REUSE OF GRAYWATER FOR LANDSCAPE CULTURE

By

MAHMOUD KHALED MOHAMED
B.Sc. Agric. Sc. (Agric. Engineering), Ain Shams University, 2011.

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MAHMOUD KHALED MOHAMED

B.Sc. Agric. Sc. (Agric. Engineering), Ain Shams University, 2011.

This Thesis for M.Sc. degree has been approved by:

Dr. Hussein Ehsan El-Atfy **……..**
Prof. Emeritus of Water Resources Management,Arabic Water Council (AWC).

Dr. Mahmoud Mohamed Hegazy **……..**
Prof. Emeritus of Agricultural Engineering, Faculty of Agriculture, Ain Shams University.

Dr. Zeinab Hussein Mahmoud Behairy **……..**
Prof. Emeritus of Horticulture, Faculty of Agriculture, Ain Shams University.

Dr. Mohamed Nabil El Awady **……..**Prof. Emeritus of Agricultural Engineering, Faculty of Agriculture, Ain Shams University.

Date of Examination: / /2016

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MAHMOUD KHALED MOHAMED

B.Sc. Agric. Sc. (Agric. Engineering), Ain Shams University, 2011.

Under the supervision of:

Dr. Mohamed Nabil El Awady

Prof. Emeritus of Agricultural Engineering, Faculty of Agriculture, Ain Shams University (Principal supervisor)

Dr. Zeinab Hussein Mahmoud Behairy

Prof. Emeritus of Horticulture, Faculty of Agriculture, Ain Shams University.

Dr. Khaled Faran EL-Bagory

Prof. of Agricultural Engineering, Faculty of Agriculture, Ain Shams University

ABSTRACT

MahmoudKhaled Hassan: Reuse of gray water for landscape culture. Unpublished M.Sc. thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2017.

Wastewater whether municipal or industrial needs to be treated before they could be feasibly used. Treatment means that wastewater undergoes a group of physical, chemical and biological processes. This processing is essential for both public health and environmentalprotection.In this work a lab scale system of Rotating Biological Contactor (RBC) was used for treating gray water collecting from a household facility which diverts water from the bath, shower and hand basin of a residencelocated at El- Adl St. EL-Marg city (ش العدل، ضاحية المرج)، west of Cairo to be used in irrigating some ornamental plants i.e ***Epipremnum aureum*** and ***SyngoniumPodophyllum*** used in landscape culture. The RBC unit was modified with a provision to vary the speed (rpm) of rotating discs, Hydraulic Retention Time (HRT) and the disc surface area. The RBC unit had four different rotating speeds 2, 3, 4 and 5 rpm,six different hydraulic retention times 15, 30, 45, 60, 75, 90 min, and three different disc surface area 48×10^2, 64×10^2 and 80×10^2 cm^2. The results indicated that the rotational speed of 4 rpm yielded better percent removal of COD at 72.5%. Hydraulic retention time 90 min yielded better percent removal of COD at 74.28%. Disc surface areas of 80×10^2 cm^2 yielded better percent removal of COD at 76.47%.In addition Escherchia coli (E.coli) decreased from 4.2×10^3 CFU/100ml to be 3.8×10^2 CFU/100ml with removal efficiency 90.9%.Results also indicated a sharp decrease of the soil heavy metals (lead, copper and zinc) for treated gray water treatment. From the obtainedresults the amount of removed COD per unit volume of gray water (R)was affected with HRT (min) and Reynolds number (Re) where, Re is function with speed (V),amount of COD in raw gray water (C), flow rate (Q) and discs surface diameter (d)in a functional relationship.

$$\frac{R}{c} = f\left(Re, \frac{HRT \cdot Q}{d^3}\right).$$

After achieving the optimum conditions, a greenhouse experiment was set up to examine the effects of treated gray water irrigation in comparison with raw gray water and fresh water on the vegetative growth of potted ***Epipremnum aureum*** and ***Syngonium podophyllum***plants. These plants were cultivated in a medium consists of peat moss and sand (1:2).Results showed no significance was detected on all the growth measurementsconcerning the effect of treated gray water in comparison with the other two irrigation sources. However, the plants irrigated with raw gray waterdemonstrated best growth and good appearance (color and turgidity). It was noticeable also that the peat moss existed in the cultivated medium played a very good role for pollutants removal from the raw gray water.It was concluded that the Rotating Biological contactor (RBC) has a high performance in the removal of dissolved pollutants with less energy and it is more suitable for heavily polluted wastewater. Thus, it was recommended that raw gray wastewater must be analyzed before applying any treatment just to pick out the best and effective methodology suitable for the irrigation purpose.

Key words: Gray water – Rotating Biological Contactor (RBC) – COD – BOD – E. coli - ***Epipremnum aureum*** and ***Syngonium podophyllum***plants

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LIST OF ABBREVIATIONS

APHA	American Public Health Association
ASB	Anaerobic Sludge Blanket
BOD	Biological Oxygen Demand, mg/L
BMC	Billion Cubic Meter
C	amount of COD, g/m3
COD	Chemical Oxygen Demand, mg/L
CFU	Colony Forming Unit
Cu	Copper
CW	Constructed Wetland
D	Disc diameter, m
DC	Direct Current
DOC	Dissolved Organic Carbon
EC	Electrical Conductivity
E. coli	Escherichia Coli
GW	Gray Water
HLR	Hydraulic Load Ratio
HRT	Hydraulic Retention Time
LSD	Least Significant Difference
MBR	Membrane Bioreactor
MWRI	Ministry of Water Resources and Irrigation
NTU	Nemotroulas Turbidity Unit
Pd	Lead
Q	Flow rate, m3/sec.
R	Removal efficiency of COD .
RBC	Rotating Biological Contactor
Re	Reynold's number

RO	Reverse Osmosis
RVFCW	Recirculating Vertical Flow Constructed Wetland
RPM	Rotation per Minute
SAR	Sodium Adsorption Ratio
SCOD	Soluble Chemical Oxygen Demand
SMBR	Submerged Membrane Bioreactor
TDS	Total Dissolved Solid, mg/lit
TKN	Total Kjeldahl Nitrogen, mg/lit.
TSS	Total Suspended Solid, mg/lit
TP	Total Phosphorus
uSc/m	Microsiemens per meter
V	Linear velocity (m/sec.
Zn	Zinc
ρ	Density of gray water
μ	Dynamic viscosity

CONTENTS

	Page
LIST OF TABLES……	I
LIST OF FIGUERS ……	V
LIST OF ABBREVIATIONS ……	VIII
1. INTRODUCTION ……	1
2. REVIEW OF LITERATURE ……	4
2.1. Water resources of Egypt……	4
2.2. Graywater percentage in Egypt ……	5
2.3.Water scarcity in Egypt ……	6
2.4. Gray water definition ……	6
2.5. Gray water origin ……	7
2.6. Why use Gray water ……	7
2.7. Gray water characteristics ……	8
2.8. Gray water benefits ……	9
2.9. Reuse of graywater for irrigation ……	9
2.10. Gray water treatment technologies ……	11
2.10.1. Physical treatments ……	11
2.10.2. Chemical treatments ……	12
2.10.3. Biological treatments ……	14
2.10.3.1.Treatment by using Constructed wetland (CW) ……	14
2.10.3.2.Treatment by using Rotating Biological Contactors (RBCs)……	15
2.10.3.3.Factors affecting on RBC performance……	18
2.10.3.3.1 Hydraulic retention time (HRT) ……	18
2.10.3.3.2 Speed ……	20
2.10.3.3.3 Rotating discs surface area ……	22
3. MATERIALS AND METHODS ……	23
3.1. System setting up ……	23

	Page
3.2. Steps followed in the experiment……	23
3.3. Treatment steps ……	23
3.3.1. Raw graywater storage tank.……	24
3.3.2. Electrical motorpump ……	25
3.3.3. RBC basin……	25
3.3.3.1. Rotating discs……	26
3.3.3.2. Electrical drivemotor ……	27
3.3.4. Sedimentation stage ……	28
3.3.5. Sand filter treatment stage……	29
3.4. Sampling and analytical methods ……	30
3.4.1. Sampling ……	30
3.4.2. Analytical method ……	30
3.4.3. Physico-chemical analysis ……	30
3.4.4. Biological analysis……	30
3.5. Greenhouse experiment ……	31
4. RESULTS AND DISSCUTION ……	35
4.1. Raw and treated gray water quality for irrigation ……	35
4.1.1. PH ……	35
4.1.2. Total Suspended Solids (TSS) ……	36
4.1.3. Total Dissolved Solids (TDS) ……	36
4.1.4. Chemical Oxygen Demand (COD) ……	36
4.1.5. Biological Oxygen Demand (BOD5)……	36
4.1.6. Chemical nutrients……	36
4.1.7. Heavy metals (Lead, Copper, and Zinc)……	37
4.1.8. Microbiological parameter (E.coli) ……	37

Page

4.2. Factors affecting RBC performance…… 37

4.2.1. Effect of speed on COD removal …… 37

4.2.2. Effect of hydraulic retention time …… 40

4.2.3. Effect of surface area of rotating discs …… 41

4.2.4 Dimensionless groups …… 42

4.2.5. Effect of irrigation treatments on plant growth …… 43

4.2.5.1. Growth measurements for Epipremnumaureum …… 45

4.2.5.2. Growth measurements for Syngonium podophyllum.. 46

4.3. Effect of various irrigation treatments on soil heavy metals 47

5. SUMMARY AND CONCLUSION …… 48

6. REFRENCES…… 51

7. APPENDIX …… 56

ARABIC SUMMARY

LIST OF TABLES

Table No.		Page
1	General characterization of gray water……	9
2	Characteristics of effluents and average pollutants removal efficiencies of EC-SMBR process various SMBR process	14
3	Comparison of untreated and treated grey water at varies hydraulic retention times……	19
4	Raw and treated gray water analysis compared with FOA guidelines……	35
5	Different growth measurements for ***Epipremnum aureum*** plants, under the various irrigation treatments ……	45
6	Different growth measurements for ***Syngonium podophyllum*** plants, under the various irrigation treatments	46
7	Effect of irrigation treatments on soil heavy metals ……	47

LIST OF FIGURES

Figure No.		Page
1	Water resource of Egypt ……	4
2	Residential water use in Egypt ……	5
3	Approximate daily water use per person in Egypt 2010 ……	5
4	Per capita fresh water in different years ……	6
5	Crushed lava rock filter implemented at household level ……	11
6	Schematic diagram of the graywater treatment MBR	12
7	Experiment setup ……	13
8	Schematic diagram ofrecirculating vertical flow constructed wetlands (RVFCW) ……	15
9	Schematic experimental setup ……	17
10	General layout of the RBC model system ……	18
11	Setup of rotating biological contactor simulator ……	19
12	Schematic diagram of experiment setup (RBC-105 L. capacity ……	21
13	Schematicdiagram of system components ……	24
14	Gray water tank……	24
15	Electrical motor and power controller ……	25
16	RBC unit ……	25
17	Line drawing of RBC ……	26
18	Discs ……	27
19	Line drawing of discs ……	27
20	Sedimentation basin ……	28
21	Line drawing of sedimentation unit……	28
22	Sand filter ……	29
23	Line drawing of sand filter ……	29

Figure No.		Page
24	System components ……	29
25	*Epipremnum aureum* and *Syngonium podophyllum* planting ……	32
26	*Syngonium podophyllum* and *Epipremnum aureum* growth in greenhouse ……	33
27	*Syngonium podophyllum* irrigated with treated gray water……	33
28	*Epipremnum aureum* irrigated with treated gray water……	33
29	Flow chart describing key steps followed during the greenhouse study.……	34
30	Effect of speed (rpm) on COD removal ……	39
31	Relation between COD removal efficiency and Re…	40
32	Effect of hydraulic retention time on COD removal	41
33	Effect of discs surface area on COD removal……..	42
34	Removed COD as function of Re and $\frac{HRT \cdot Q}{d^3}$……	43
35	*Syngonium podophyllum* and *Epipremnum aureum* growth in greenhouse.……	45
36	*Syngonium podophyllum* irrigated with treated gray water ……...	46

INTRODUCTION

Water is continuously moved around in the hydrologic cycle. The distribution of water varies between locations,some have plenty of it while others have very little. What is common to all places, is that water is vital for life. Our bodies need at least two liters of water daily. We also need water for other purposes such as washing; cooking, cultivating etc. (**Harju 2010**).

Water is one of the most abundant resources covering about 70% of the earth's surface with total global water reserves of about 1.4 billion km^3, around 97.5% of it is in the oceans and the remaining 2.5% is fresh water. The greater portion of this fresh water is (68.7%) in the form of ice and permanent snow cover in the Antarctic, the Arctic, and in the mountainous regions. Next, 29.9% exists as fresh groundwater. Only 0.26% of the total amount of fresh waters on the Earth are concentrated in lakes, reservoirs and river systems where they are most easily accessible for our economic needs and absolutely vital for water ecosystems. (**Shatat*et al*., 2013**)

Egypt is located in a dry climate zone where rainfall is scarce and the desert covers most of the land. In addition to its fixed Nile quota and deep groundwater reservoir which is not renewable and the higher exploitation rate. The water shortage is the main constraint and a major limiting factor facing the implementation of the country's future economic development plans.

Furthermore, climate change is likely to affect water availability to Egypt, although the direction of change is uncertain (**UN Office 2008).**Some experts say that there will be water increase with more rainfall from the Ethiopian plateau and some say there will be a decrease because of water evaporation (**EL-Raey2009**).

The most prominent challenge is that Ethiopia is proceeding with the implementation of the Renaissance 'El Nahda' Dam that represents the greatest threat to Egypt's water security, in light of the available information on the Renaissance Dam which is located on the Blue Nile in western Ethiopia. **(El Bedawy 2014).**