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Improving Wastewater Effluent of Septic Tank Using Filtration Membranes

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Abstract- Septic tank one of the on-site systems are commonly used in rural areas, which has a suitable efficiency in sewage treatment. The simplicity of its operation and the low cost of construction and the ease of maintenance rise the depending on the septic tanks in rural areas. One of septic tank disadvantages is low removal efficiency.

This study used simple modification of septic tank using filtration membranes of different fabrics such as (cotton, nonwoven polyester, non-woven polypropylene geo-textile 300gm, non- woven polypropylene geo-textile 800 gm. and filter labbad).

Study results show that using cotton and non-woven polypropylene geo-textile 800gm improve the removal efficiency of septic tank to (96 % - 97 %) for TSS & 87 % for BOD & (72% - & 75%) for COD.

Keywords- *Wastewater Treatment, Low Cost Treatment Systems, Septic Tanks Development, Use of Fabric Filters*

I. INTRODUCTION

In Egypt, the water sector suffers from scarcity as well as deterioration of water quality due to the disposal of untreated municipal wastewater into surface water especially in rural areas. This dilemma makes developing new affordable and appropriate technologies for municipal wastewater treatment are need [1].

This perspective, one technology that could deliver similar effluent quality of the secondary treatment of wastewater in terms of TSS, BOD and COD removal compared to the conventional wastewater treatment plants is the modified septic tank system, which is also able to do so at a much lower cost.

In rural areas about 95% of the wastewater produced from each household of these villages is collected in united septic tanks, where a small fraction of SS organic matters is removed.

Through settling and liquid stream containing a significant quantity of biodegradable organic matters is disposed into the subsurface soil.

The selection of the most appropriate wastewater treatment technology is usually uncertain and complex since many alternatives are available and many criteria such as investment costs, energy consumption, odours, etc. are involved in the decision-making process In most rural areas, there is a tremendous demand to develop reliable domestic wastewater treatment technologies which must fulfil many requirements, such as simple design, use of non-sophisticated equipment, high treatment efficiency, low operating and capital costs. Wastewater treatment processes that can achieve an effluent standard at minimal cost are generally preferred especially in counties have a shortage in water and energy crisis. Energy cost becomes year by year a hard-difficult issue for the municipalities putting major economic barriers to their sustainability and to supply quality services to their citizens. It has been estimated that over 20% of the total energy spending by the municipalities is for the operation of the wastewater treatment plants [2].

However, as mentioned before, one of the best alternative technologies in rural areas is the modified septic tank. The advantages of septic tank are low construction, operation and maintenance cost with small occupied area with comparable to aerobic treatment. Also it produces a good source of energy in the form of methane gas especially when treating highly concentrated wastewater. These gases can be used to produce electricity.

Septic tanks are most appropriate in low- to medium-density urban areas. Septic tanks with on-site disposal of their effluent or off-site disposal by settled sewerage are normally less expensive than conventional sewage. So serving middle and upper income areas with septic tanks leaves (or should leave) more resources available to serve low-income areas.

A septic tank generally consists of a concrete or plastic tank (or sometimes more than one tank) of between 4000 and 7500 liters (1,000 and 2,000 gallons) connected to an inlet wastewater pipe at one end and a septic drain field at the other. In general, these pipe connections are made via a T pipe, which allows liquid to enter and exit without disturbing any crust on the surface. Today, the design of the tank usually incorporates two chambers (each equipped with a manhole cover), which are separated by means of a dividing wall that has openings located about midway between the floor and roof of the tank [3].

The purpose of the septic tank is to provide an environment for the first stage of treatment in onsite and decentralized wastewater systems by promoting physical settling, flotation, and the anaerobic digestion of sewage. Additionally, the tank allows storage of both digested and undigested solids until they are removed. So that that two main process in the septic tank are the physical processes followed by biological or/and chemical processes.

Physical processes: Septic tanks allow the separation of solids from wastewater as heavier solids settle and fats, greases, and lighter solids float. The solids content of the wastewater is reduced by 60-80% within the tank.

Biological and chemical processes: Septic tank solids include both biodegradable and non-biodegradable materials; although many of the solids will decompose, some solids will accumulate in the tank. Anaerobic and facultative biological processes in the oxygen-deficient environment of the tank provide partial digestion of some of the wastewater components [4].

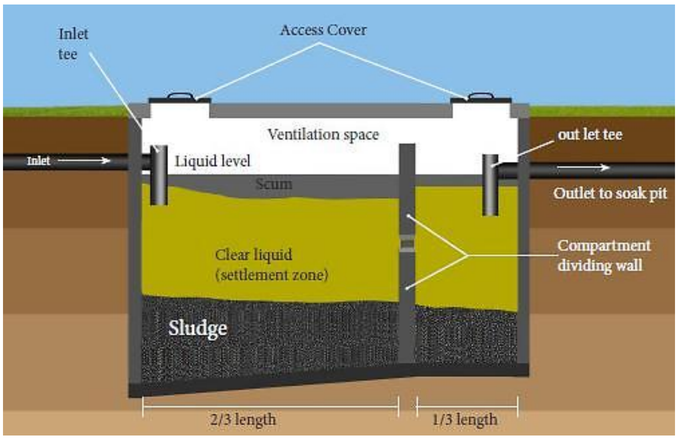

Figure 1. Typical septic tank

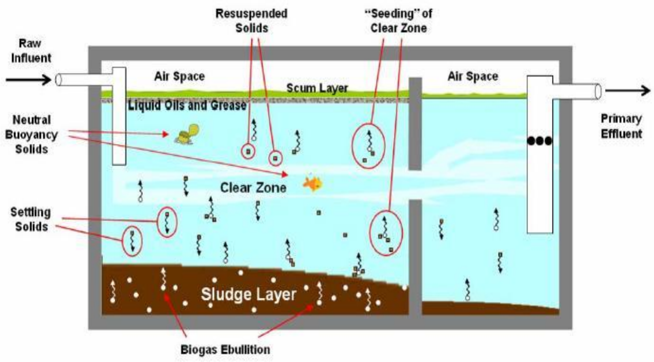

Figure 2. Septic tank processes

II. Research Significance and Previous Work

There are many septic tanks had simple modifications which were introduced into a conventional septic tank by building cross walls in order to improve its performance or filled the tank with crashed bricks to breakdown the soluble part of the influent BOD, The following applications describe the most popular applications of modified septic tank in world and Egypt.

In the thirtieth septic tank was used with two rooms in El Fayom villages by the government to raise the efficiency from 40% to 50% [5].

In the fiftieth and the beginning of the sixtieth septic tank was used with three rooms in El Tahrer administration and some areas of the new valley by the ministry of lands reclamation and the high dam to raise the efficiency to 55 % [5].

Septic tank followed by submerged gravel filter applied in three villages in Fayoum governorate by eng. Ebaid Fahiem through Care project for sanitation raised the efficiency to 70 % [6].

Septic Tank followed by gravity sand filter applied in El Kelh El Baharyia village in Edfo, Aswan made by El Nadi, M. H. for SFD project and raised the efficiency to 75% [7].

Septic Tank followed by gravel filter then gravity sand filter applied in Fayoum & Beni Sweif by Galal, A. S. infive villages for Care project for sanitation in rural areas and raised the efficiency to 75-80% [8].

Two chambers Septic Tank followed by upflow gravel filter by El Nadi, M. H. in two villages in Qena for SFD project raised the efficiency to 70 % [9].

Septic Tank followed by sand filter then cool filter by El Nadi, M. H., for SFD project in Sohag & Qena and aised the efficiency to 77-82% [10].

In the ninetieth and the beginning of the twenty one century septic tank was used with assistant rooms containing unsubmerged gravel (aerobic reaction) behind the tank increased the efficiency of tank to 75% in Sohag and Asuit villages at years 1995-2003. [5].

Using the unsubmerged plastic media (aerobic reaction) by el Nadi, M. H. behind the tank increased the efficiency of it to 80% in Aswan villages at year 2000 [11].

Using the gravel then crushed stone then sand as a physical filter behind the tank increased the efficiency to 75% in Aswan and Edfo villages at year 1999 [11].

Using simple modified septic tank divided to three compartments one for settling, second for submerged bio gravel filter & third for upflow bio plastic filter by El Sergany, F.A.G.R, El Hosseiny, O.M. Improve the removal efficiency of the septic tank from 50% for BOD & 60% for TSS to become 83.66% for BOD & 86.91% for TSS [13].

III. MATERIALS & METHODS

The set up for the modified septic tank reactor was as follows:

1- Holding tank

2- mixer

3- Lab scale model of septic tank

The examined materials were cotton, nonwoven polyester, non-woven polypropylene geo-textile 300gm, non- woven polypropylene geo-textile 800 gm. and filter labbad. These materials were used for filtration in the bench scale reactor.

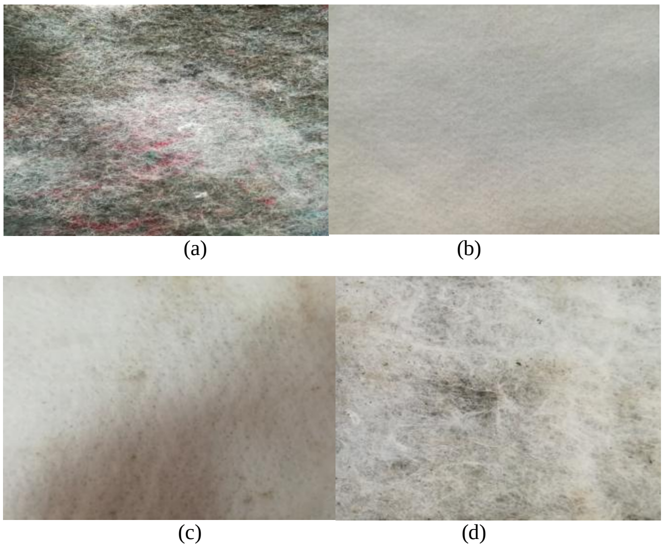

Figure 3. Examined materials (a) Filter labbad (b) Non-woven geo-textile 300 gm (c) Non-woven geo-textile 800 gm (d) Non-woven polyester

IV. INOCULATION AND START UP

The lab set up was properly saturated with real wastewater for maximum 72 hours. The wastewater was seeded to a holding tank and fed afterwards to the lab scale model of septic tank. In the start-up phase, a constant influent flow rate of 2.5 lit/d was fed into the system. This phase continued for 60 days. During this phase, pH, COD, BOD and TSS were analyzed in the influent and effluent of the reactor to follow up its stability.

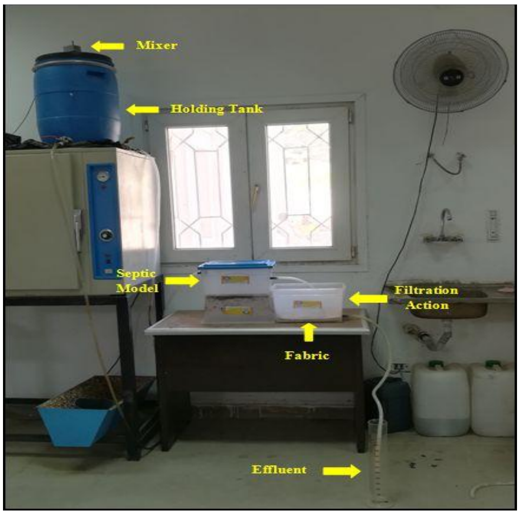

Figure 4. Lab scale model

V. EXPERIMENTAL RESULTS

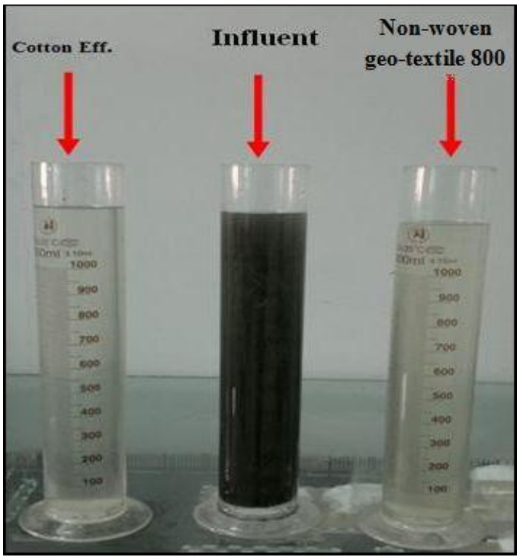

Figure 5. Wastewater effluent

The results of removal efficiency percent of used fabrics for TSS, BOD and COD where the PH value have no effect of removal efficiencies in gravity filter after 72 hrs. Are shown below:

TABLE I. REMOVAL EFFICIENCY OF GRAVITY FILTER

Fabric / Parameter	Non-Woven Polyester	Cotton	Filter lebbad	Non-woven polypropylene Geo-textile (300 gm)	Non-woven polypropylene Geo-textile (800 gm)
TSS	93.23 %	97.76 %	94.41 %	94.41 %	96.05 %
BOD	83.82 %	87.74 %	79.89 %	79.89 %	87.34 %
COD	72.18 %	75.59 %	69.30 %	69.30 %	72.92 %

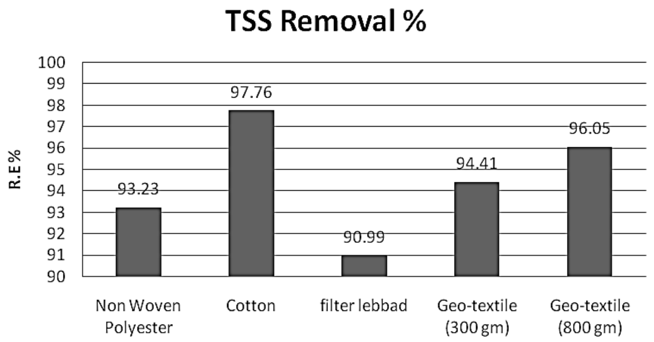

Figure 6. TSS Removal efficiency of Gravity filter

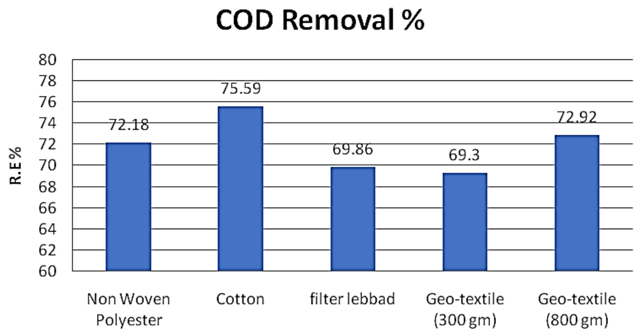

Figure 8. COD Removal efficiency of Gravity filter

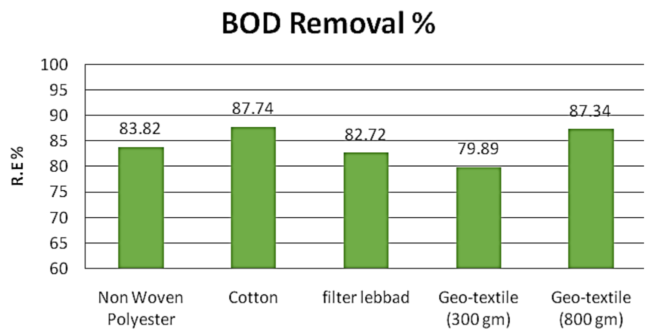

Figure 7. BOD Removal efficiency of Gravity filter

According to table (1) it can be seen that using of fabrics as a filter media after conventional septic tank improve the removal efficiency for TSS, BOD and COD. Cotton and non-woven polypropylene geo-textile 800 gm gives high removal efficiency than the other fabrics

In spite of the variation in removal efficiency of fabrics are in a small range. But according to table (2) cotton and non-woven polypropylene geo-textile 800 gm are low cost and more efficient than the other fabrics.

TABLE II. USED FABRICS COMPARISON

Type of Fabric	Source	Weight (gm/m2)	Thickness (mm)	Pore size (micron)	Permeability (m/sec)	Water flow capacity (L/hour/m2)	washing	Cost / m2 EP
Cotton	Locally manufactured	500	30	70	0.040	2.0	No	5.0
Non-woven polyester	Locally manufactured	160	10	100	0.085	3.0	Yes	6.0
Filter lebbad	Locally manufactured	200	8	95	0.100	3.0	No	7.0
Non-woven polypropylene (800gm)	Locally manufactured	800	15	80	0.030	5.0	Yes	12.0
Non-woven polypropylene (300gm)	Locally manufactured	300	6	80	0.060	2.0	Yes	9.0

VI. CONCLUSIONS

The study analyzed several wastewater samples as mentioned in the experimental work to identify the efficiency of used fabrics. Conclusions are drawn from the results carried out from the bench scale reactor. The results can be interpreted into the following points:-

1. The use of fabrics as a modification of septic tank enhancement of wastewater effluent.
2. Both Cotton and non-woven geo textile (800 gm) are more efficient than the other fabrics used in gravity filter.
3. Study results show that using cotton and non-woven polypropylene geo-textile 800gm improve the removal efficiency of septic tank to (96 % - 97 %) for TSS & 87 % for BOD & (72% - & 75%) for COD.
4. The system stability and easy operation and maintenance needs raise the possibility of its application in future.

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