Table of Content

Dedication I
Acknowledgement II
Abstract III
Table of content V
List of Tables VIII
List of Figures IX

1. chapter 1 :Introduction 1

1.1. Background 1
1.2. Objectives 3

2. chapter 2 :Literature review 5

2.1. Introduction 5
2.2. Present Status of Wastewater Management in Palestine 6

2.2.1. Urban and rural Sanitation 6
2.2.2. Urban and Rural Wastewater Characteristics 7
2.2.3. Wastewater Treatment Plants in West Bank 8

2.3. Wastewater Treatment 9
2.4. Wastewater Treatment systems 10

2.4.1. Conventional Wastewater Treatment 10
2.4.2. Anaerobic Treatment Systems 11

2.4.2.1. Overview of Anaerobic Digestion 11
2.4.2.2. Anaerobic Digestion Processes 12

2.4.2.2.1. Hydrolysis 12
2.4.2.2.2. Acidogenesis or fermentation 14
2.4.2.2.3. Syntrophic acetogenesis 14
2.4.2.2.4. Acetoclastic methanogenesis 16

2.5. Advantages and limitations of Anaerobic Treatment 17

2.5.1. Advantages 17
2.5.2. Limitations or Disadvantages 18

2.6. Upflow Anaerobic Sludge Blanket (UASB) reactor 18
2.7. UASB -septic tank system 19
2.8. Practical application of anaerobic treatment 21

2.8.1. Anaerobic treatment of domestic sewage under tropical condition 21
2.8.2. Anaerobic treatment of domestic sewage at low temperatures 21

2.9. Performance of Anaerobic Reactor 23

2.9.1. Role of SRT 23
2.9.2. Role of Temperature 25

2.10. Options for Post-Treatment of UASB Reactor Effluents 26

2.10.1. Mechanically Aerated Post-Treatment 28
2.10.2. Trickling Filter as post treatment 28
2.10.3. Low Energy Post-Treatment Technologies 29

2.11. Constructed Wetlands 29
2.12. Waste Stabilization Pond 30

2.12.1. Types of Waste Stabilization Pond 31

2.12.1.1. Anaerobic ponds 31
2.12.1.2. Facultative ponds 32
2.12.1.3. Maturation ponds 33

2.12.2. BOD Removal 34
2.12.3. Nutrients Removal 36

2.12.3.1. Nitrogen Removal 36
2.12.3.2. Phosphorus Removal 37

2.12.4. Environmental Impact of WSP System 38
2.12.5. Waste Stabilization Ponds for Post-Treatment 38

2.13. Aquatic Farming Systems 39

2.13.1. Duckweed Based Wastewater Treatment System 40
2.13.2. Duckweed production rates 41
2.13.3. Duckweed treatment/ farming systems 41
2.13.4. Aim of duckweed application in developing countries 42
2.13.5. Kind of waste can be treated by duckweed 42
2.13.6. External climatic and environmental factors limit duckweed application 42
2.13.7. Technical designing aspects for duckweed wastewater treatment ponds 42
2.13.8. Significant removal of BOD, TSS, nutrients, mosquitoes, odors 43
2.13.9. Primary Treatment of Raw Wastewater before treating by duckweed 43

2.14. Comparison between duckweed treatment systems and Waste Stabilization Ponds 45

3. chapter 3: Material and methods 47

3.1. The pilot (UASB-lagoon) system setup 47
3.2. System operation and monitoring 49
3.3. Sampling 50
3.4. Analysis 50

3.4.1. Chemical analysis 51
3.4.2. Physical analysis 51

3.5. Calculations 52

4. chapter 4: Results and discussion 53

4.1. Wastewater characterization 53
4.2. UASB septic tank results 55

4.2.1. Organic removal 56

4.2.1.1. Total COD removal 57
4.2.1.2. COD_{ss} removal 58
4.2.1.3. COD_{col} removal 58
4.2.1.4. COD_{dis} removal 59
4.2.1.5. BOD removal 59

4.2.2. Solids removal 60
4.2.3. Nutrient removal 61
4.2.4. Temperature and pH results 63

4.3. Ponds system results 64

4.3.1. Environmental conditions in ponds 64
4.3.2. Organic matter removal 66
4.3.3. Solids removal 68
4.3.4. Nutrients removal 70

4.3.4.1. Orthophosphate removal 70
4.3.4.2. Nitrogen removal 72

4.4. Comparisons 75

5. chapter 5 :Conclusions and Recommendations 78

5.1. conclusions 78
5.2. recommendations 79
References 80
All results obtained at HRT1 92
All results obtained at HRT2 96