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Effect of sponge Density on septic tank effluent quality for dairy wastewater treatment

Samar Mohamed[1], Khaled Hassan[2] and Rehab Mohammed[3]
[1] PhD Student Faculty of Engineering, Shoubra, Banha University, Egypt.
[2] Associate Professor, Higher Institute of Engineering, El Shorouk Academy, Egypt
[3] Associate Professor, Faculty of engineering Shoubra, Banha University, Egypt.

Abstract：The aim of the study was to describe the modification of septic tank using different densities of sponge for treating dairy wastewater. The sponge used as a gravity filter media after conventional septic tank. The densities of sponge has a strong effect of total suspended solid (TSS), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) efficiencies which are achieved removal efficiencies 94.96%, 79.72%, 79.19% respectively.

1. Introduction

The dairy industry is one of the most polluting of industries, not only in terms of the volume of effluent generated as well as its characteristics. Dairy wastewaters are characterized by high biological-oxygen demand (BOD) and chemical oxygen demand (COD) concentrations. A wide range of high technologies is available for dairy industrial wastewater treatment such as activated sludge process aerated lagoons, trickling filters, **SEQUENTIAL BATCH REACTOR (SBR) SEEMS TO BE THE MOST PROMISING TECHNOLOGY FOR TREATMENT OF DAIRY WASTEWATER [1]**, anaerobic sludge blanket reactor, anaerobic filters, etc. Management of industrial wastewater by using conventional high treatment technologies consumes high energy during operation. In additional, the conventional treatment systems require regular maintenance and skilled labor for their operation which are normally not available in such remote areas. Shortage of financial. Resources is a big challenge facing the owners to meet the limits of Egyptian environmental law.

Filtration is considered the keystone of water and wastewater treatment. The filter media, such as cotton, wool, linen, glass fiber, porous carbon, metals, and rayons, can be categorized by their construction materials. New polymeric technologies have been used for the treatment of water and wastewater [2].

2.Research Significance and Previous Work

The three main options for the dairy industry are [3]:

(a) Discharge and subsequent treatment of wastewater from a nearby wastewater treatment plant.
(b) Removal of semi - solid and special waste from the site by using waste disposal contractors.
(c) Treatment of wastewater from a wastewater treatment plant on site.

The first two options are continually impacted by rising costs, while controlling the permissible levels of suspended solids (SS), BOD, and COD in discharged wastewaters is also becoming stricter. As a result, the third option for industrial waste treatment on site must be considered by an increasing number of dairy industries. However, it should be remembered that the treatment chosen should meet the requirements and reduce the costs associated with the long - term discharge of industrial wastewater [4].

The up flow anaerobic fixed-bed reactor for digestion of dairy industry effluent using polypropylene pall rings as a packing media pointed out that the average efficiency of COD

removal is 87% and maximum biogas production of 9.8 l/d was reached [5].

A septic tank is a key component of the septic system, a small-scale sewage treatment system common in areas with no connection to main sewage pipes provided by local governments or private corporations. Other components, typically mandated and/or restricted by local governments, optionally include pumps, alarms, sand filters, and clarified liquid effluent disposal means such as a septic drain field, ponds, natural stone fiber filter plants or peat moss beds. [6]**.** The Solar Septic Tank (SST) is a novel septic tank design that uses passive heat from the sun to raise in-tank temperatures and improves solids degradation [7].

Membrane filtration is widely used in the dairy industry. Applications of membrane filtration in milk processing are then discussed, including on-farm concentration of milk, removal of microorganisms, and fractionation of protein and fat [8].

The effect of sponge pore size (SPS) in a down flow hanging sponge reactor were evaluated in terms of removing organic and substances from anaerobic reactor effluent for the treatment of domestic wastewater [9].

The efficiency of domestic wastewater treatment via sponge – based moving bed biofilm reactor (S – MBBR), suspended solid (SS), Total Nitrogen (TN) and total phosphors (TP) were found to be 85 %, 85.7 % and 68.9 % where the treatment plan uses polyurethane sponge. [10].

3.Methodology

The pilot plant operation aims at determining the main process operation and design criteria. During the investigation period several runs were conducted as mentioned following table. Dairy wastewater will be filtered using different media of sponge placed in the modified section, where the suspended solids detained on the surface of the filter and some characters were examined BOD, COD, total suspended solids (T.S.S) and power of hydrogen (pH) to study the unit efficiency for dairy wastewater treatment.

The samples were collected from three different locations to evaluate the efficiency of the modified septic tank pilot plant as following:-

- Raw wastewater before septic tank
- After conventional septic tank
- After sponge filter

The pilot plant is made of Galvanized Steel tank. It is a rectangular tank with two modified compartments with different outlets configuration simulating two parallel septic tank as following:-

1- Conventional septic tank.
2- Conventional septic tank with second compartment for sponge filter.

Fig (1) Pilot unit of study

1. Holding Tank
2. Mixer
3. Tank influent
4. Septic tank
5. Modified compartment
6. Tank Effluent

Table (1) pilot scale sponge runs

Action	Run no.	Type of material	Operation period		Remarks
			from	To	
Filtration action	(1)	Industrial sponge	11/2/2019	3/3/2019	density 33 gm/cm^3
	(2)		17/3/2019	4/4/2019	density 25 gm/cm^3
	(3)		8/4/2019	21/4/2019	density 20 gm/cm^3
	(4)	Conventional septic tank	11/2/2019	21/4/2019	

4.Experimental Results and discussion

Sponge runs divided to three runs for filtration action. The removal efficiencies of these runs and the efficiency of conventional septic tank in each run are shown below

4-1 Removal efficiencies of run (1)

This run was applied with flow rate 9 lit/hr/m2 for 20 day of operation for filtration action with one plain layer of filter media (sponge) density 33 gm/cm3 and conventional septic tank. Data has been recorded and repeated every two days. Two samples were taken in each time.

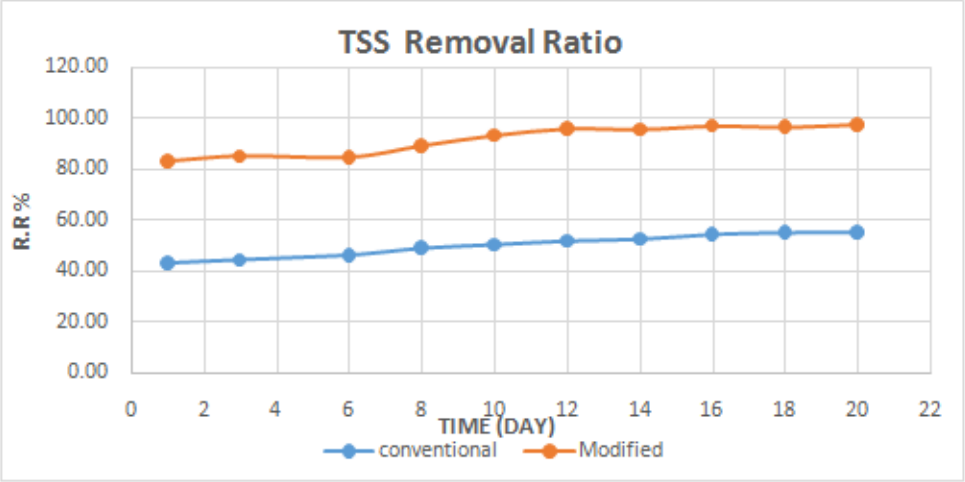

Fig (2) TSS removal ratio of run (1)

The figure (2) shows that filtration action give the highest removal ratio 97.77% which is higher than TSS removal ratio of septic tank by 42.17% after 20 days.

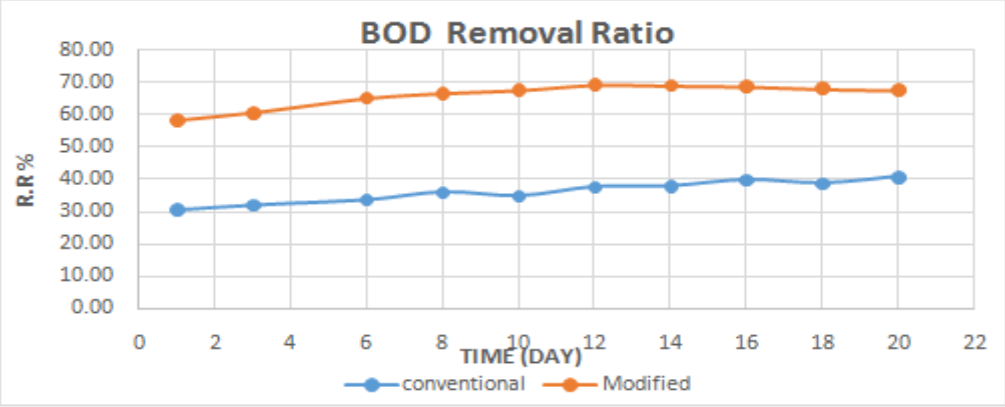

Fig (3) BOD removal ratio of run (1)

The figure (3) shows that filtration action give the highest removal ratio 68.64 % which is higher than BOD removal ratio of septic tank by 28.9%.

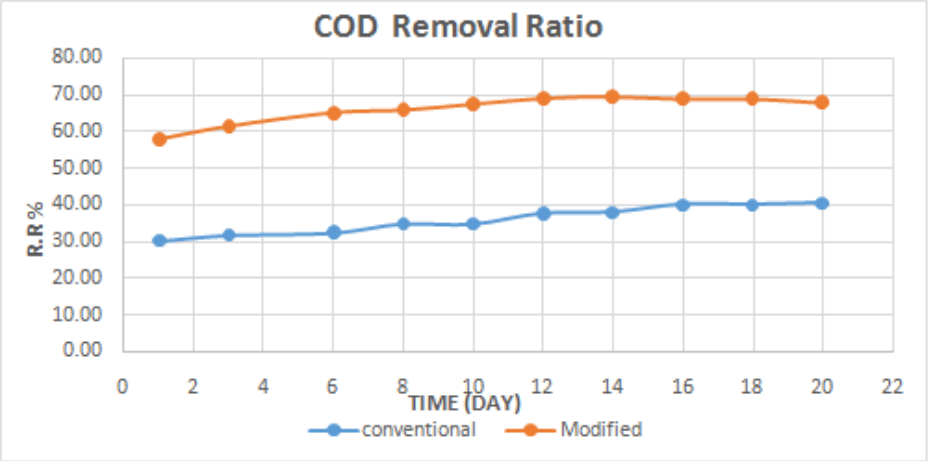

Fig (4) COD removal ratio of run (1)

The figure (4) show that filtration action give the highest removal ratio 69.37 % which is higher than COD removal ratio of septic tank by 29.32%.

4-2 Removal efficiencies of run (2)

This run was applied with flow rate 9 lit/hr/m^2 for 18 day of operation for filtration action with one plain layer of filter media (sponge) density 25 gm/cm^3 and conventional septic tank. Data has been recorded and repeated every two days. Two samples were taken in each time

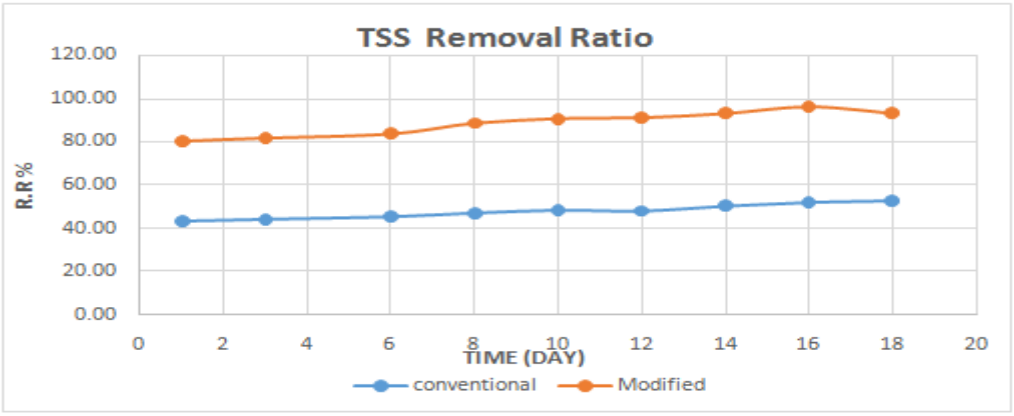

Fig (5) TSS removal ratio of run (2)

The figure (5) shows that filtration action give the highest removal ratio 95.98% which is higher than TSS removal ratio of septic tank by 43.38 after 18 days.

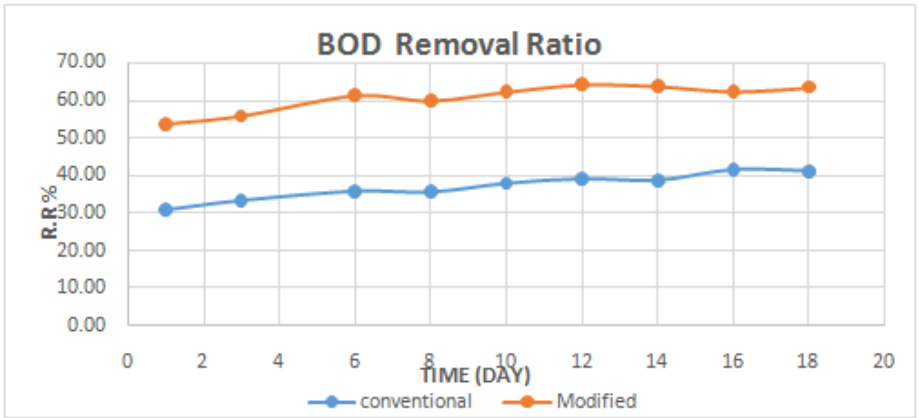

Fig (6) BOD removal ratio of run (2)

The figure(6) shows that filtration action give the highest removal ratio 64.18 % which is higher than BOD removal ratio of septic tank by 22.71%.

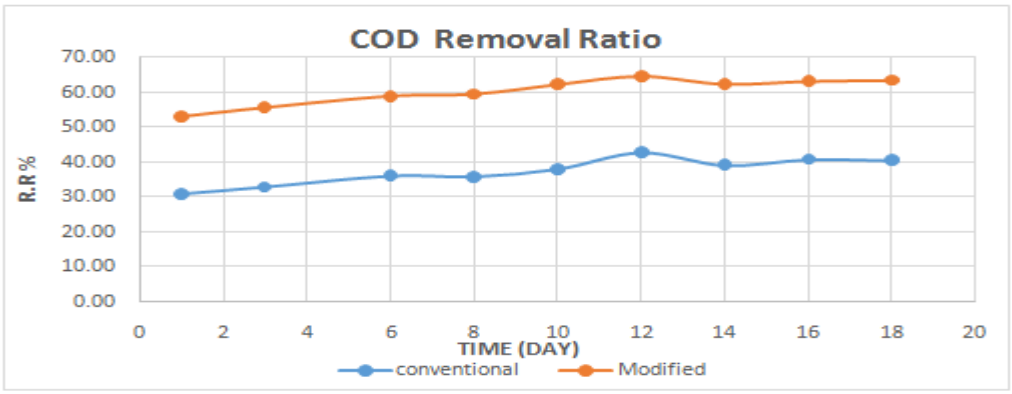

Fig (7) COD removal ratio of run (2)

The figure(7) shows that filtration action give the highest removal ratio 64.80 % which is higher than COD removal ratio of septic tank by 21.93%.

4-3 Removal efficiencies of run (3)

This run was applied with flow rate 9 lit/hr/m^2 for 12 day of operation for filtration action with one plain layer of filter media (sponge) density 20 gm/cm^3 and conventional septic tank. Data has been recorded and repeated every two days. Two samples were taken in each time.

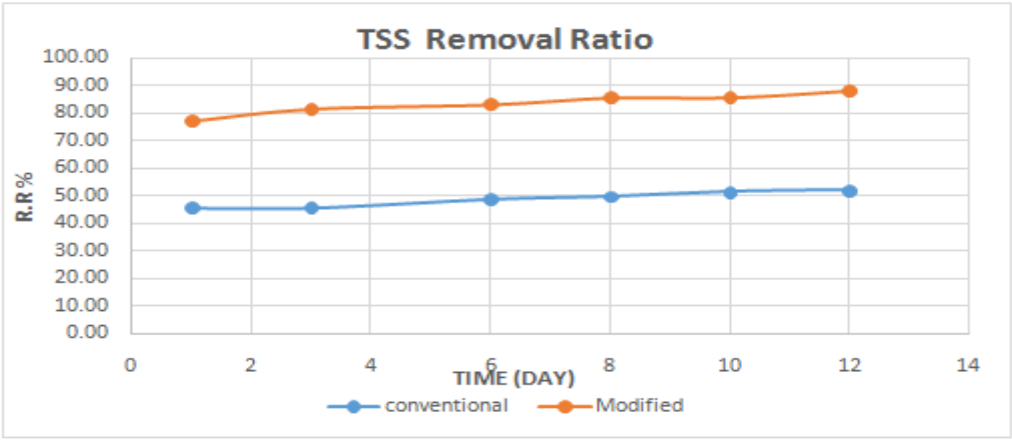

Fig (8) TSS removal ratio of run (3)

The figure(8) shows that filtration action give the highest removal ratio 87.95% which is higher than TSS removal ratio of septic tank by 36.04% after 12 days.

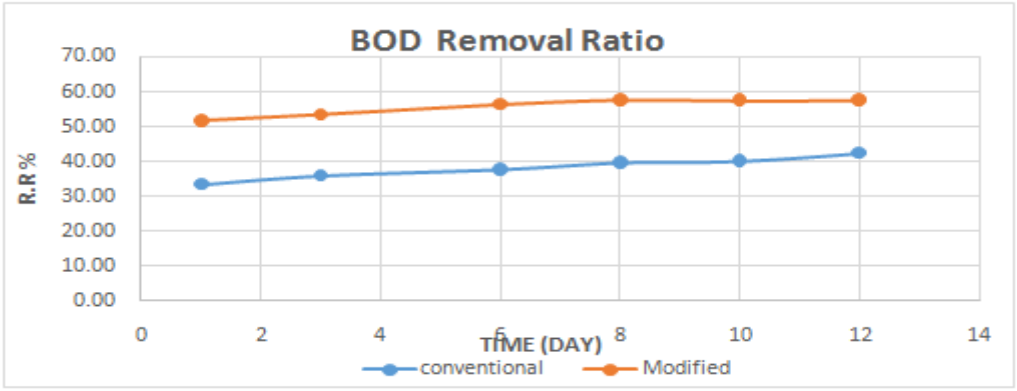

Fig (9) BOD removal ratio of run (3)

The figure(9) shows that filtration action give the highest removal ratio 57.72 % which is higher than BOD removal ratio of septic tank by 17.22%.

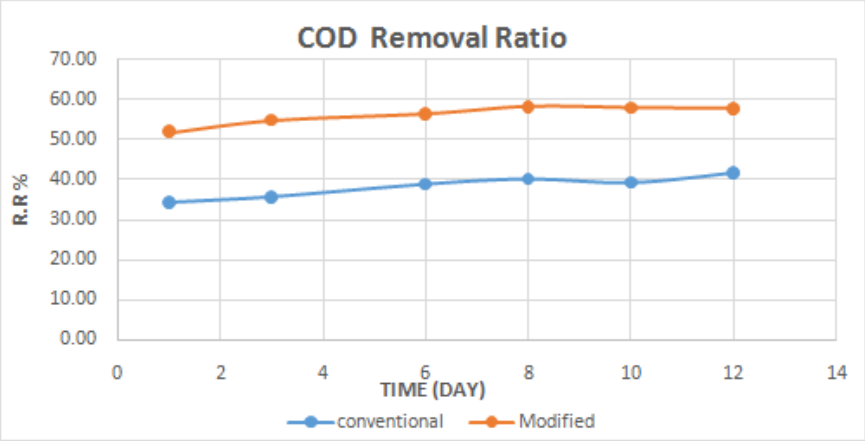

Fig (10) COD removal ratio of run (3)

The figure(10) shows that filtration action give the highest removal ratio 57.92 % which is higher than COD removal ratio of septic tank by 16.07%.

5. Conclusions

The main target of this study is to ensure, discuss and evaluate the durability of a proposed new technique of septic tank to improve it effluent quality. This technique was proposed to meet the characteristics of industrial wastewater and also for its low capital cost.

1- Using sponge with density 33 gm/cm^3 achieve removal efficiencies 97.77%, 68.64% and 96.37% of TSS, BOD and COD respectively.
2- Using sponge with density 25 gm/cm^3 achieve removal efficiencies 95.98%, 64.18% and 64.80% of TSS, BOD and COD respectively.
3- Using sponge with density 20 gm/cm^3 achieve removal efficiencies 87.95%, 57.72% and 57.92% of TSS, BOD and COD respectively.

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