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TREATMENT OF DOMESTIC WASTE WATER BY USING ABR AND DUCKWEED POND

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ABSTRACT

Population growth and climatic instability are putting increasing pressure on water resources, and promoting increased interest in the treatment of domestic wastewater as an alternate source. Domestic wastewater is originating from showers, bath. Kitchen sinks and laundries. Grey water does not include toilet waste. Although it may contain a complex mixture of organic matter, suspended solids, bacteria and common household chemicals, when used judiciously and in a manner protective to public health and the environment domestic water can serve limited water supplies while advancing the environment. Treatment of domestic wastewater reserve special consideration because it is produced in large quantities. In this study the treatment of domestic wastewater was performed in a 15 L ABR as pretreatment and duckweed pond for post treatment can purify the water and this water can be used for agricultural purpose. The final treated domestic sewage characteristic was in compliance with the Egyptian standards for irrigation.

KEYWORDS-Anaerobic baffled reactor, anaerobic treatment, Egyptian standard, Duckweed

INTRODUCTION

Water is a compound made up of two parts hydrogen and one part oxygen. This is true, however, only for "pure" water. The water of our everyday lives contains many substances in addition to hydrogen and oxygen. These substances, since they are not found in "pure" water, may be considered impurities. In fact, the water that we drink every day contains many substances that can be considered impurities. Wastewater contains the impurities that were present when the water was obtained, and any impurities added through human uses. The term "sewage" is often used to refer to wastewater but is more properly applied to domestic (household) wastewater. Operators refer to the raw wastewater coming into a treatment plant as influent. The treated water is discharged from a wastewater treatment plant.

Wastewater is a term that is used to describe waste material that includes industrial liquid waste and sewage waste that is collected in towns and urban areas and treated at urban wastewater treatment plants (UWWTPs) as well as sewage that comes from single houses in the countryside that is treated on-site in either septic tanks or individual wastewater treatment systems (domestic waste water treatment systems - DWWTS).

Domestic sewage includes all wastewater generated by home dwellings, public restrooms, hotels, restaurants, motels, resorts, schools, places of worship, sports stadiums, hospitals and other health centres, apartments and the like. They all produce high volumes of wastewater.

Non sewage include water from floods (storm water), runoff (rain water running through cracks in the ground and into gutters), water from swimming pools, water from car garages and cleaning centres. They also include beauty salons, commercial kitchens, energy generation plants and so on. Wastewater is also generated from agricultural facilities. Water used for cleaning in animal farms, washing harvested produce and cleaning farm equipment.

TYPES OF WASTEWATER

BLACK WATER

This is wastewater that originates from toilet fixtures, dishwashers and food preparation sinks. It is made up of all the things that you can imagine going down the toilets, bath and sink drains. They include poop, urine, toilet paper and wipes; body cleaning liquids, anal cleansing water and so on. They are known to be highly contaminated with dissolved chemicals, particulate matter and is very pathogenic.

GREY WATER

This is wastewater that originates from non-toilet and food fixtures such as bathroom sinks, laundry machines, spas, bathtubs and so on. Technically it is sewage that does not contain poop or urine. Greywater is treated very differently from Blackwater and is usually suitable for re-use.The sludge in each compartment of the ABR was levelled up until the last sampler at the beginning of the study. The sludge profile in the reactor compartment was evaluated to determine the volatile solids that remained during the shutdown period. For microscopic analysis of fungi the samples were collected by composite sample from each sampler of the ABR. The corresponding sludge volume 5ml was collected sterile plastic bottles of 70ml. The aliquots were sent to the laboratory of agricultural research company, which were prepared for inoculation and cultivation. The same methodology of collection for fungi was applied to bacteriological test. The total alkalinity in the effluent is higher than the influent. The alkalinity generation is quite important in the digestion process since it allows the neutralisation of the volatile acid produced increasing the pH which favours methane production and stabilisation of the organic matter. It can be noted that the ABR has high efficiency in removing settleable solids and suspended solids. This fungus has a growth temperature between 25 to 30 degree and does not grow above 35 degree. In this study the average temperature of the liquid in reactor was 20 degree. The ABR was also effective in removing oil and grease and suspended solids.The primary treatment of wastewater is achieved in an ABR because of its huge potential in removing the pollutants. The main advantage is reducing the complexity in construction. Operation and maintanenance of high rate anaerobic reactor. The use of ABR as pretreatment has not yet been investigated. It can be concluded that there is high potential of using ABR as primary treatment. The ABR is very effective in the removal of organic parameters and could achieve. In anaerobic zone where substrate (BOD)5 concentration is high the absence of oxygen causes the microorganism to release the stored intraocular polyphosphates by decomposition to simple orthophosphates .

METHODOLOGY AND MATERIALS

An anaerobic baffled reactor (ABR) is an improved septic tank with a series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment. The majority of settleable solids are removed in the sedimentation chamber at the beginning of the ABR,

Which typically represents 50% of the total volume

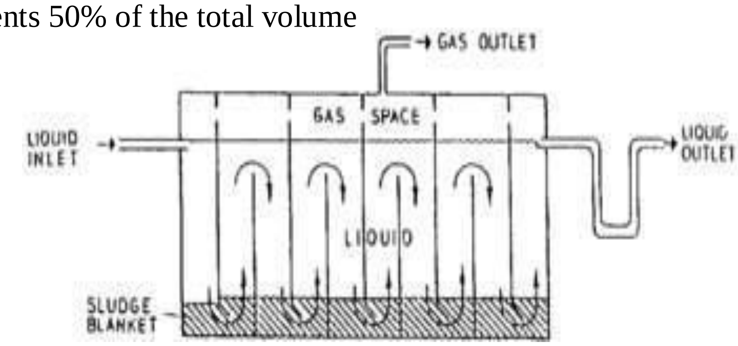


Figure 1: Anaerobic baffle reactor

The up-flow chambers provide additional removal and digestion of organic matter: BOD may be reduced by up to 90%, which is far superior to that of a conventional septic tank. As sludge is accumulating, desludging is required every 2 to 3 years. Critical design parameters include a hydraulic retention time (HRT) between 48 to 72 hours, up-flow velocity of the wastewater less than 0.6m/h and the number of up-flow chambers (2 to 3).

a. DESIGN CONSIDERATIONS

Centralized Treatment plants that combine the ABR with another technology for primary settling, or where prefabricated, modular units are used. Typical inflows range from 2 to 200 m3 per day. Critical design parameters include a hydraulic retention time (HRT) between 48 to 72 hours, upflow velocity of the wastewater below 0.6 m/h and the number of upflow chambers (3 to 6). The connection between the chambers can be designed either with vertical pipes or baffles. Accessibility to all chambers (through access ports) is necessary for maintenance. Usually, the biogas produced in an ABR through anaerobic digestion is not collected because of its insufficient amount. The tank should be vented to allow for controlled release of odorous and potentially harmful gases.

b. OPERATION & MAINTENANCE

An ABR requires a start-up period of several months to reach full treatment capacity since the slow growing anaerobic biomass first needs to be established in the reactor. To reduce start up time, the ABR can be inoculated with anaerobic bacteria, e.g., by adding fresh cow dung or Septic Tank sludge. The added stock of active bacteria can then multiply and adapt to the incoming wastewater. Because of the delicate ecology, care should be taken not to discharge harsh chemicals into the ABR.

Scum and sludge levels need to be monitored to ensure that the tank is functioning well. Process operation in general is not required, and maintenance is limited to the removal of accumulated sludge and scum every 1 to 3 years. This is best done using a motorized emptying and technology technology . The desludging frequency depends on the chosen pre-treatment steps, as well as on the design of the ABR. ABR tanks should be checked from time to time to ensure that they are water tight.

c. DUCKWEED POND

Duckweeds, or water lens, are flowering aquatic plants which float on or just beneath the surface of still or slow-moving bodies of fresh water and wetlands. Also known as "bayroot", they arose from within the arum or aroid family (araceae), so often are classified as the subfamily Lemnoideae within the Araceae. Classifications created prior to the end of the 20th century classify them as a separate family, Lemnaceae. These plants are very simple, lacking an obvious stem or leaves. The greater part of each plant is a small organized "thallus" or "frond" structures only a few cells thick, often with air pockets (aerenchyma) that allow it to float on or just under the water surface. Depending on the species, each plant may have no root or may have one or more simple Evolution of the duckweed inflorescence remains ambiguous due to the considerable evolutionary reduction of these plants from their earlier relatives. The flower of the duckweed genus wolffia is the smallest known, measuring merely 0.3 mm long. The fruit produced through this occasional sexual reproduction is a utricle, and a seed is produced in a sac containing air that facilitates flotation.

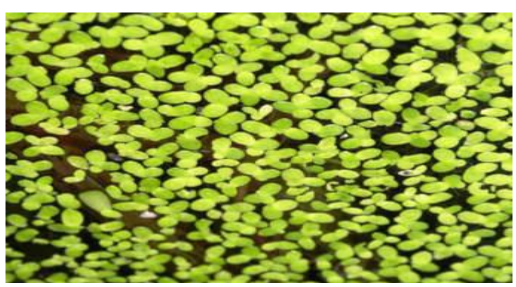


Figure 2: Duckweed pond

d. METHODOLOGY

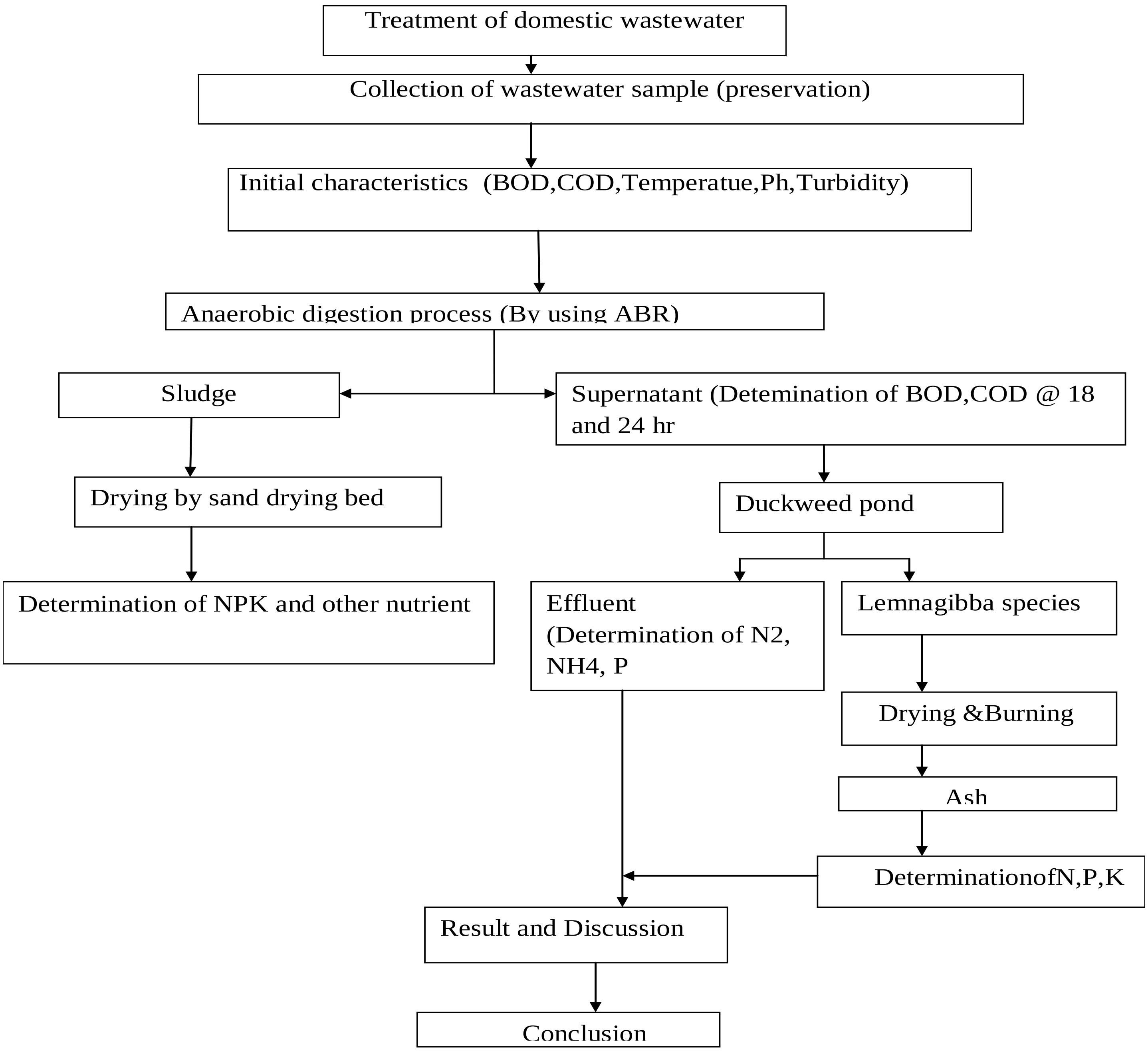
The methodology followed in this study comprises the sample collection that required to start the project work and to know about the details related with the collection of water sample before and after allowing the water to ABR and duckweed pond. The analysing the results to provide best conclusion.

1. **SAMPLE COLLECTION:**

The sample for testing is collected from our collage hostel. The domestic waste water is used as the sample. The required samples are collected at the time of testing using large bottles. The sample is collected from a place where the water is stagnant. After that rinsed the bottle which is going to collect the water sample. Then the test are conducted accordingly.

Figure 3: collection of sample

METHODOLOGY



2. INITIAL CHARACTERISTICS

The initial characteristics of water are to be tested. The initial characteristics which are to be tested are COD, BOD, temperature, PH and turbidity. Electrode method was used to analyse PH. Thermometer is used for measuring temperature. Turbidity is measured by using Nephlometric turbidity metric method

3. ANAEROBIC DIGECTION PROCESS

The ABR was made of Perspex material. It consisted of a serious of vertical baffles that divided in to five identical compartments. The sludge content was maintained at around 15g VSS/l flocculent sludge. The total liquid volume of the reactor is 15l. A schematic diagram of the ABR reactor is presented in fig. The reactor was fed continuously with domestic waste water. The ABR was operated at different hydraulic retention times (HRT), and hence different organic loading rates (OLR), in order to arrive at the optimum operating conditions of the ABR. After the treatment, sludge and supernatant collected separately. The sludge is passed through sand drying bed and finally determines the nutrient content in the sludge. Finally the sludge can be used as fertilizer for plant growth.

Figure 4. ABR reactor

4. SAND DRYING BED

The total depth of sand drying bed is 60cm. The drying bed consists of coarse gravel layers of 30cm height with 20mm size and fine aggregate 15cm in height and also 5 cm height. Fine sand layer which passes through 4.75mm sieve is laid at top. The sludge applied on the sand bed after treatment and is allowed to dry by evaporation and drainage of excess water over a period of two days. The dried sludge was taken out from the sand drying bed and was tested for finding the nutrient content.

5. DUCKWEED POND

A Perspex pond with length 30cm, breadth 19cm, depth19cm. Lemna gibba was chosen as the duckweed species in the study. The ABR effluent was fed to the duckweed pond. The duckweed pond was inoculated with lemnagibba, obtain from local drain at 600g fresh duckweed per$m2$. The duckweed biomass was harvested once a week. The thickness of the residual limna after harvesting was maintained at 600g/$m2$. The harvested biomass was drained, weighed, and dried in oven at 70°C and the dry matter content was calculated. The dry matter content was calculated. The dry matter was powdered in a tissue grinder, and 0.2g was used for organic N analysis. Then 0.1g from the powder taken and burned at 550°C for 1 h. the ash analyzed for phosphorus content.

Figure 5: Duckweed pond

III. RESULT AND DISCUSSION

The treatment of domestic wastewater was employed using ABR and the same water is used for agricultural purpose.

1.CHARACTERISTICS OF RAW WASTEWATER:

Monitoring of the domestic sewage during this study indicated that the characteristics of domestic wastewater in terms of biological oxygen demand (BOD), total nitrogen (TN), total phosphorus, turbidity, pH and temperature were measured. Raw domestic wastewater sample was collected from our college hostel and analysed for it various parameters. The various parameters are listed in the table given below:

SL.NO	PARAMETER	PREVAILING RANGE
1.	Temperature	28°*c*
2.	Ph	6.9 Mg/l
3.	Turbidity	120 NTU
4.	BOD	86 Mg/l
5.	Nitrogen	60 Mg/l
6.	Phosphorus	11.5 Mg/l

Table 1: Initial characteristics of domestic wastewater

REMARKS:

This water cannot be directly used for irrigation because its quality is very poor and some degree of treatment is essential to improve the quality and made fit for agricultural purpose.

2. PERFORMANCE OF THE ANAEROBIC BAFFLED REACTOR:

Anaerobic digestion is a mineralization process. Consequently, little removal of nitrogen and phosphorus can be expected. The phosphorus removal as being utilized for biomass growth and precipitated and entrapped with the digested sludge. The insignificant drop in the pH value in the compartments with increasing the OLR indicates the stability of the reactor. Results show a slight increase in the pH value in the first compartment with increasing the OLR and decreasing the HRT. The pH value in this compartment remain less than the corresponding values in all other compartments. Results achieved showed that the pH value in the third, fourth, and fifth compartments fall in the neutral zone. The amount of solids accumulated in each compartment during this study at the different HRT indicated that the sludge accumulation is directly proportional to the increase of OLR and decrease of the HRT. Compartment- wise, the sludge accumulation was found to be highest in the first compartment and least in the fifth compartment.

PARAMETER	18 HOURS	24 HOURS
Temperature	23.5°c	25.1°c
pH	7.3 Mg/l	7.1 Mg/l
Turbidity	95 NTU	56 NTU
BOD	65 Mg/l	52 Mg/l
Nitrogen	32.3 Mg/l	37.1 Mg/l
Phosphorus	7.8 Mg/l	6.2 Mg/l

Table 2 .characteristics of wastewater from ABR

3. PERFORMANCE OF THE DUCKWEED POND (DWP)

The nutrient- rich effluent from the ABR should be post- treated for removal of pathogenic bacteria and recovery of nutrients to produce an effluent suitable for irrigation. The duckweed pond working at 10 and 15 days HRT's. The duckweed pond was inoculated with Lemna gibba, obtained from local drain at 600g fresh duckweed per m². The results are shown in table. The achieved results indicated that the photosynthetic activity of the duckweed raises the pH from 7.1 in the ABR effluent to 8.4 in the DWP effluent. It can be seen that the treatment system looks practically feasible for domestic waste water treatment. Comparing the physico- chemical and biological quality of the treated waste water Egyptian standards that set out conditions and criteria and disposal of waste water by irrigation of agricultural land, the treated waste water could be used for restricted irrigation.

Parameters	Unit	Water from ABR	After 10 days in duckweed	After 15 days in duckweed
pH	Mg/l	7.1	7.9	8
EC	dSm^{-1}	5.51	3.34	1.3
Boren	Mg/l	5	3.9	2
Nitrogen	Mg/l	37.1	24	17.6
Phosphorous	Mg/l	6.2	4	2.7
BOD	Mg/l	52	51	28

Table 3. Performance of duckweed as post treatment

The above table indicates that the nutrients are absorbed by the duckweed which causes a deficiency in the nutrients. The water from the ABR has high nutrient content and it is not suitable for irrigation. By the growth of this duckweed the quality of water is improved and it suits to the agricultural standards.

4 .PREPARATION OF FERTILIZER:

The lemnagibba species has absorbed the nutrient content from water for their growth. After 15 days this plant is taken out from the duckweed pond and it is dried for some days and cooled in oven at $110°C$. Then 20 gram of the sample was taken out to find nitrogen and it is burnt to find the phosphorus content and the following results are obtained:

Sl.no	Sample name	N (%)	P (%)
1.	Manure	2.506	2.113

Table 4: Results of manure sample

The results shows that it suits for agriculture because nitrogen and phosphorous are the major constituents for the growth of plant and this water contains considerable amount of this constituents.

IV.SUMMARY

The wastewater treatment by using ABR at hydraulic retention time ranging from 8 and 24 hours gave satisfactory results. It also gives economic advantage. The ABR compartmentalized structure gave results higher than those produced by a two phase anaerobic digestion process. Duckweed ponds as post treatment operated at 10 and 15 days gave the best results where it was possible to remove nitrogen and phosphorus in the form of protein rich duckweed. The final treated domestic sewage was in compliance with the Egyptian standards for use in irrigation.

V. CONCLUSION:

The present study demonstrates the reuse and treatment of domestic waste water such as kitchen waste, bathing water, etc. After the treatment of waste water was used for irrigation, plant growths and gardening. The ABR compartmentalized structure have results higher than that produced by an one stage digester and similar to those produced by a two face anaerobic digestion The benefits used are low energy demand less operating and maintenance , high effective purification.

Hence this is an environmental friendly, cost effective and resourceful domestic water treatment for rural devolpment. The duckweed pond process was eco-friendly way to reduce the fecal coliform concentration of domestic waste water. This process has proved its superiority to other conventional methods of waste water treatment. The nutrient level will be reduced by the help of growing lemna gibba and its able to use as a irrigation water.

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