

Biogas Production From Raw Palm Oil Mill Effluent Using A Pilot-Scale Anaerobic Hybrid Reactor

By

Chinnapong Wangnai, PhD.

**Pilot Plant Development and Training Institute (PDTI)
King Mongkut's University of Technology Thonburi (KMUTT)**

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Presentation Outline:

Introduction

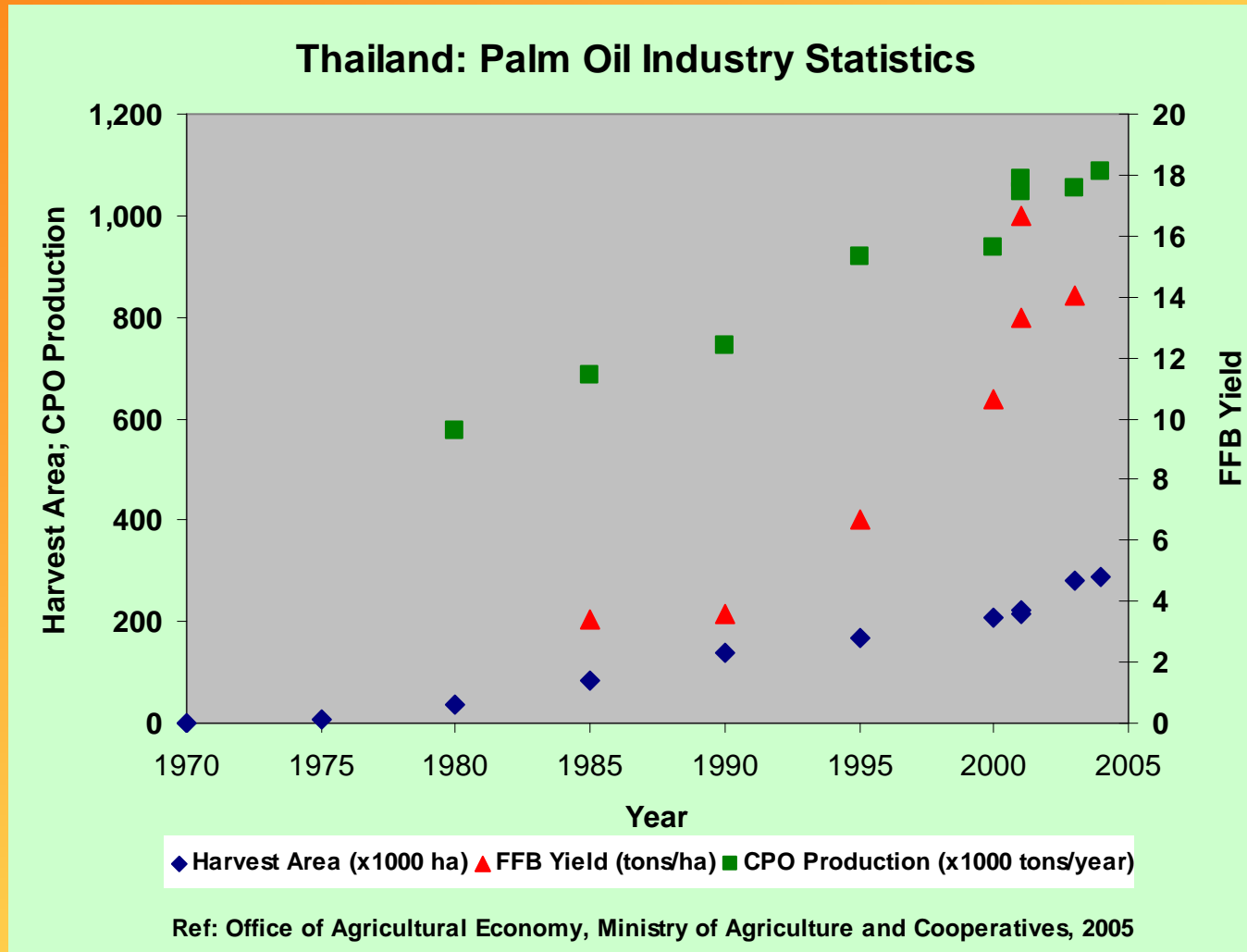
Objectives

Experiment Set-up

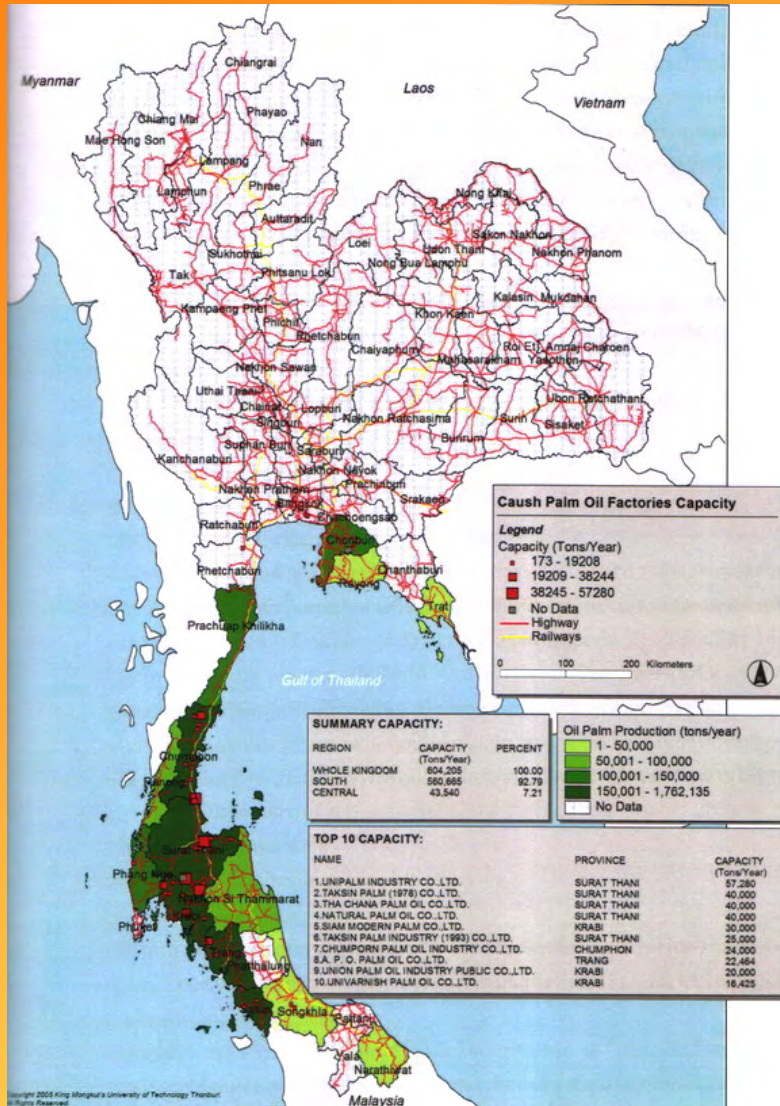
Results and Discussion

Conclusion

Introduction: Palm Oil Industry: Thailand



Introduction: Palm Oil Industry: Thailand



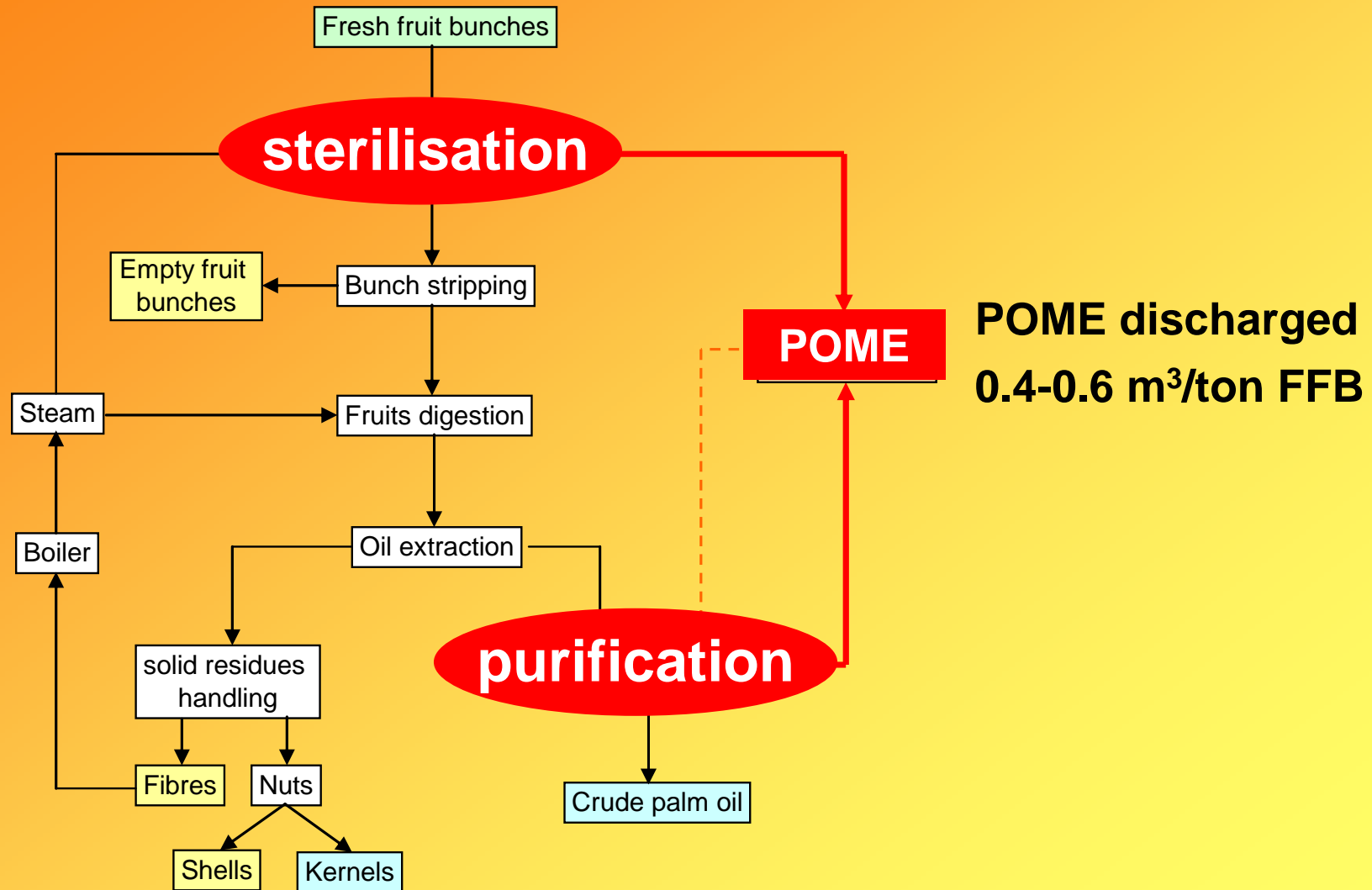
> 60 palm oil mills

Wet processing mill

High water consumption

High water discharged

Introduction: Palm Oil Mill Effluent (POME)



Introduction: Palm Oil Mill Effluent (POME)



Dark-brownish

Low pH

High COD&BOD

High SS

High O&G

High Temperature

Introduction: POME Treatment Systems

Anaerobic ponds/Opened pond system



Introduction: POME Treatment Systems

Anaerobic ponds/Opened pond system



Introduction: POME Treatment Systems

Closed anaerobic digester tank - CSTR



Introduction: **High-Rate Anaerobic Reactors**

Anaerobic contact reactor (AC)

Anaerobic Filter (AF)

Anaerobic Fixed-Film reactor (AFF)

Upflow Anaerobic Sludge Blanket (UASB)

Anaerobic Hybrid Reactor (AHR)

AFF + UASB

Research Motivation:

Practical wastewater treatment system:

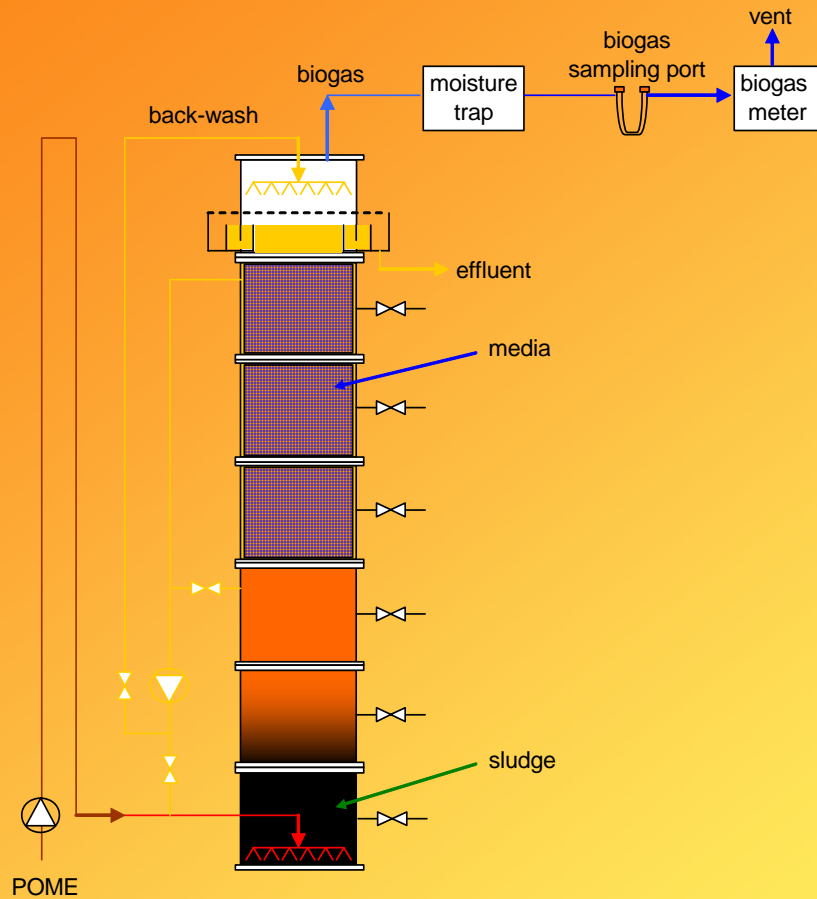
- Easy to operate and maintain
- No need of pre-treatment system
- Capable to convert high SS and O&G contents to biogas
 - ≥ 80% COD removal
 - ≥ 0.5 m³ biogas/kg COD_{removed}
- Low capital cost

Objectives:

To assess the feasibility of an AHR combining fixed-film and sludge bed reactors in treating raw POME: start-up

To evaluate the AHR efficiency in terms of COD reduction and biogas production

Experiment set-up: Pilot-scale AHR



Experiment set-up: **Pilot-scale AHR**



Coated-metal sheet tank

Total volume: 7 m³

Working volume: 6 m³

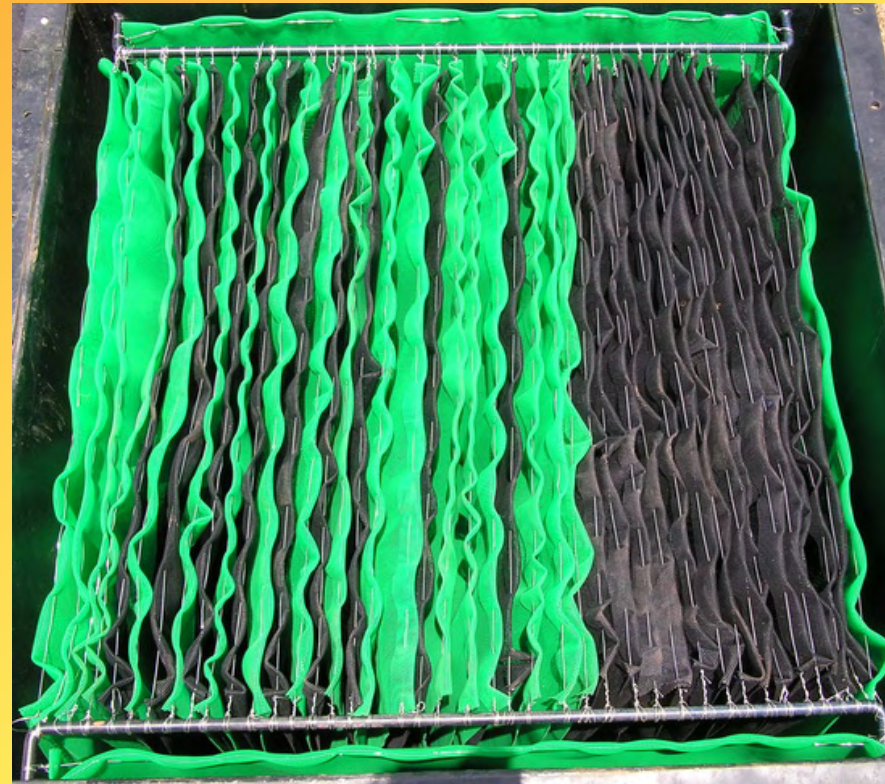
Experiment set-up: Pilot-scale AHR



Experiment set-up: **Packing Media**

Packing Media Type: **Plastic screens**

Specific Surface Area: **100 m² m⁻³**



Experiment set-up: Feedstock - POME



Experiment set-up: **POME Characteristics**

Parameter	Unit	Amount
pH		4.40 - 4.55
Alkalinity	mg L ⁻¹	750 - 1,000
Total Volatile Acids	mg L ⁻¹	2,200 - 3,000
Total COD	mg L ⁻¹	66,420 - 81,450
Soluble COD	mg L ⁻¹	33,500 - 41,500
BOD	mg L ⁻¹	33,000 - 41,000
TKN	mg L ⁻¹	950 - 1,000
Total Phosphorus	mg L ⁻¹	60 - 70
Oil & Grease	mg L ⁻¹	4,700 - 5,500
TS	mg L ⁻¹	49,000 - 56,000
SS	mg L ⁻¹	28,000 - 38,000
VSS	mg L ⁻¹	26,000 - 35,000

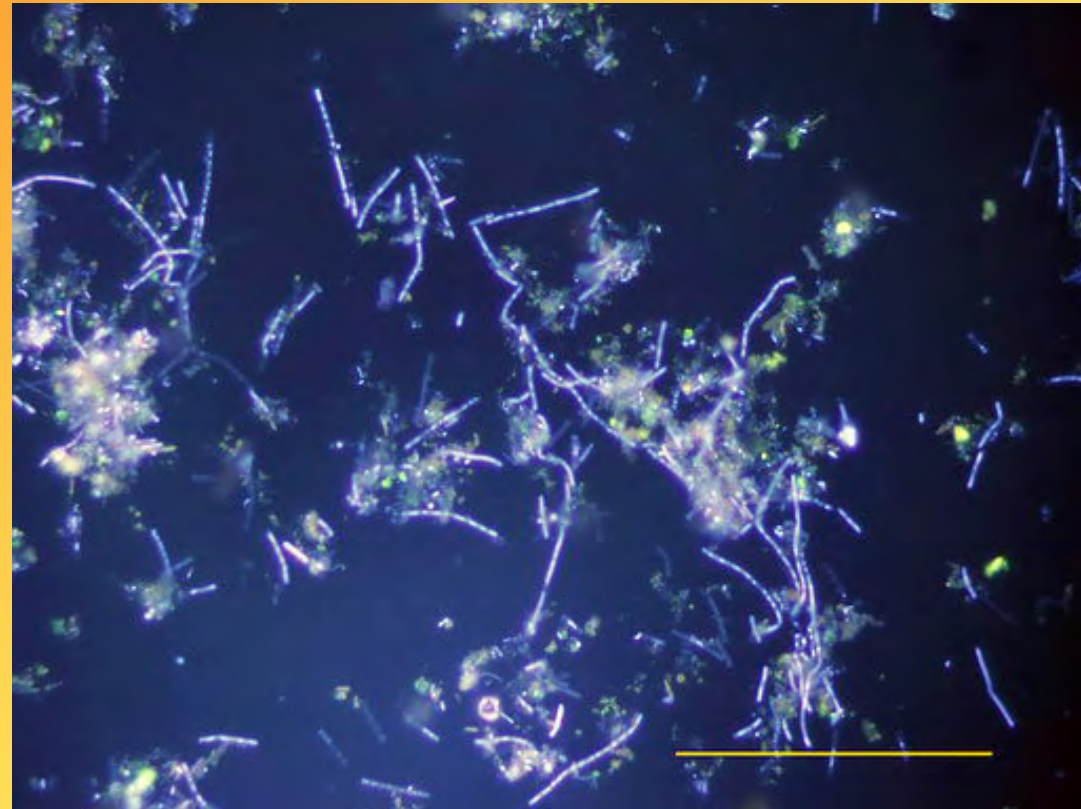
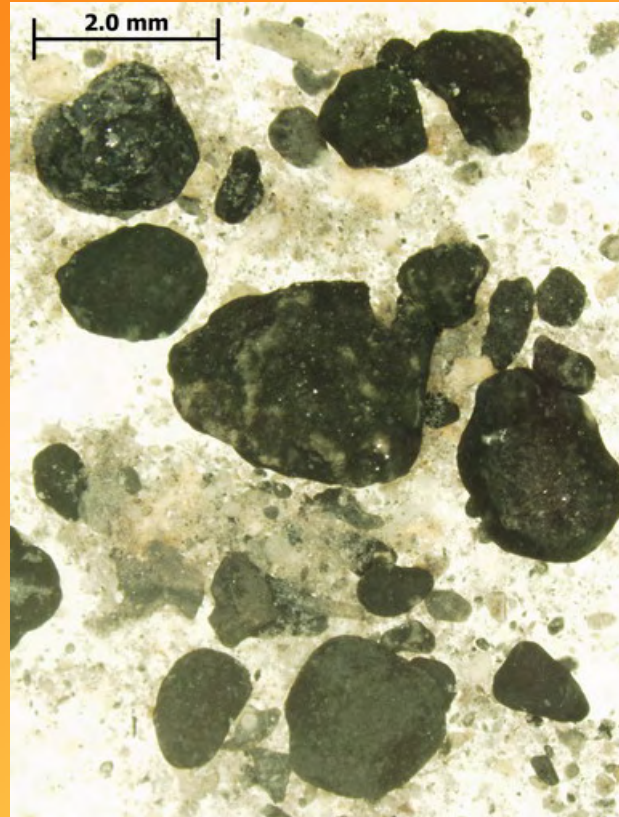
Experiment set-up: Seed Sludge



Anaerobic pond sludge



Experiment set-up: Seed Sludge



Experiment set-up: **Reactor Operation**

Influent: raw POME (no pre-treatment)

Feeding pattern: Upflow & semi-continuous

Stepwise OLR increasing

Reactor performance monitoring:

- **Reactor stability; pH, ALK, TVA**
- **COD & SS reduction efficiency**
- **Biogas production & contents**

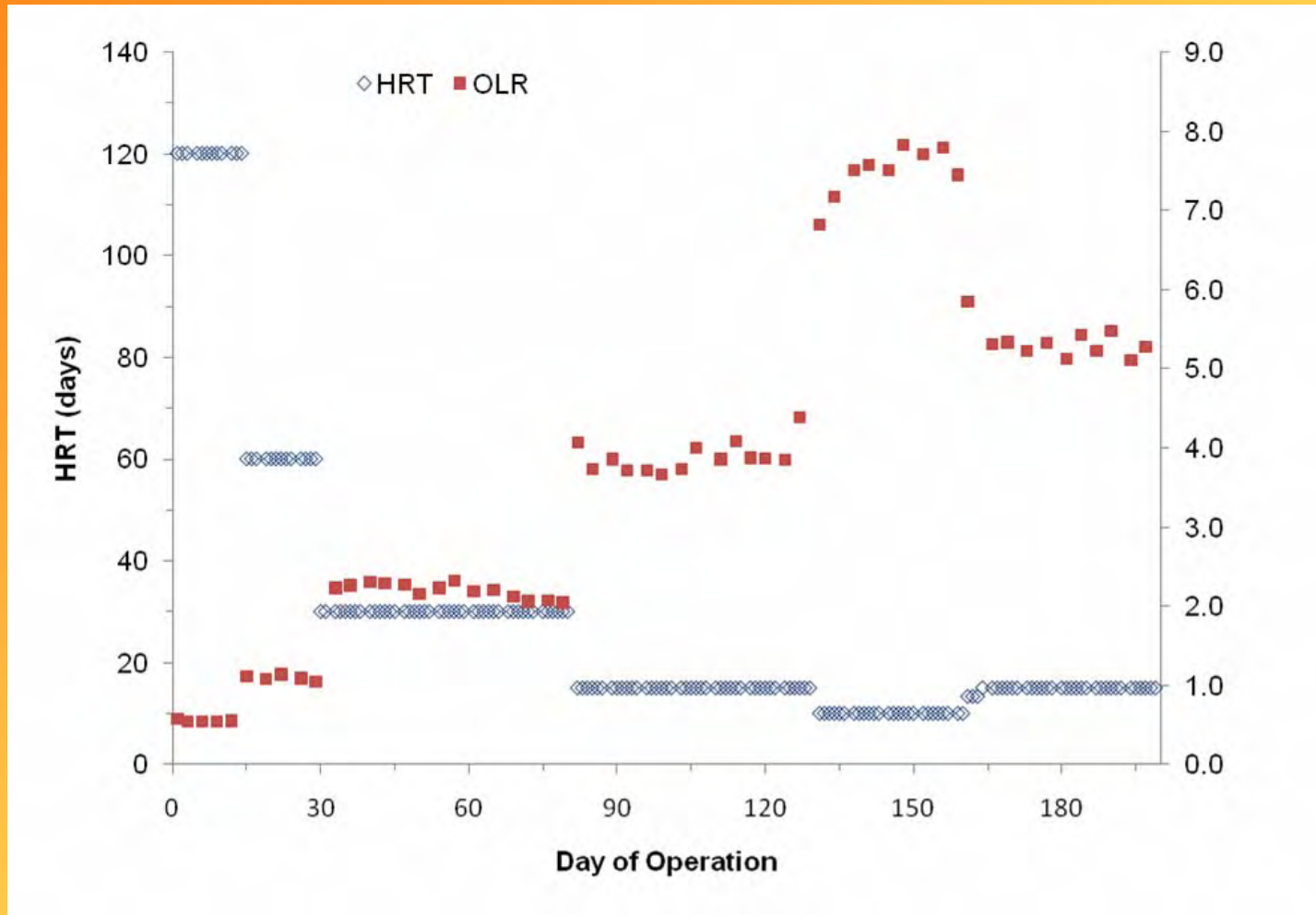
Experiment set-up: Analytical Methods

pH, COD, TS and SS: **Standard Methods (APHA)**

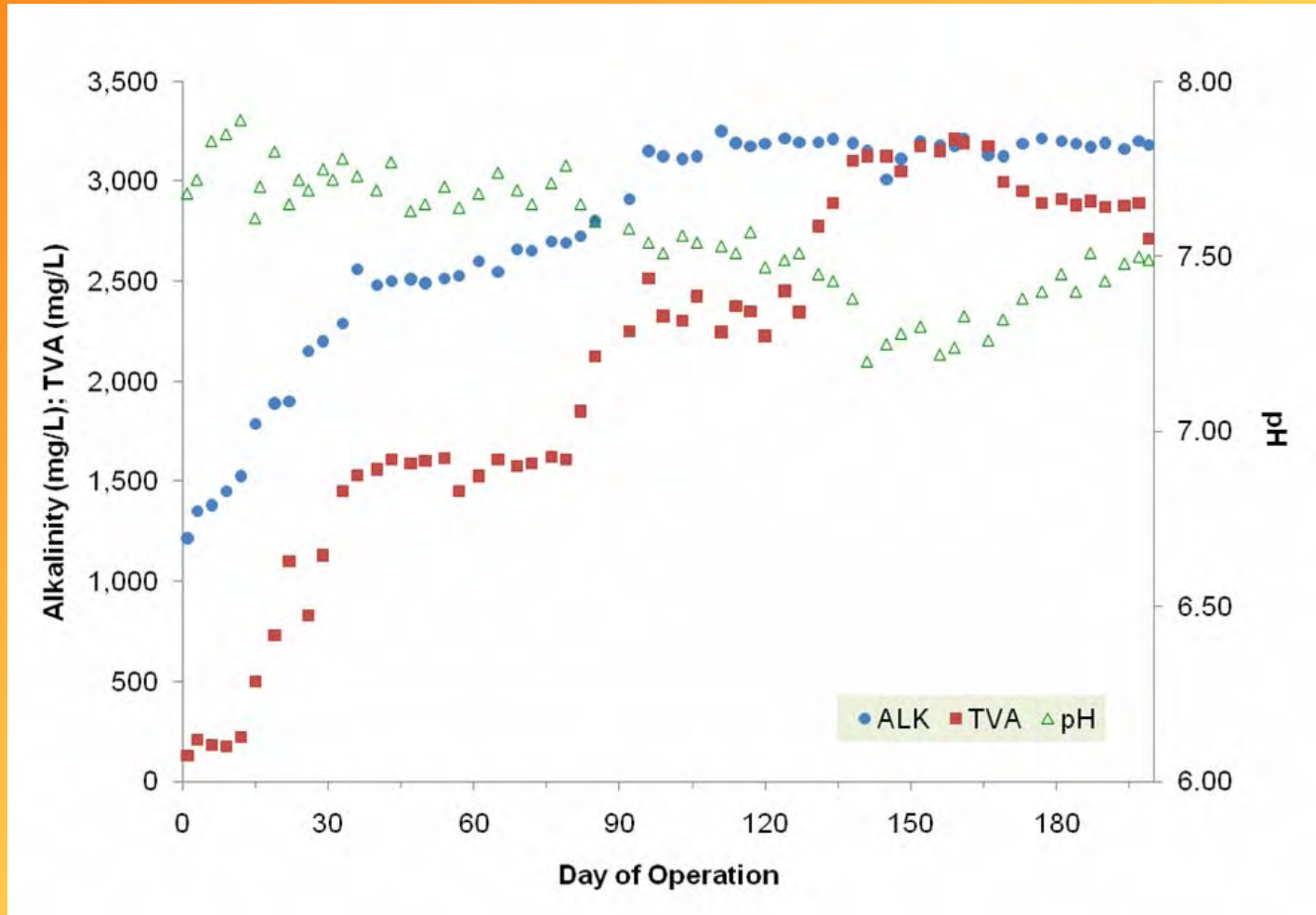
Alkalinity and TVA: **Titration method
(Anderson & Yang, 1992)**

Biogas contents: **IR sensors**

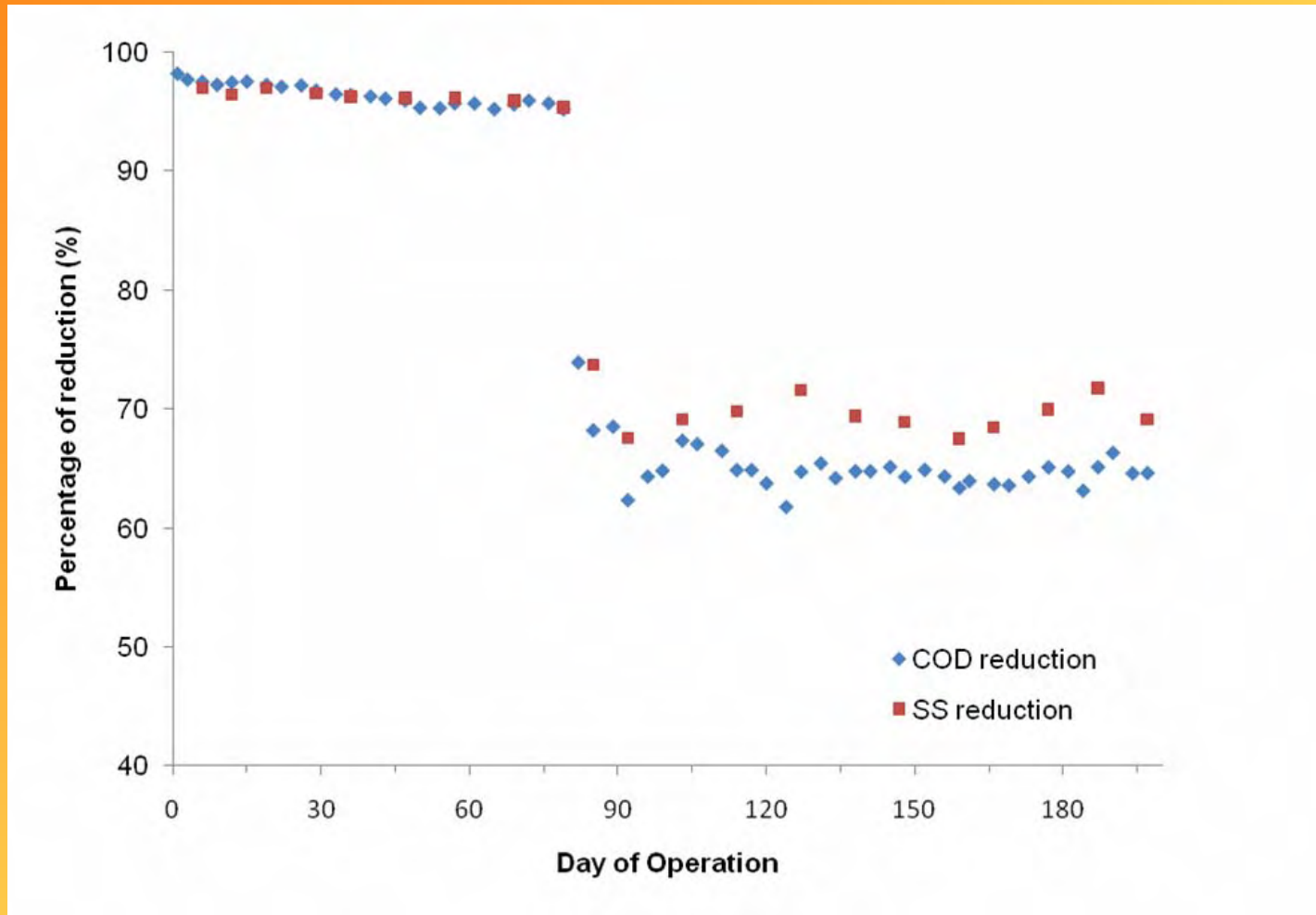
Results and Discussion:



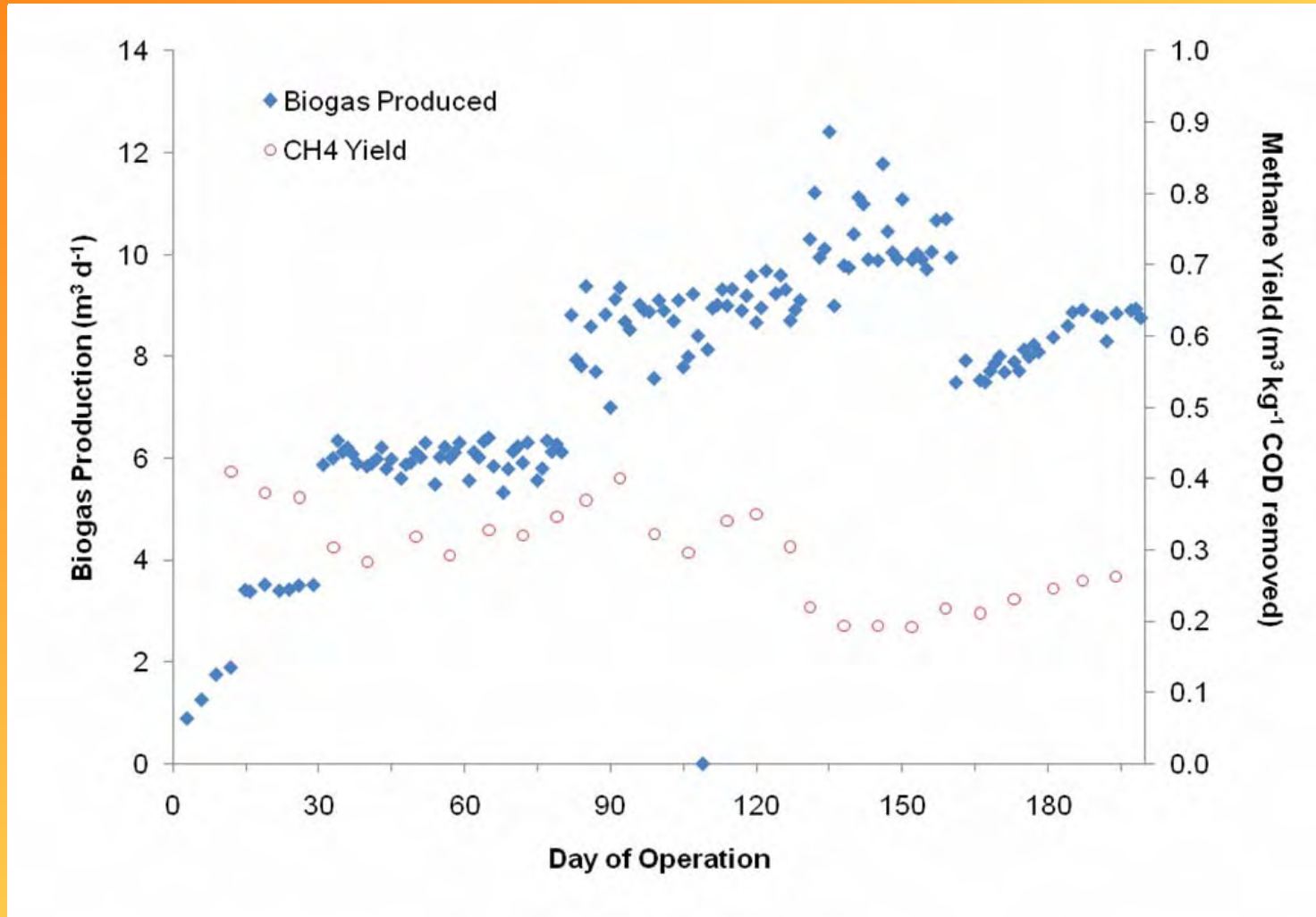
Results and Discussion:



Results and Discussion: Organic Removal



Results and Discussion: Biogas Production



Results and Discussion: Biofilm



Results and Discussion: Biofilm



Conclusion:

The AHR using plastic screens as packing media could be applied as economic wastewater treatment and biogas production system for palm oil industry.

Long-term operation efficiency and scum accumulation should be investigated.

To be continued...



5000 m³ full-scale AHR study

Any Questions?

Thank you for your attention...

Chinnapong Wangnai, PhD.

Pilot Plant Development and Training Institute
King Mongkut's University of Technology Thonburi (Bang Khun Thian)
49 Soi Thian Thale 25, Bang Khun Thian Chai Thale Road, Tha
Kham, Bang Khun Thian, Bangkok 10150, Thailand
Phone: +66 24707522 Fax: +66 24523455
chinnapong@pdti.kmutt.ac.th