# Table of Contents

List of Tables .......................... IX  
List of Figures .......................... X  
List of photos .......................... XIII  
List of abbreviation .................. XIV  

## Chapter 1: Introduction

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 Publically 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 6  
  a modified UASB septic tank ...... 6  
1.7 Objectives .......................... 7  
1.8 Approach ........................... 7  

## Chapter 2: Literature review

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 Conventional 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 description 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

2.4.1 physical removal of organic matter in domestic sewage

2.4.1.1 removal of SS.

2.4.1.2 removal of colloidal particles

2.4.1.3 removal of dissolved matter

2.4.2 Anaerobic conversion of domestic sewage

2.4.2.1 Anaerobic conversion of particulate matter.

2.4.3 Theoretical calculation of biogas and methane production.

2.5 High rate Anaerobic systems

2.5.1 The UASB reactor

2.5.2 The AF reactor

2.5.2.1 General

2.5.2.2 Effect of characteristics of PM on reactor performance

2.6 Practical application of anaerobic treatment of domestic sewage

2.6.1 Anaerobic treatment of domestic sewage under tropical condition

2.6.2 Anaerobic treatment of domestic sewage at low temperature

2.6.2.1 Use of granular seed sludge

2.6.2.2 Removing of SS prior to anaerobic treatment by settling or physical-chemical pretreatment

2.6.2.3 Applying high up-flow velocities

2.6.2.4 Treatment of raw domestic sewage in a two step anaerobic system

2.7 Anaerobic degradation equations

2.8 Biodegradability

Chapter 3: Material and Methods

3.1 Site description

3.2 UASB pilot plant experiments

3.3 Experimental setup (UASB septic tank)
3.4 Inoculation
3.5 Start-up
3.6 Analysis
  3.6.1 Chemical analysis
  3.6.2 Physical analysis
3.7 Sampling
  3.7.1 Types of samples

Chapter 4: Results and discussions
4.1 General
4.2 Wastewater Characteristics
4.3 Inoculation
4.4 Influent measurement
4.5 performance of reactor
  4.5.1 COD values
  4.5.2 BOD values
  4.5.3 TSS values
  4.5.4 VSS values
  4.5.5 Total PO_{4}^{3-} values
  4.5.6 ortho- PO_{4}^{3-} -P
  4.5.7 NH_{4}^{+} -N values
  4.5.8 TKN values
  4.5.9 pH values
  4.5.10 Wastewater and weather temperatures
  4.5.11 Color
  4.5.12 Summary of results
4.6 Previous study: the Biofarma reactor (Indonesia)
  4.6.1 Site description
  4.6.2 Influent measurements
  4.6.3 Performance of reactor
    4.6.3.1 Gas production