/l, average removal efficiency 63%. Dissolved oxygen content in the aquatic model is 3.7mg/l at water layer nears the surface, is 1.3mg/l at the depth about 20cm from surface and is lower than 1mg/l at the bottom. Nitrogen in wastewater was treatment through nitrificationate and denitrification processes. TKN in effluent also was increased when wastewater flow changed from 30 to 50 l/day. And treatment efficiency also depends on harvesting process. TKN treatment efficiency is shown in Figure 6.

Figure 6. Development of water hyacinth

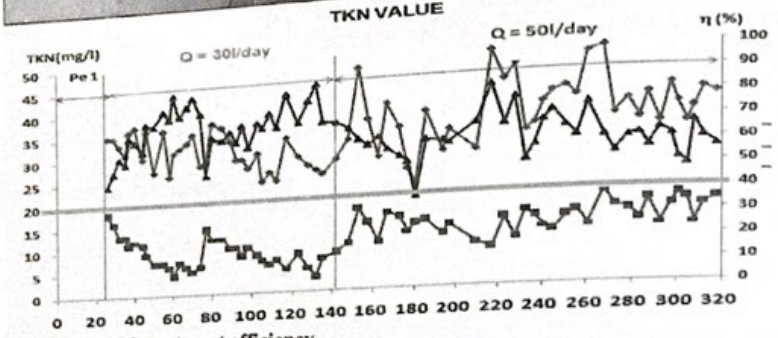

Figure 7. TKN treatment efficiency

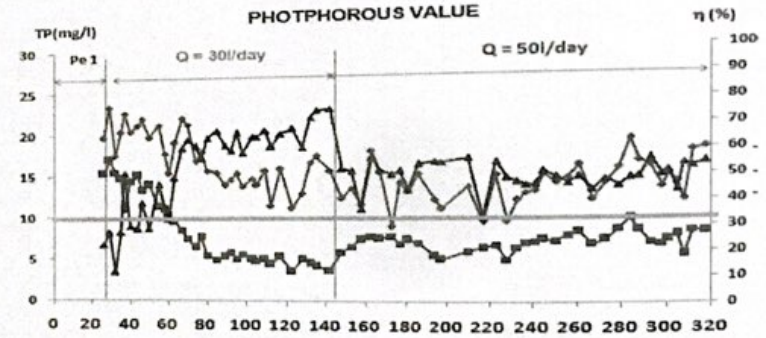

Figure 8. TP treatment efficiency

3.4 TP

TP treatment efficiency is showed in Figure 8. In period 2, concentration of TP in effluent is from 3.5 to 6 mg/l, average removal efficiency 50%. In Period 3, TP content in effluent is from 4 to 9.8 mg/l, average removal efficiency 48%. Treatment efficiency of period 2 and 3 did not change so much when the retention time was changed from 18 days to 11 days. Harvesting process did not affect to TP content in the effluent.

4. Conclusion

Studying result showed that in the studying area there is no wastewater treatment plant. Therefore, wastewater was discharged directly to Nhue River. Environment has been polluted by wastewater. Concentrations of almost environmental parameters were higher than the limitation of Vietnam Standard QCVN 40:2011/ BTNMT - 14:2008/BTNMT from 2 ⊠ 4 times e.g. SS, BOD, COD, NH_4^+, TKN, PO_4^{3-}, TP.

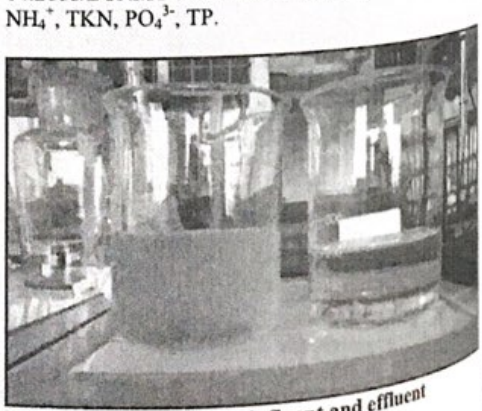

Figure 9. Wastewater in influent and effluent

The research results of domestic wastewater treatment by aquatic model with HRT 11 and 18 days showed that

concentrations of determined parameters in wastewater in effluent reduced to reach A and B level of Vietnam standard QCVN 14: 2008 and QCVN 40: 2011/BTNMT. Average removal efficiency for TSS is 90% (remaining 6-12mg/l); COD and BOD5 are from 63 to 81% (remaining 10-48mg/l); TP is 48 - 50% (remaining 3.5-9.8mg/l); TNK is 63 - 75% (remaining 8 – 17mg/l). The doubling time of water hyacinth in summer is 18 days, and in autumn and winter is 28.5 days.

We can apply this natural treatment method to treat wastewater by utilizing existing natural ponds and abandoned agricultural land with capacity up to 500m^3/ha/day.

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