

Table of Contents

List of Tables	IX
List of Figures	X
List of photos	XIII
List of abbreviation	XIV
Chapter 1 : Introduction	1
1.1 Background	1
1.2 Urban sanitation in Palestine	1
1.3 Existing sewerage system	2
1.4 Existing treatment plant	3
1.4.1 Publicaly owned treatment plant	3
1.4.2 Privately owned treatment plant	3
1.5 Wastewater characteristics	4
1.6 House on-site treatment of total sewage and night soil in a modified UASB septic tank	6
1.7 Objectives	6
1.8 Approach	7
Chapter 2: Lietrature review	8
2.1 General (Anaerobic treatment)	8
2.2 Advantages and disadvantages of anaerobic treatment	10
2.3 Treatment systems of domestic wastewater	11
2.3.1 Conventinal septic tank system.	11
2.3.2 UASB-septic tank system.	12
2.3.3 Upflow Anaerobic Sludge Blanket	12
2.3.3.1 Technical discription and design parameter of UASB reactors	13
2.3.4 Modified one stage UASB reactor	17
2.3.5 Hybrid reactors	20
2.3.5.1 Hybrid UASB/Attached growth reactor	20
2.3.5.2 Hybrid baffled plug flow/UASB reactor	20

2.4 Anaerobic removal and conversion of organic matter in domestic sewage	23
2.4.1 physical removal of organic matter in domestic sewage	23
2.4.1.1 removal of SS.	23
2.4.1.2 removal of colloidal particles	24
2.4.1.3 removal of dissolved matter	25
2.4.2 Anaerobic conversion of domestic sewage	25
2.4.2.1 Anaerobic conversion of particulate matter.	25
2.4.3 Theoretical calculation of biogas and methan production.	28
2.5 High rate Anaerobic systems	28
2.5.1 The UASB reactor	28
2.5.2 The AF reactor	29
2.5.2.1 General	29
2.5.2.2 Effect of characteristics of PM on reactor performance	29
2.6 Practical application of anaerobic treatment of domestic sewage	30
2.6.1 Anaerobic treatment of domestic sewage under tropical condition	30
2.6.2 Anerobic treatment of domestic sewage at low temperature	31
2.6.2.1 Use of granular seed sludge	32
2.6.2.2 Removing of SS prior to anaerobic treatment by settling or physical-chemical preatment	33
2.6.2.3 Applying high up-flow velocities	33
2.6.2.4 Treatment of raw domestic sewage in a two step anaerobic system	33
2.7 Anaerobic degradation equations	34
2.8 Biodegradability	35
Chapter 3: Material and Methods	36
3.1 Site description	36
3.2 UASB pilot plant experiments	37
3.3 Experimental setup (UASB septic tank)	37

Chapter 3: Results	
3.4 Inoculation	39
3.5 Start-up	39
3.6 Analysis	39
3.6.1 Chemical analysis	39
3.6.2 Physical analysis	40
3.7 Sampling	41
3.7.1 Types of samples	41
Chapter 4: Results and discussions	44
4.1 General	44
4.2 Wastewater Characteristics	44
4.3 Inoculation	44
4.4 Influent measurement	47
4.5 performance of reactor	44
4.5.1 COD values	48
4.5.2 BOD values	49
4.5.3 TSS values	49
4.5.4 VSS values	50
4.5.5 Total PO ₄ ⁻³ values	51
4.5.6 ortho- PO ₄ ⁻³ -P	52
4.5.7 NH ₄ ⁺ -N values	53
4.5.8 TKN values	53
4.5.9 pH values	54
4.5.10 Wastewater and weather temperatures	55
4.5.11 Color	56
4.5.12 Summary of results	57
4.6 Previous study: the Biofarma reactor (Indonesia)	58
4.6.1 Site discription	58
4.6.2 Influent measurments	58
4.6.3 Performance of reactor	59
4.6.3.1 Gas production	60

4.7 Comparison of results	60
4.8 Sludge Blanket of UASB (model)	62
4.8.1 General	62
4.8.2 Concentration of solids at different height	62
4.8.3 Physical model of an UASB-septic tank system	63
4.8.4 Biological model	64
4.8.5 model description	64
4.8.5.1 model input parameter	66
4.8.5.1.1 influent	66
4.8.5.1.2 physical parameter	67
4.8.5.1.3 Inoculum sludge	67
4.9 Calculation model for HRT from required SRT	67
Chapter 5: Conclusions and Recommendations	69
5.1 Conclusions	69
5.2 Recommendations	70
References	71
Annexes	79
Annex A: Tables	79
Annex B: Figures	90
Annex C: Photos	104