RESEARCH WATER TREATMENT ABILITY OF OUTDOOR AQUARIUM BY CONSTRUCTED WETLANDS

Vi Thi Mai Huong*
University of Technology - TNU

SUMMARY

This report presents the initial results about capacity of using constructed wetlands to treat water of outdoor aquarium. The experimental model includes an outdoor aquarium (0.7 x 0.3 x 0.4)m, a constructed wetland (0.67 x 0.25 x 0.38)m, a wastewater tank (0.4 x 0.2 x 0.33)m. The model was operated for 30 days, aquariums had 07 goldfish, 5-7 cm long. Water flow into constructed wetland was 12 l/d and water retention time was 1 day. The result indicated that fish was always healthy, water in aquarium was maintained with good quality, reaching QCVN 38:2011/BTN&MT on water quality regulation to protect aquatic life. The values of pH, DO, TSS, NH_4^+-N of water in aquarium were 7.1-7.4; 5.2-5.9 mg/l; 16-27 mg/l; 0.61-0.76 mg/l respectively.

Key words: *Aquarium, aquarium water treatment, constructed wetlands, aquarium water filters, outdoor aquariums*

INTRODUCTION

Water filtration systems are essential for aquariums. They have the function of filtering, purifying water in the tank thanks to the filter layer equipped in the filtration systems. That will make water in aquarium clean, oxygen-rich and creating a favorable environment for fish to grow well. Aquarium water filter systems on the market today are quite diverse in types. In general, these systems consist of three main mechanisms: mechanical filtration, chemical filtration and biological filtration. Filtration systems are usually a combination of two mechanisms including mechanical filtration and biological filtration or a combination of all three mechanisms mechanical filtration, chemical filtration and biological filtration to ensure system efficiency. Popular filter systems on the market today such as Hang on back filter, Sponge Filter, Overflow Filter, Canister /external filter, Undergravel filter, Fluidized bed Trickle Filter, Diatom filter… In these systems, water is continuously pumped through one or several layers of material during the filter operation. When passing through the layers of material, large particles of contaminant will be trapped on the surface of the material. Small size particles, solutes will be microorganisms that adhere to the surface of the decomposing filter material, transformed into simple or non-toxic inorganics. As a result, the water in the aquarium is cleaned. The advantage of these systems is the ability to treat quite well with the containants in the water, diverse designs, beautiful, easy to install and use. But these systems have many disadvantages. Those are quickly clogged, often have to clean or replace the filter materials. On the other hand, water pumps must operate continuously during filtration.

Constructed wetland is a wastewater treatment technology in natural conditions, environmentally and friendly. It has low cost of construction and operation, high efficiency with wastewater polluted by organic waste, nitrogen, phosphorus and pathogenic microorganismsn [1]. Constructed wetlands have been extensively researched and applied in the treatment of wastewater in the world and has been applied in Vietnam in recent years. The application of constructed wetlands in fishpond wastewater treatment has been known worldwide since the 1970s [3] and has been applied in Vietnam.

* *Tel: 0915 565955; Email: huonganhtn@gmail.com*

Aquaponics is a good example of constructed wetland application in treating wastewater from aquariums. This is a closed recirculation system that combines aquaculture and hydroponic farming [3]. The system includes an aquarium, a constructed wetland (tree planting tray) and an automatic circulating water pump system. In the aquaponic system. Water from fish tank containing fish waste is pumped into the constructed wetland. Pollutants are treated by sedimentation, filtration through filter material, organic matter decomposition, nitrification, nitrifying reaction by microorganisms adhering to the surface of filter materials and around the roots. As a result, fish waste is transformed into nutrients for plant growth. Water is cleaned and returned to the aquarium. Therefore, water can be re-used indefinitely, just add the amount of evaporative losses and no emission of wastewater to the environment [3]. However, this system has the disadvantage that the water retention time in the filtering plant is short 20-30 minutes [3] so it is not enough for microbial metabolism to reduce the efficiency of the system. On the other hand, the system only operates when the pump is operated. In order to keep the system running continuously, the pump must operate continuously. This results in energy costs and reduces the life of the pump. Therefore, the study proposes a treatment system to overcome the shortcomings of this system in order to improve the applicability of the constructed wetland in the treatment of aquarium water is essential.

In Vietnam today, along with the development of the national economy, the living standard of people has been raised, the spiritual demand is paid more attention. One of the more popular types of entertainment is the aquarium. Aquariums of various sizes can be placed in the living room, courtyard or garden of the family. It creates a beautiful, lively landscape, expressing love for nature, helping people relieve stress, fatigue in life. However, one of the biggest difficulties for aquarists is that water filters for aquariums are often clogged, must be rinsed, replaced or water change if not, water will be contaminated causing fish to die. Therefore, it cost a lot of money, time and effort during aquarium. For small fish tanks placed in a room, this work is not difficult, but with larger outdoor fish tanks, high investment costs and large tanks, it is a difficult and costly task. Many outdoor aquariums after a period of use did not work anymore. Therefore, the research to find out a suitable technology to treat wastewater of outdoor aquarium to improve the disadvantages of existing systems is very important significance. On that basis, author selected the topic: *"Research water treatment ability of outdoor aquarium by constructed wetlands"* to assess the possibility of applying constructed wetlands in wastewater treatment of outdoor aquariums. Beside, constructed wetland can create a natural ecological landscape for the aquarium.

MATERIAL AND METHOD RESEACH

Design the experimental model

The experimental model consist of an aquarium with LxBxH = (0.7 x 0.3 x 0.4) m; a constructed wetland with LxBxH = (0.67x0.25x0.38) m; a wastewater tank with LxBxH = (0.4x0.2x0.33) m. The experimental model diagram is shown in Figure 1. The model was made of glass with a steel frame and located at Thai Nguyen University of Technology.

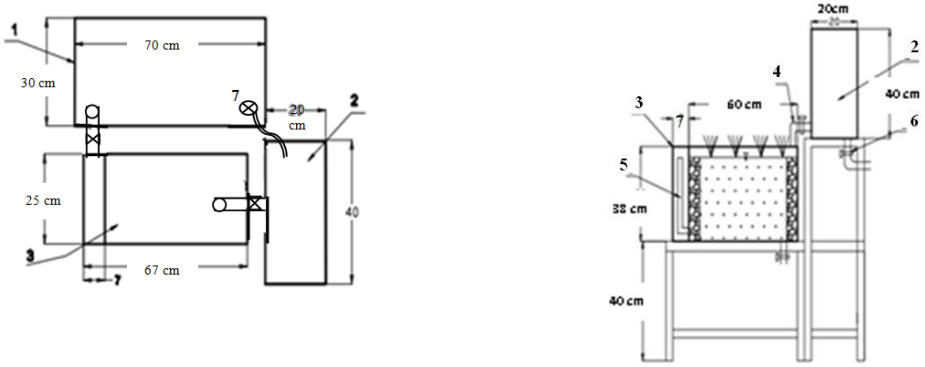

Figure 1. *Diagram of the experimental model. (a): Diagram of experimental layout. (b): Diagram of constructed wetland structure.*
(Note: 1: Aquarium; 2:wastewater tank; 3: constructed wetland; 4: Flow control valve; 5: Water collecting pine; 6: Flush valv; 7: pump)

Operated the experimental model

- *Step 1: Fish breeding.* Choose gold fish, 5-7cm in length, 7 fish. Feed the fish twice daily at 7am and 5.30pm with synthetic feeds exclusively for goldfish. - *Step 2: Prepare filter material:* including gravel (d = 4-5 cm), filter gravel (d = 1-2 cm), washed, dried and then arranged into the constructed wetland as designed. - *Step 3: Planting:* Choose the plant is Dracaena Sanderiana/Lucky Bamboo. This species is well adapted to both wetland and terrestrial environments [4]. In addition, the tree is also commonly grown as ornamental plants with meant to bring luck, fortune to the family *[4]*. The tree is about 15-30 cm high, roots about 10-15 cm in length, leaves of old leaves and pests, washed soil root and planted below the bed of gravel about 5 cm deep. The plants are distributed evenly over the whole filter, the distance between the trees is 5-10 cm.

- *Step 4: Operating model.* The water from the aquarium is pumped into the wastewater tank and fed to the constructed wetland with Q = 1 l/h. Pump acted two times a day at time fed fish. The model was operated continuously in 30 days, from 21/4/2017 to 21/5/2017.

Sampling and analysis methods

After 10 days operated the model was stable, the plants took roots and produced new young leaves, that was time to sample and analyze to evaluate the efficiency of the system. Water samples were taken at the aquarium once a day in 20 days. Sampling method accordings to TCVN 5999:1999. Analytical parameters include pH, DO, TSS, NH_4^+-N. pH and DO is determined by pH Meter of Hanna model HI 98107 and DO meter of Cole-parmer USA. TSS and NH_4^+-N are determined according to TCVN 6625:2000 and TCVN 5988:1995 respectively.

RESULTS AND DISCUSIONS

The pH change of water in the aquarium

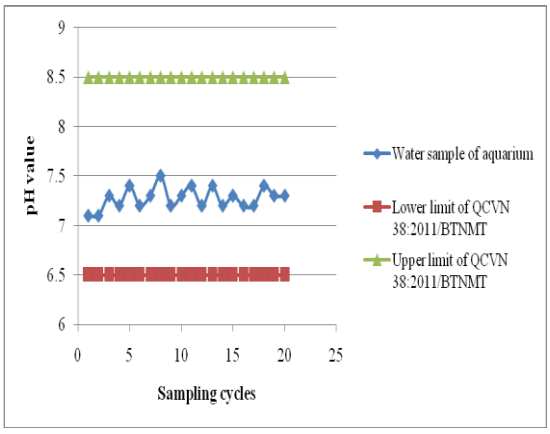

Figure 2. *pH values of water in the aquarium during the experiment*

pH of water in the aquarium during the experiment perior was stable and oscillated in a narrow band of 7.1 to 7.5 (Figure 2). This value range was within the limits of QCVN 38:2011/BTN&MT which has given the limits of pH for water quality for aquaculture

from 6.5 to 8.5. Thus, during the experiment the water in the aquarium is always maintained neutral pH, ensuring the environment for fish to grow well.

The DO (Disovled Oxygen) change of water in the aquarium

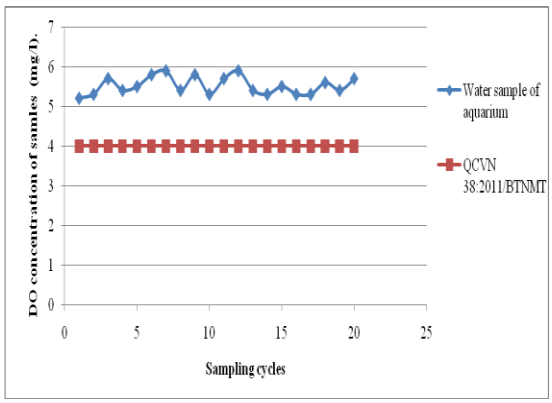

Figure 3. *The DO concentration of water in the aquarium during the experiment*

The dissolved oxygen content of water plays an important role in the survival of the fish, ensures that the process of fish respiration smoothly. According to QCVN 38:2011/BTN&MT, water quality standards ensure that aquatic life requires a DO content of more than 4 mg/l. The results showed that the DO content in the water of the aquarium was quite high, fluctuating between 5-6 mg/l (Figure 3). Thus, during the experiment the system always maintained the required oxygen content in the water for fish development.

The TSS (Total Suspended Solids) change of water in the aquarium

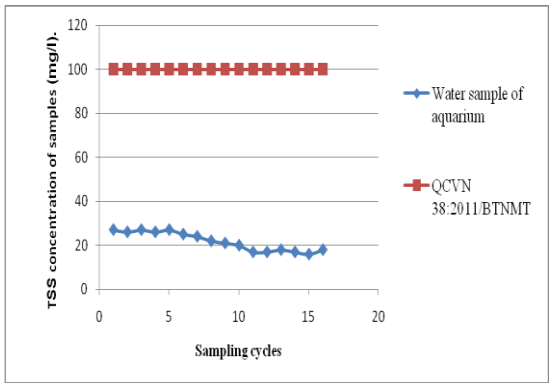

Figure 4. *The TSS concentration of water in the aquarium during the experiment*

TSS concentration in water shows the turbidity, the transparency of water. The higher the TSS content, the higher the turbidity. Turbidity affects on the aesthetics of the aquarium. It is a parameter for assessing the level of water pollution for suspended solids in aquariums. These substances are derived from fish waste and from sources eat excess when feeding fish. The results showed that the TSS concentration of water in the aquarium was rather stable and remained low <30 mg/l (Figure 4). This value is much lower than the limit of the TSS parameter in QCVN 38:2011/BTN&MT as 100 mg/l. This shows that constructed wetland have played an important part for maintaining the aquarium water achieved the necessary transparency level, not turbid, ensure the aesthetics as well as environmental conditions favorable for fish development.

The NH_4^+-N change of water in the aquarium

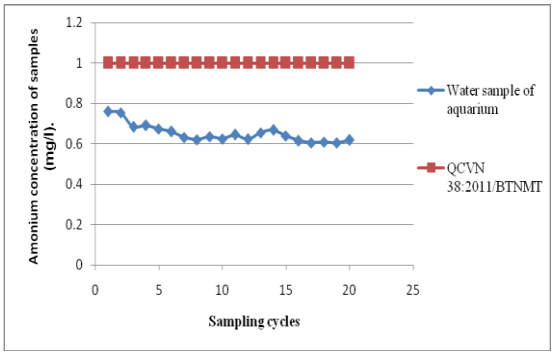

Figure 5. *The NH_4^+ - N concentration of water in the aquarium during the experiment.*

NH_4^+-N is a parameter that can make fish poisoned if the concentration is too high. The limit value of NH_4^+-N of QCVN 38:2011/BTN&MT is less than 1 mg/l. Experiment results show that the NH_4^+-N concentrationo in the aquarium water varies between 0.6-0.8 mg/l (Figure 5) and ensures a safety, non-toxic environment for fish. Thus, the constructed wetland has an important role in the treatment of NH_4^+-N in aquarium water and maintaining a safe environment for fish growth.

The development of fish and plants in the system

During the experiment tracking the growth of the fish shows that the fish is always healthy, swimming with no signs of illness. The weight of whole goldfish increased from 208 to 220 grams. Dracaena Sanderiana grew well, more young leaves and and new sprouts. This shows that the aquarium system and constructed wetland to filer water for aquariums are worked well and stable. Both fish and trees in the system are well adapted and developed.

CONCLUSION

Constructed wetlands recently have known as the effective technologies to treat wastewater in the world. This reseach used construted wetland to treat wastewater of outdoor aquarium. The result indicated that fish was always healthy. The weight of whole goldfish increased from 208 to 220 grams. Water in aquarium was maintained with good quality, reaching QCVN 38:2011/BTN&MT on water quality regulation to protect aquatic life. The values of pH, DO, TSS, NH_4^+-N of water in aquarium were 7.1-7.4; 5.2-5.9 mg/l; 16-27 mg/l; 0.61-0.76 mg/l respectively. Constructed wetland can be used to filter water for aquariums, especially outdoor aquariums with high efficiency, ensuring a safe water environment for fish to grow. The system operate simply, can complete automation, not cleaning, replacement of filter materials as often as water filter systems for aquariums existing on the market rencently.

REFERENCES

1. Xanthoulis, Leu Tho Bach, Tran Hieu Nhue, Tran Duc Ha, Wang Chengduan, Hans Brix (2009), *Low-cost wastewater treatment*, Hanoi Construction Publishing House

2. *http://www.thuysinhasin.com/tin-tuc-thuy-sinh/the-gioi-thuy-sinh/tong-hop-cac-loai-loc-ho-ca*.html. Date 3*0-07-2014.*

3. Christopher Somerville, Moti Cohen, Edoardo Pantanella, Austin Stankus, Alessandro Lovatelli (2014), *Small-scale aquaponic food production Integrated fish and plant farming*, FAO Fisheries and Aquaculture technical Paper 589.

4. Mohammad Javad Shakouri, Jafar mohammadi , Soodabeh Shahmohammadi and Safoora Asadi Kapourchal (2012), "*Assessing the effect of different levels of NAA and time on Dracaena sanderiana (lucky bamboo)"*, Indian Journal of Science and Technology, Vol. 5 No. 1, ISSN: 0974- 6846.

TÓM TẮT

NGHIÊN CỨU KHẢ NĂNG XỬ LÝ NƯỚC CHO BỂ NUÔI CÁ CẢNH NGOÀI TRỜI BẰNG CÔNG NGHỆ BÃI LỌC TRỒNG CÂY

Vi Thị Mai Hương*

Trường Đại học Kỹ thuật Công nghiệp – ĐH Thái Nguyên

Bài báo trình bày nghiên cứu về khả năng xử lý nước cho bể nuôi cá cảnh ngoài trời bằng công nghệ bãi lọc trồng cây. Mô hình thí nghiệm gồm 1 bể cá kích thước (0,7 x 0,3 x 0,4)m, 1 bãi lọc trồng cây kích thước (0,67 x 0,25 x 0,38)m, 1 bể chứa nước thải kích thước (0,4 x 0,2 x 0,33)m. Mô hình được vận hành trong 30 ngày. Bể cá thả 07 con cá vàng, lưu lượng nước vào bãi lọc 12 lít/ngày và thời gian nước lưu trong bãi lọc 1 ngày. Kết quả thí nghiệm cho thấy, cá luôn khỏe mạnh, nước trong bể cá được duy trì với chất lượng tốt, đạt QCVN 38:2011/BTN&MT về quy định chất lượng nước bảo vệ đời sống thủy sinh. Giá trị của các thông số pH, DO, TSS, NH_4^+-N trong nước bể cá dao động trong khoảng tương ứng là 7,1-7,4; 5,2-5,9 mg/l; 16-27 mg/l; 0,61-0,76 mg/l.

Từ khóa: *Nuôi cá cảnh, Xử lý nước bể cá cảnh, Bãi lọc trồng cây, Lọc nước bể cá cảnh, Bể nuôi cá cảnh ngoài trời*

Ngày nhận bài: 01/11/2017; Ngày phản biện: 16/11/2017; Ngày duyệt đăng: 05/01/2018

* *Tel: 0915 565955; Email: huonganhtn@gmail.com*