Cairo University

INFLUENCE OF USING PACKING MATERIALS ON THE UASB PERFORMANCE

By

Eng./ Amr Mohamed Saad Abdelhamid Sorour

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Civil Engineering - Public Works

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At the end, I offer my regards and blessings to all of those who support me in any respect during the completion of the research.

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Abstract

A lot of researchers studied the main factors affecting the performance of using the Up flow Anaerobic Sludge Blanket (UASB) reactors for domestic wastewater treatment. The previous researches and experiments to investigate some parameters which affecting the treatment process using UASB reactors such as Hydraulic retention time, sludge blanket thickness, mode of operation (Continues and feed – feed less), feed less period and internal media inside the reactor.

This study investigate the influence of using pieces of sponge used as an internal media (packing materials) on the UASB performance in treating the municipal wastewater. The main purpose of using the internal media inside the reactor is to allocate large surface area for bacterial community growth.

Two parameters have been checked during the experimental work. The first parameter is the retention time and the second parameter is the sponge (packing material) thickness. Retention time for continues operation (6 hr., 8 hr. and 10 hr.) and Sponge thickness (20, 40 and 60cm).

A pilot scale setup was designed and constructed at Zenien wastewater treatment plant (Zenien WWTP) in Giza Governorate, Egypt. It was operated under ambient environmental conditions.

Increasing the backing material thickness gives better removal efficiency for the TSS and VSS, however, it gives worst removal efficiency for the COD and BOD.The optimum hydraulic retention time is 6 hrs for COD, BOD, TSS and VSS removal efficiencies and The optimum backing material thickness from 20 to 40 cm

Chapter 1: Introduction

1.1. General

In recent years there has been a growing interest in the anaerobic treatment of wastewaters. Compared to aerobic growth

Characteristics of anaerobic processes, such as low cost, operational simplicity, low biosolids production and considerable biogas production, together with suitable environmental conditions have contributed to highlight anaerobic systems for the treatment of sewage in small communities of tropical regions.

There are several anaerobic processes for the treatment of wastewater; one of these is the Up flow Anaerobic Sludge Blanket (UASB) reactor. This type of reactor may, in many cases, be the optimal solution for wastewater treatment in developing countries due to its simplicity and low cost. Moreover, this kind of treatment may be a very attractive alternative for wastewaters (industrial or/and municipal) containing high amounts of organic material in tropical countries, since the UASB reactor work better at high temperatures.

The previous researches and experiments, investigate some parameters which affecting the treatment process using UASB reactors such as Hydraulic retention time, sludge blanket thickness, mode of operation (Continues and feed – feed less), feed less period and internal media inside the reactor.

1.2. Purposes

A lot of researchers studied the main factors affecting the treatment process using UASB reactors for domestic wastewater treatment. The main target of this thesis is to study the effect of using packing materials on the UASB to improve the performance of existing systems and helping in the design of new facilities.

Due to the different parameters in the research we have to change each of them with fixing the others to reach the optimum so, we will fix the Thickness of sludge bed, average temperature, average PH, and change the other two parameters (Hydraulic retention time & the media (Sponge) thickness).

Experimental work was carried out in order to link the idea of using new packing material (Sponge) with the reality, In order to assess the performance of the treatment plants followed by the analysis's and recommendation

A compact shape pilot scale setup was designed and constructed at Zenien wastewater treatment plant (Zenien WWTP) in Giza Governorate, Egypt. It was operated under ambient environmental conditions

We have six chapters at this thesis concluded the research works (Introduction, Literature Review, Methodology, Practical Results, Analysis, Conclusion & recommendations)

Chapter 2: Literature Review

2.1. Introduction

Treatment process of waste water happen by removing all types of contaminants from the sewage

Treating the sewage can be conducted near to the sewage source by any local system such as (bio-filters, septic tank or by aerobic systems) otherwise it can be collected and drained by gravity lines and pumped through force main lines to the municipal sewage treatment plant.

There is an interest those days toward the wastewaters anaerobic treatment comparing to the aerobic treatment.

There are a lot of advantages when using the anaerobic systems at the sewage treatment for the small communities. Such as simplicity of the operational, low production of bio solids, and the general cost, also when we look environmentally the produced biogas will be considerable.

Up flow anaerobic sludge blanket (UASB) reactor is a popular anaerobic reactor for both high and low temperature (Dinsdale, et al., 1997).

2.2. Background

2.2.1. Waste water

To understand the meaning of waste water, we have to understand first the meaning of water, which is compound of two elements the first element is hydrogen and the second element is oxygen, our domestic water which we use every day includes a lot of substance added to the hydrogen and oxygen .

Sewage is always used to define the waste water, but it is mainly the domestic waste water (household wastewater). The wastewater flow which coming to the sewage treatment plant is defined as influent and the treated wastewater flow by the sewage treatment plant are defined as effluent.

So, to start the below section we have to define the below two terms:

Wastewater: each type of waste either domestic or industrial drainage, storm water drainage and clean water.

Source: is the location where the waste water generated

Both solids waste and liquids waste are produced from each community, the liquid waste is the domestic water which already used at the purpose and applications, (See Fig. 2-1) showing a wastewater management.

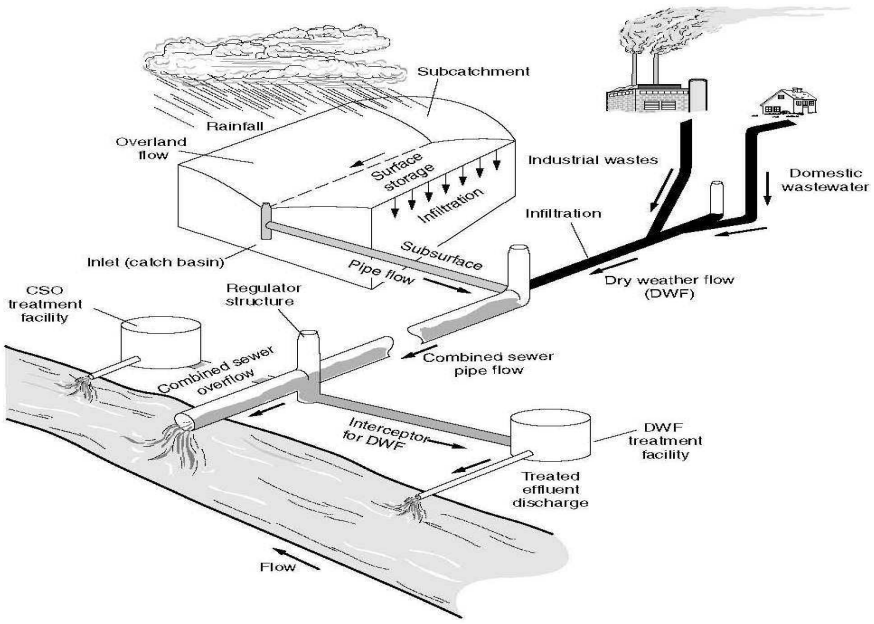

Figure 2.1: Schematic diagram of a wastewater management infrastructure

2.2.1.1. Sewage types as per sources.

There are many sources of wastewater, as it can be originating from homes, industries, surface and ground water.

The main reason of treating the wastewater is to avoid any problems due to the pollutions, at 2009 (CIDWT) defined the type of the wastewater as follow:

a. Black water: the wastewater generated from food preparation sinks, dishwasher and toilets.
b. Gray water: the waste water which not including food preparation sinks or toilets waste as it is need different system for treatment.
c. Yellow water: the waste water contains urine, which can be collected by some special fixtures, and it shall not be contaminated.

2.2.1.2. Characteristics of sewage types.

The quantity and strength of wastewater is governed by the size and socioeconomic status of the population of the community (Haskoning and Wageningen, 1994).

Characteristics of the municipal wastewater including industrial and domestic wastewater differ based on the place activity and the economic condition of the network users. Below are the main sewage characteristics

- Temperature
- pH
- Colour and Odour
- Solids
- Nitrogen and Phosphorus
- Chlorides
- Organic Material
  - Biochemical Oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)
- Toxic Metals and Compounds

2.3. Waste water treatment

Any development at the methods of wastewater treatment match directly with the main important points either the human health or the environmental requirements including the recent researches findings. Wastewater treatment researches become more relabel based on the characteristics of the wastewater, also the analyzing techniques.

It is very important to conduct a community dialogue to make sure that all health and environmental problems already addressed for better development.

2.3.1. History of waste water treatment.

From 20 years back biological nutrient removal (BNR), by nitrogen and phosphorus removal, it is considered as a developed process at the waste water treatment systems.

The natural systems commonly used for the land treatment, which is combined chemical, physical and biological treatment, the quality of the effluent water from this system, similar to the quality from the advance treatment systems.

New Concerns and Directions appears at the wastewater treatment, the changes which happen to the nature of the waste water, the new concerns of health and

environment, in addition to (the performance of treatment plant, infrastructure, disinfection of wastewater and odor control)

2.3.2. Waste water treatment stages. (Primary-Secondary- tertiary) treatment

The procedures utilized as a part of a present day wastewater treatment plant are intended to expel most of suspended material, including colloidal particles and settleable solids Not all treatment plants utilize similar units or treatment techniques in light of the fact that there are numerous approaches to achieve the treatment objectives. Treatment Plant Process Schematic, on the accompanying (Figure 2-2) demonstrates the normal treatment processes and their location in the treatment plants.

2.3.2.1. Preparatory treatment

Preliminary treatment stage contains Screening then Grit chambers after that the Skimming tanks. The Preliminary treatment stage main target is to separate the floating materials, such as (tree branches, dead animals, wood, paper, etc.) and furthermore the large settleable inorganic solids alongside oil and grease which obstruct effective sewage treatment and are undesirable toward the last product the bio solids.

Screening is the primary operation at sewage treatment plant and comprises in direct the sewage through the diverse sorts of screens, in order to trap and drive out the skimming materials. Then the second step is the grit chamber which is a channel, with wide cross section to reduce the velocity of the flow in order to force the suspended materials settle dawn by the gravity force. Skimming tanks are utilized for drive out grease and oil from sewage, including waxes, fats, fatty acids, soaps, etc. which came from restaurants kitchens.

2.3.2.2. Primary treatment

The second stage is the primary treatment which contains sedimentation and the floatation; these procedures are most likely one of the old water treatment techniques known at the current treatment plant. The Primary treatment is intended to expel solids which are not expelled at the preliminary treatment by using the sedimentation.

The effluents of the primary treatment include a lot of suspended organic material which have BOD at a high rate. Primary treatment considered as the first step of the biological treatment.

Sedimentation process is required to reduce the settleable and suspended material concentration, by using the Sedimentation tanks.