BioAlgaNyx™

Phagotrophic algae enhanced sludge management

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BioAlgaNyx™ : A new Technology based on phagotrophic algae for resource recovery and sludge management

- INTRODUCTION
- AEROBIC DIGESTION ENHANCEMENT
- ANAEROBIC DIGESTION ENHANCEMENT
- ALGAL OIL PRODUCTION FROM SLUDGE

➢INTRODUCTION

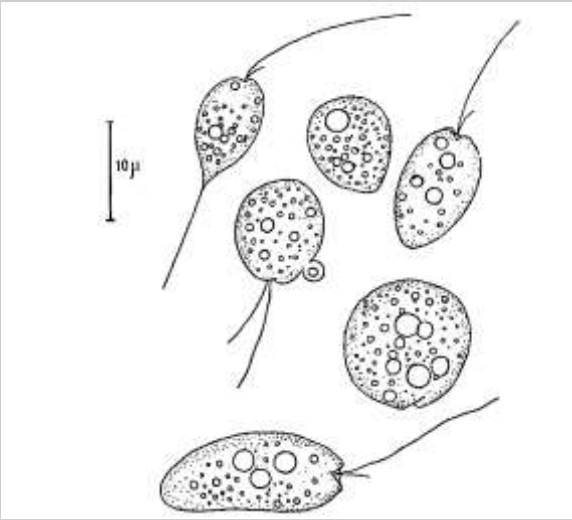
Problem

Sludge Disposal represents one of the highest operational costs for a Waste Water Treatment Facility

Disposal can represent as much as 30% of the plant O&M Costs

INTRODUCTION

Ovivo's BioAlgaNyx™ Technology



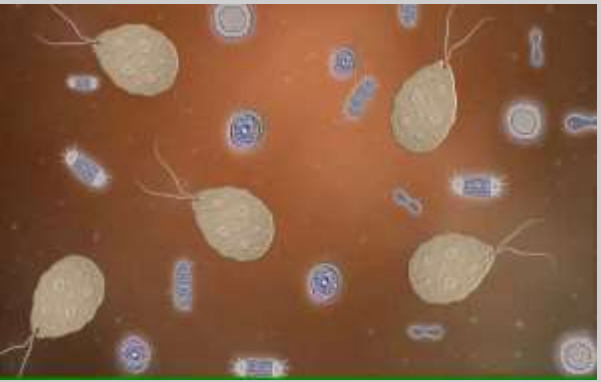
Ovivo, in partnership with the University of Akron, is developing a unique solution for:

- Organic Carbon capture
- Enhancing Sludge Digestion

Phagotrophic Algae is to be used for Resource Recovery and Biosolids Management

➢INTRODUCTION

Phagotrophic algae



Phagotrophic Algae does NOT require sunlight

It is capable of:

- Ingesting small microbial, viral and other organic particulates (***Phagotrophic***) – Ideal for harvesting
- Consuming dissolved organics (***Heterotrophic***) – Ideal for harvesting
- Can Survive with light (***Phototrophic***), not for growth

➢ INTRODUCTION

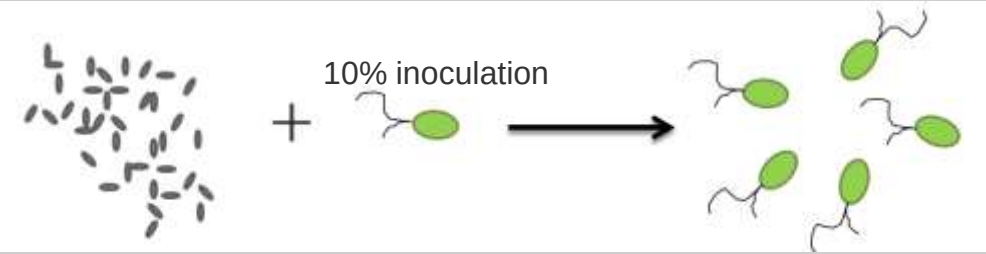
Photosynthetic algae (limited in sludge treatment)

- Phototrophy (light)
- Heterotrophy (dissolved organics)
- Phagotrophy (bacteria)

Phagotrophic algae

➢ INTRODUCTION

Grow with free bacteria



a. With pure *Ecoli* cells

➢>98% bacterial cells were consumed in 21 h

➢Algae yield from bacteria was 43.7%

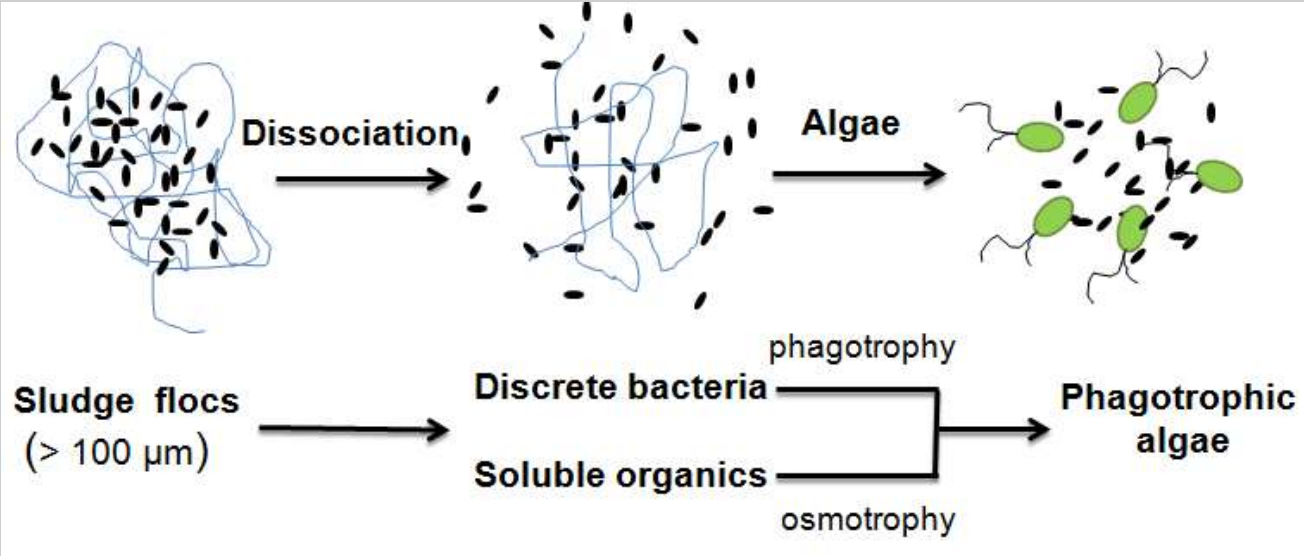
b. With mixed bacterial cells originated from waste activated sludge

➢>98% bacterial cells were consumed in 15 h

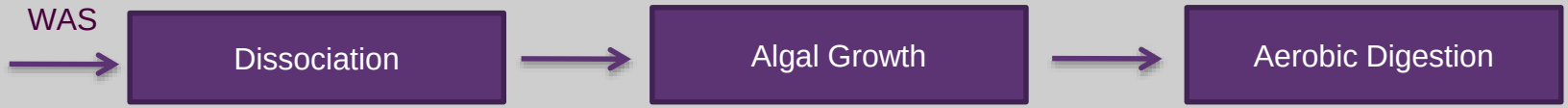
➢Algae yield from bacteria was 53%

➢ INTRODUCTION

Grow with waste activated sludge (WAS)



➢Aerobic Digestion Enhancement



Benefit:

a. Less time requirement

b. Less aeration requirement

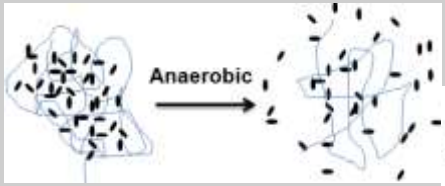
Algae oxygen uptake rate (SOUR is only 1/10 of bacteria.

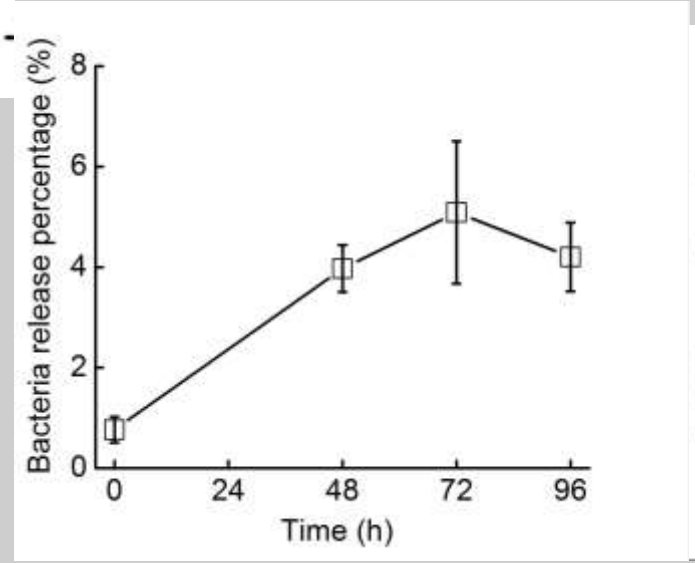
Bacteria	→	Algae
SOUR: 500 mg O2/ g-TS*h		SOUR: 50mg O2/ g-TS*h

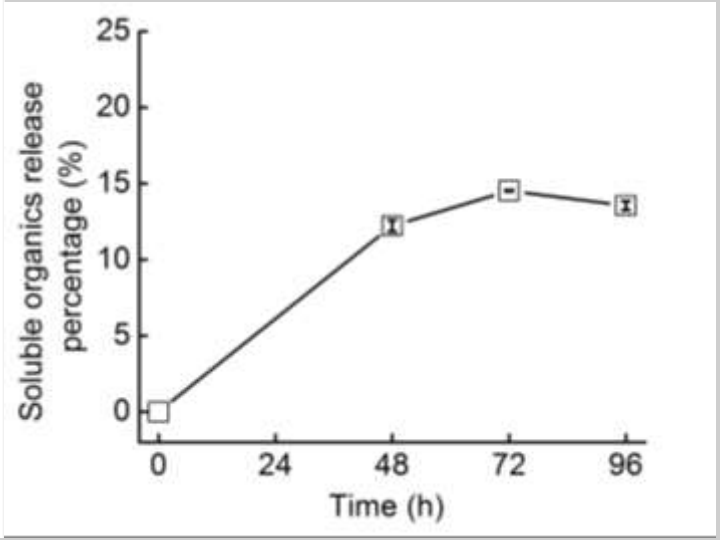
➢Aerobic Digestion Enhancement

1. WAS dissociation by anaerobic pretreatment

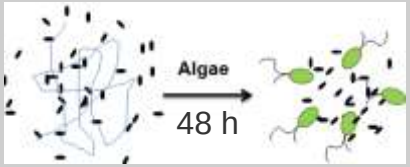
a. Lab study

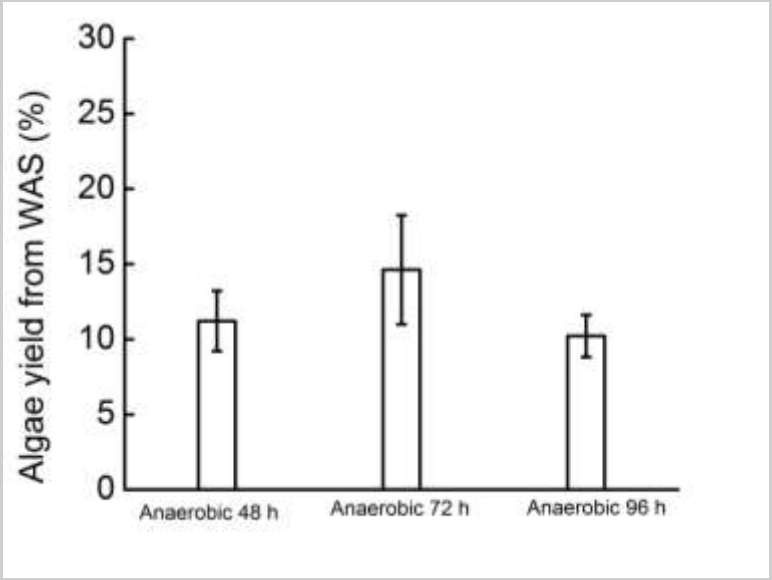


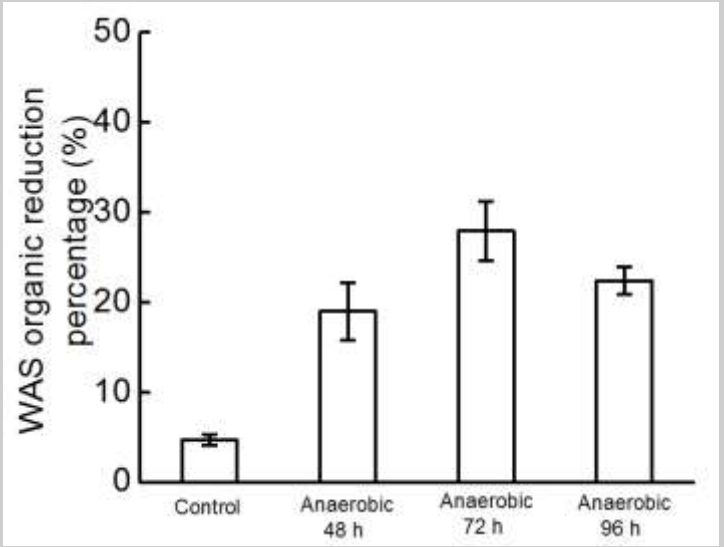




➢Aerobic Digestion Enhancement







➢Aerobic Digestion Enhancement

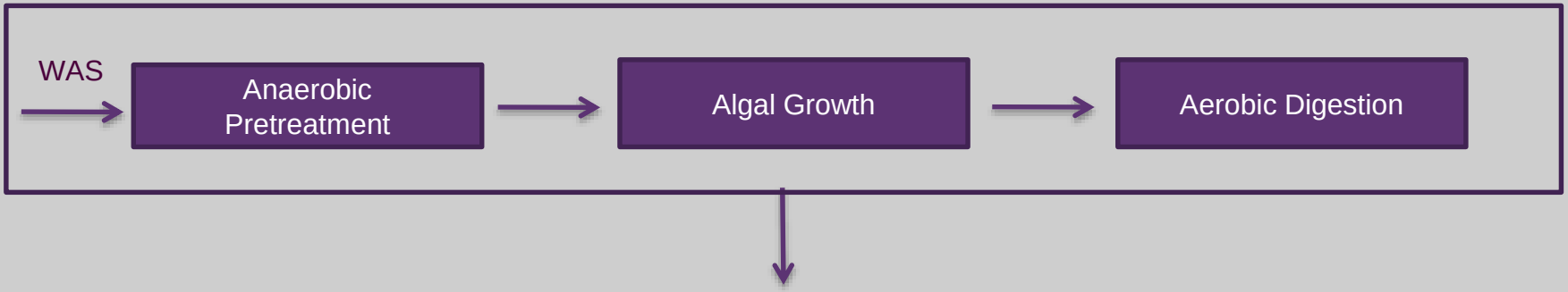
b. Pilot test

Total volume: 6,000 gallon

Test duration: Aug 2016 to Nov 2016, 3 month

Temperature: 15 ^{o}C – 31 ^{o}C

➢Aerobic Digestion Enhancement

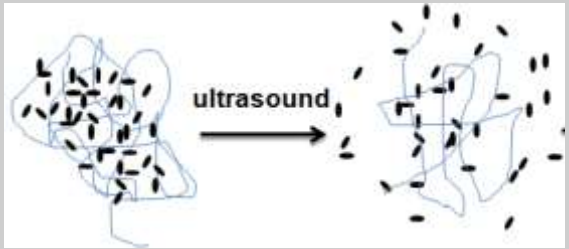


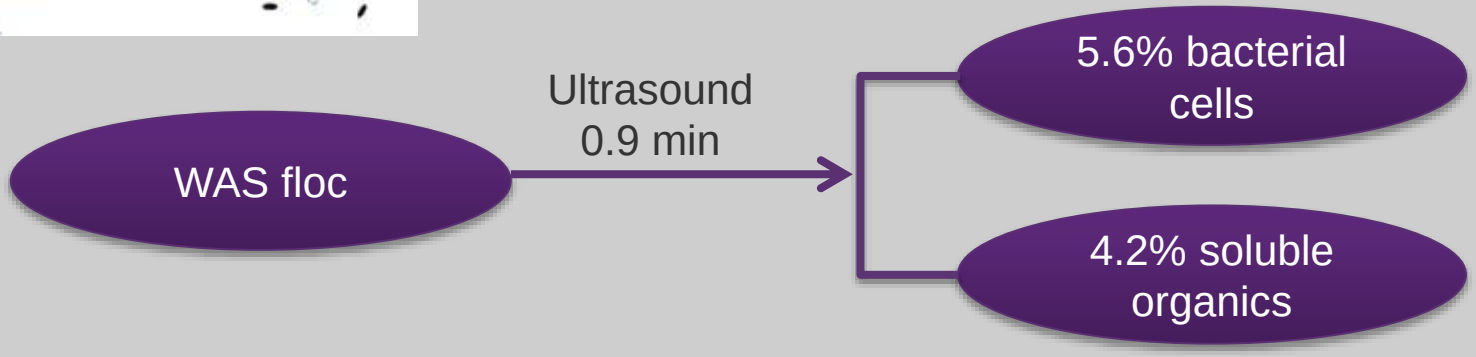
Meet Class B biosolids in 10 days
Pathogen: 0.84 million/ g-TS
SOUR: 1.2 mg O2/ g-TS*h

➢Aerobic Digestion Enhancement

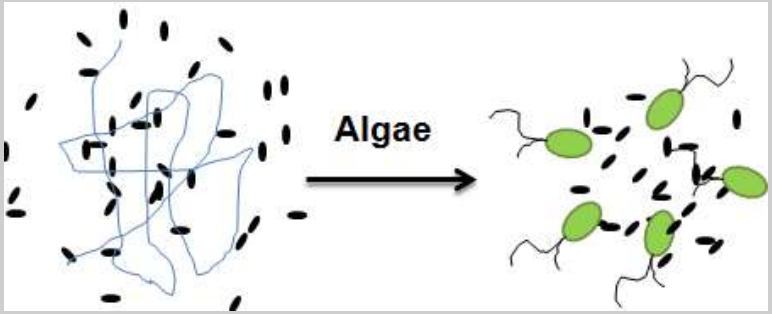
2. WAS dissociation by short-time ultrasound

a. Lab studies





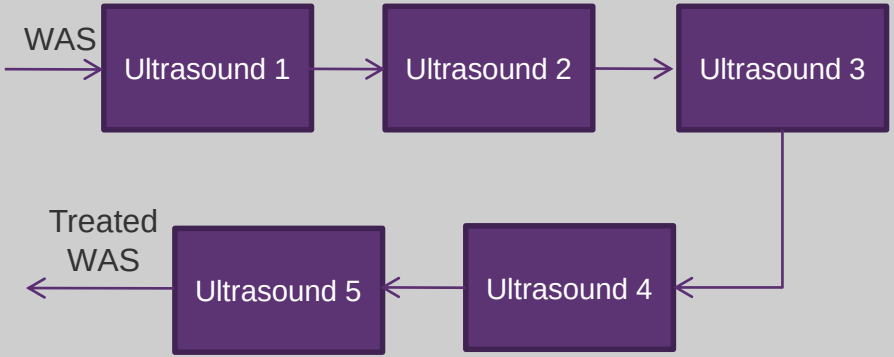
➢Aerobic Digestion Enhancement



➢Algae yield from released bacteria and soluble organics was 38.6%
➢ WAS VS was reduced by 18.5% in 48 h

➢Aerobic Digestion Enhancement

b. Pilot test

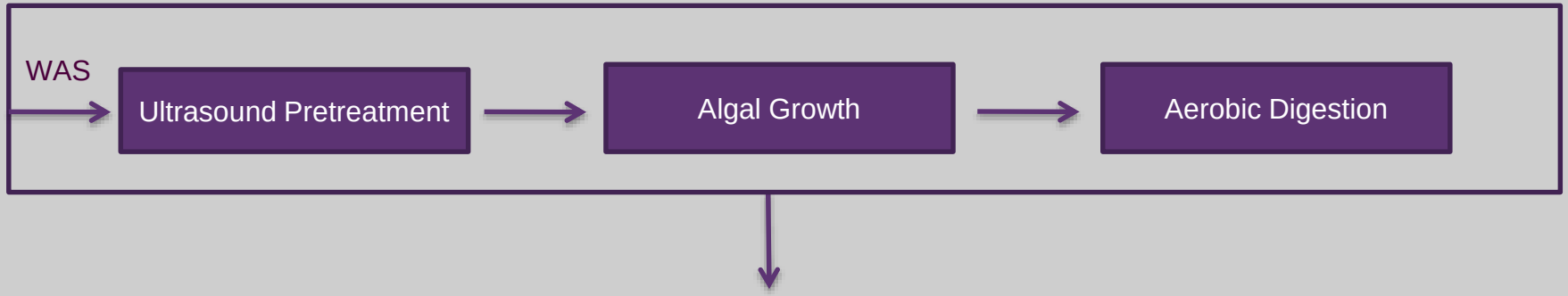


Ultrasound power: 950 watt

Chamber volume: 5 L

Energy intensity: 190 watt/L

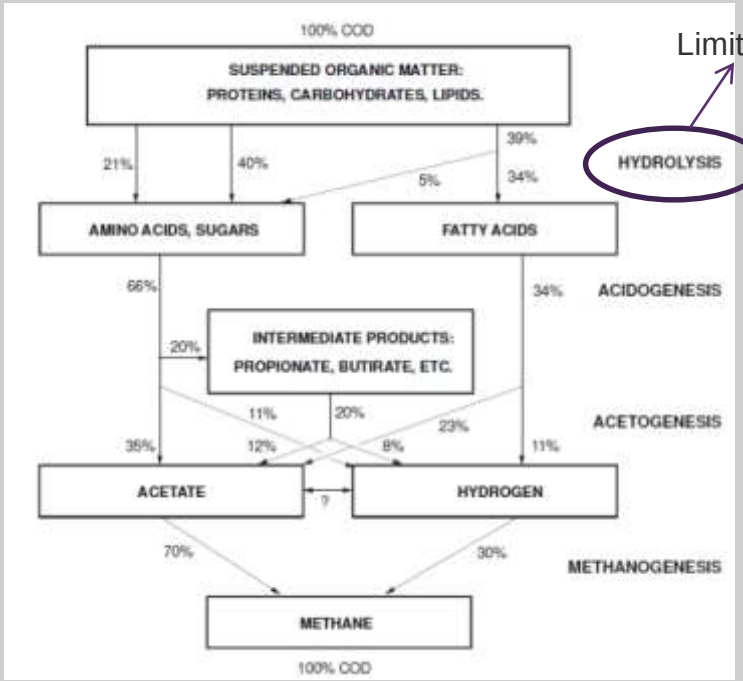
➢Aerobic Digestion Enhancement



Meet Class B biosolids in 8 days
Pathogen: 0.83 million/ g-TS
SOUR: 1.5 mg O2/ g-TS*h

➢Anaerobic digestion enhancement

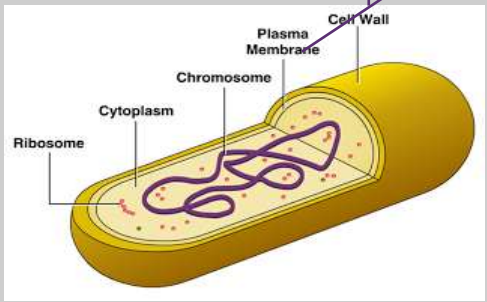
Anaerobic digestion



Limitation step

Protect cells against mechanic stress

Protect cells against osmotic lysis



➢Anaerobic digestion enhancement

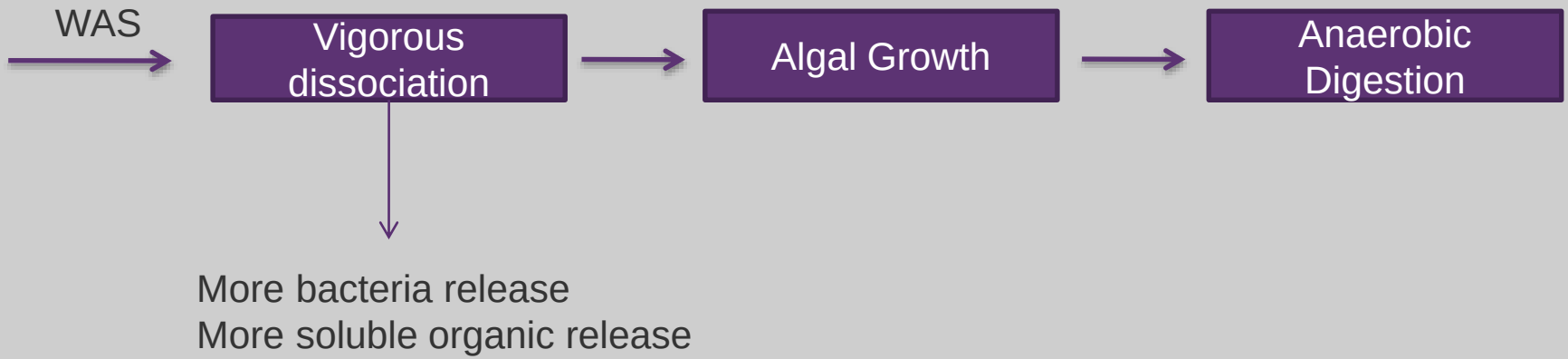
a. No cell wall, easy to break
b. Rich in oil, good starter for anaerobic digestion

ANAEROBIC DIGESTION WITH ALGAE

INITIAL VS	30-35,000	MG/L
T	35	°C

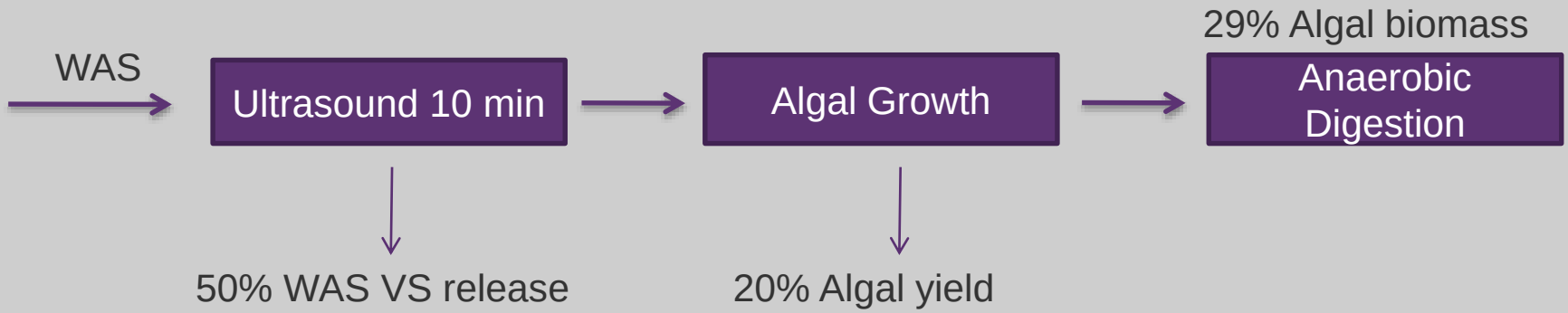
SAMPLE COMPOSITION	DAYS	VS REDUCTION
100% WAS	15	30%
90% WAS + 10% Algae	15	35%
10% WAS + 90% Algae	15	50%

➢Anaerobic digestion enhancement



➢Anaerobic digestion enhancement

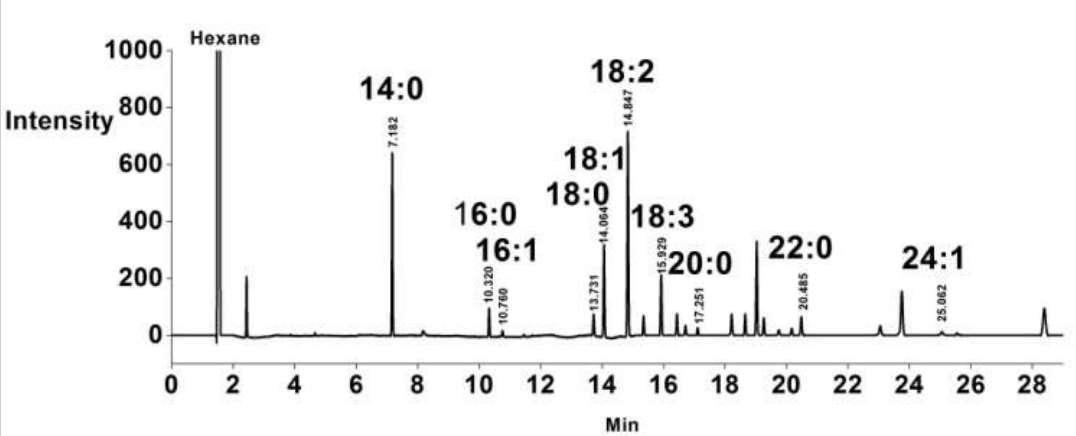
Lab study



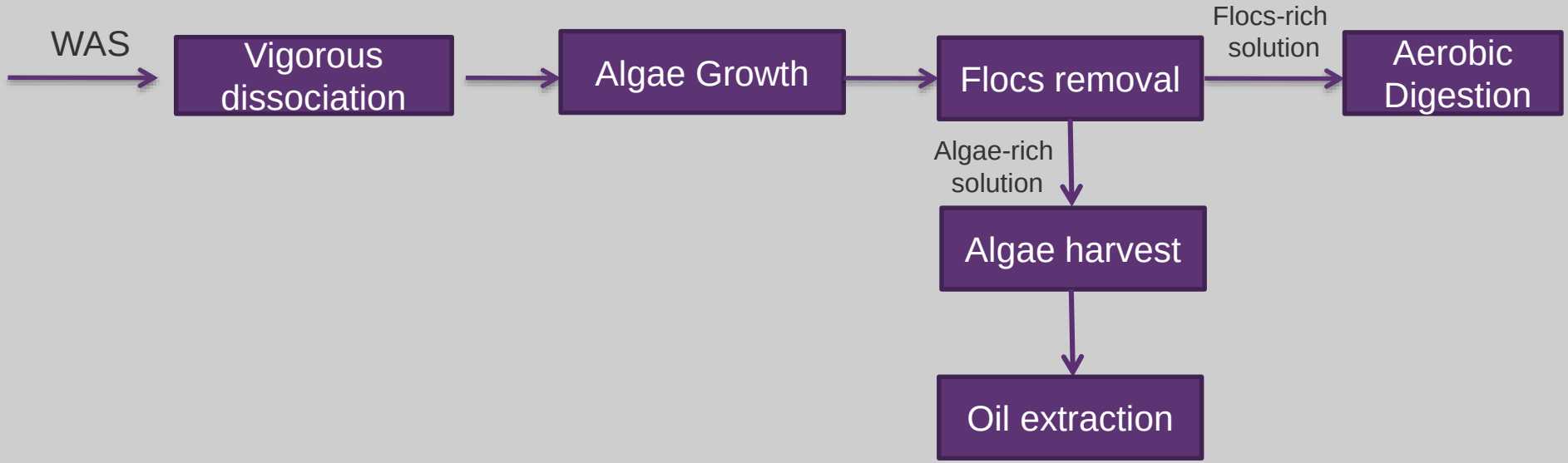
➢Oil production from sludge

Phagotrophic algae – oil reservoir

- ➢With bacteria, oil content of phagotrophic algae is about 40-50%;
- ➢With WAS, oil content of phagotrophic algae is about 30-40%;



➢Oil production from sludge



➢Oil production from sludge

Flocs removal →

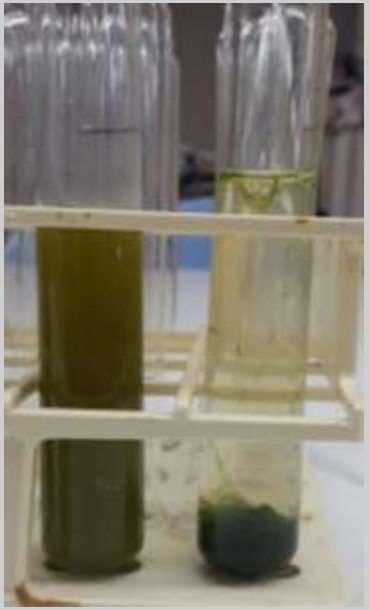
Settling time (min)	Volume ratio: Supernatant/settling (v:v)	Algae ratio: Supernatant/settling (N:N)	Flocs ratio: Supernatant/settling (w:w)
5	0.24±0.02	0.23±0.01	0.013±0.001
15	0.63±0.01	0.62±0.01	0.028±0.005
30	3.77±0.32	3.59±0.41	0.044±0.003
60	3.96±0.28	2.88±0.42	0.067±0.003

At settling time of 30 min: 95.8% of the remaining WAS flocs were settled down
78.2% of algal cells presented in supernatant.

➢Oil production from sludge

Algae harvest → Flocculant

1 min



5 min

➢Summary

Phagotrophic algae provides unique, easy-to-operate solutions for sludge treatment

- Up to 50% reduction in digestion time requirements feasible
- No light source necessary to grow/sustain algae
- Lower O&M Costs

➢Summary

Example : 1.5 MGD Plant Evaluation

	Sludge Holding Tank Expansion	Conventional Aerobic Digestion	BioAlgNyx Enhanced Aerobic Digestion
Capital	$ 118,750	$ 682,750	$ 381,336
O&M	$ 347,236	$ 408,391	$ 205,025
Year 1	$ 465,986	$ 1,091,141	$ 586,361
Year 2	$ 813,222	$ 1,499,532	$ 791,386
Simple Payback	0	never	1.85

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