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WATER TECHNOLOGIES

EXCELLENCE IN WASTEWATER PART III:

ANAEROBIC DIGESTION FOR FOOD AND BEVERAGE PROCESSORS

Your Presenters

José Molina and Barry Reicker bring over 30 years of consulting, sales and practical application experience in biological treatment of food and beverage wastewater

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Safety

SAFETY IS NOT ONLY ABOUT TAKING PRECAUTIONS, IT'S ALSO ABOUT TAKING RESPONSIBILITY.

There's a catch phrase that's being heard more and more these days. "See it. Own it." That phrase is particularly applicable to safety.

If you see an unsafe situation, or even a potentially unsafe situation, don't just walk away. Take responsibility for getting it corrected.

Whether it's in the office, while you're traveling, or at the work site, wherever you see something that you believe is unsafe, or could lead to an adverse incident, speak up. If it's unsafe to actually do something about it yourself, keep others out of the unsafe zone and contact your supervisor.

Think how you'd feel if you did nothing, then heard later that someone was injured.

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Agenda

Intro to Anaerobic Digestion

Growth Drivers

Technology Selection

Case Studies

What is Anaerobic Digestion (AD)?

AD is a biological process as old as bacteria itself.

- These particular bacteria have decided life is better without the availability of free oxygen for respiration

Rules are rules

- Specialized bacteria access oxygen by removing it from other organic compounds and in the process effectively dismantle complex carbon chains into their (simpler) constituents
- Second type of bacteria further process the remaining short chain organics into their most basic elemental form where they are naturally attracted to each other to form C02, methane and small amounts of H2S.

Industrial AD is the business of creating and controlling the environment in which these bacteria thrive

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Sounds Simple Enough

It can be.

- In many ways simpler
- Like wastewater, AD comes in many forms
- Specialized for different situations.
- Typically classified in terms of organic loading rate (OLR)

Getting it right

- With choices comes potential for confusion
- AD is not always the right choice
- Consult with 3rd party engineer or vendor with multiple process options

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Old Concept, New Demand

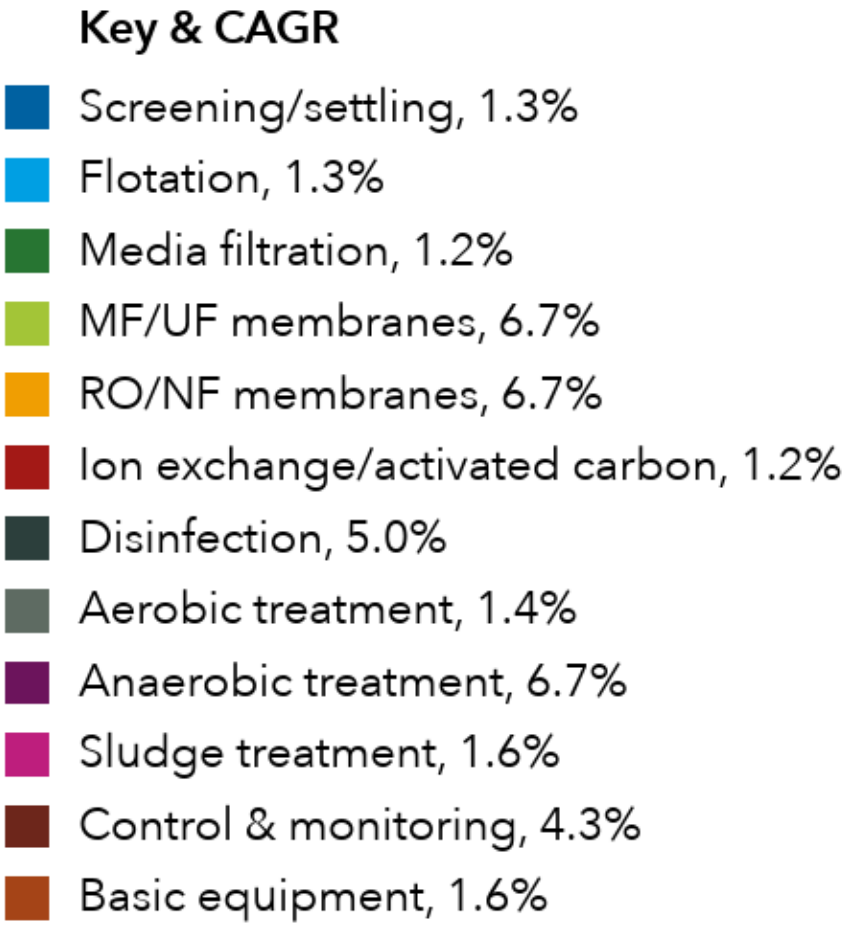
Reduced Operating cost (1/10th of Aerobic)

- Minimal electrical demand (no aeration)
- Minimal chemical demand (no polymers or coagulants)
- Simplified operations (less unit processes)
- Reduced hauling (no sludge handling, storage or dewatering*)
- Sludge can be land applied
- Reduced labour

Sustainability Goals

- Reduced carbon footprint
- Valuable biogas produced as a biproduct
- Facilitates future re-use goals

AD is becoming better understood and accessible to a broader audience



Biogas Utilization

All AD systems produce biogas

- Not all use it

Typical uses in order of scale and investment required

- Dual-fuel boiler
- CHP / Microturbine
- Pipeline injection (RNG)

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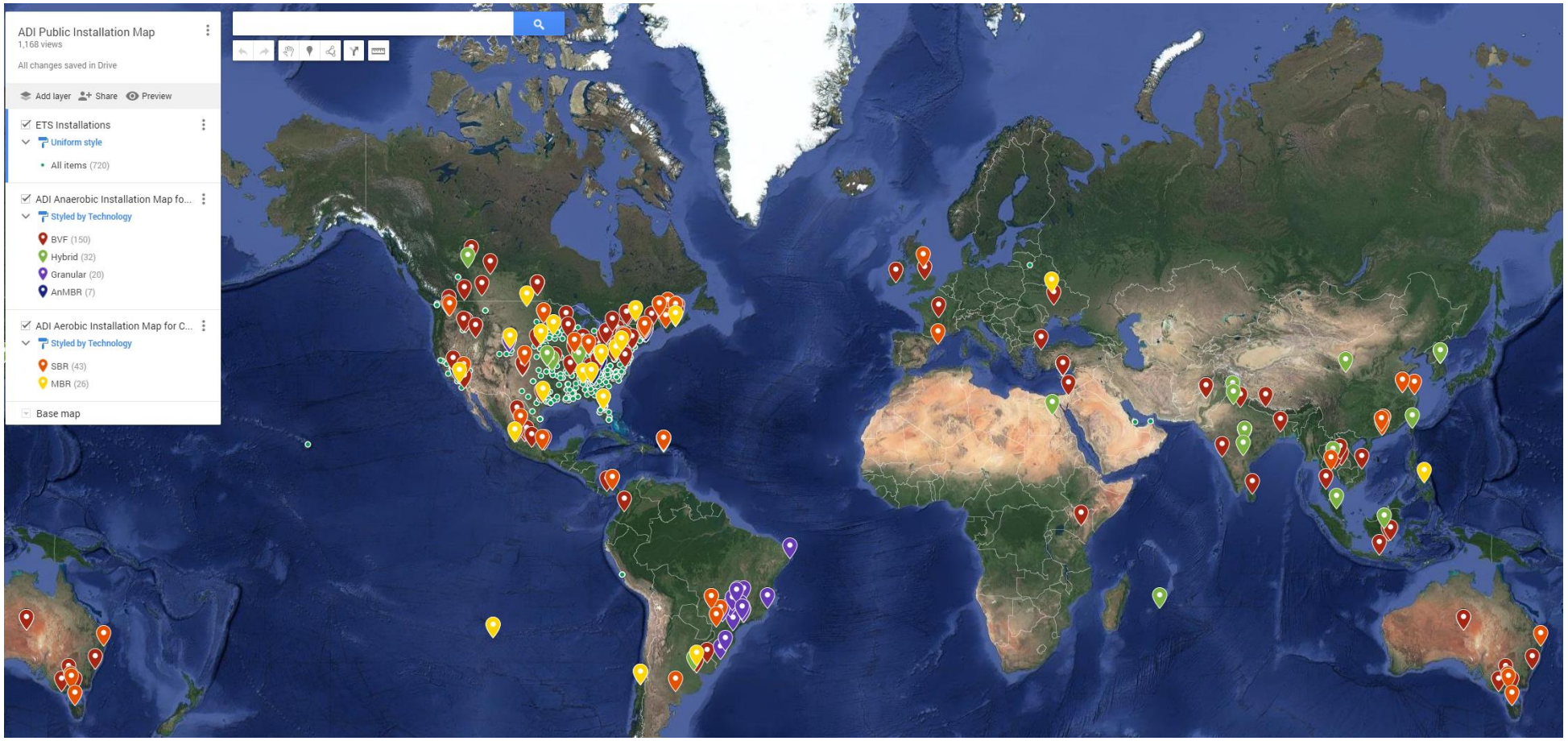
Reference Installations



Row Labels	Count of Segment
Food	154
Beverage	63
Chemical	25
Pulp and Paper	16
Pharma and Biotech	7
Municipal	6
Biofuel	4
Waste Collection	4
Manufacturing	2
HPI	1
Grand Total	**282**

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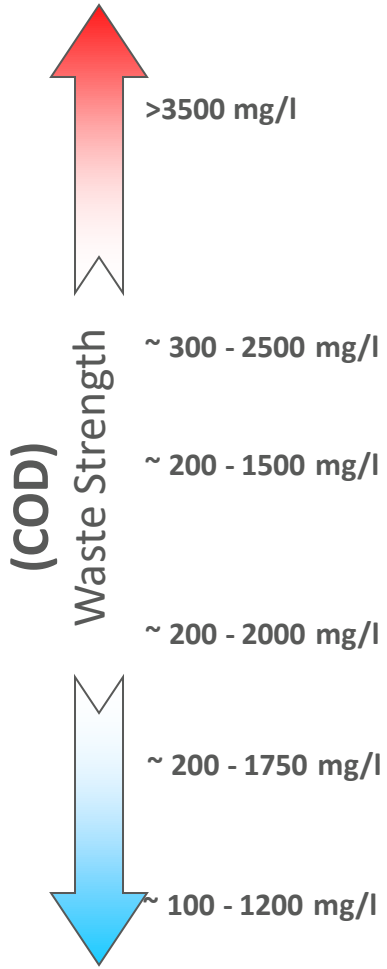
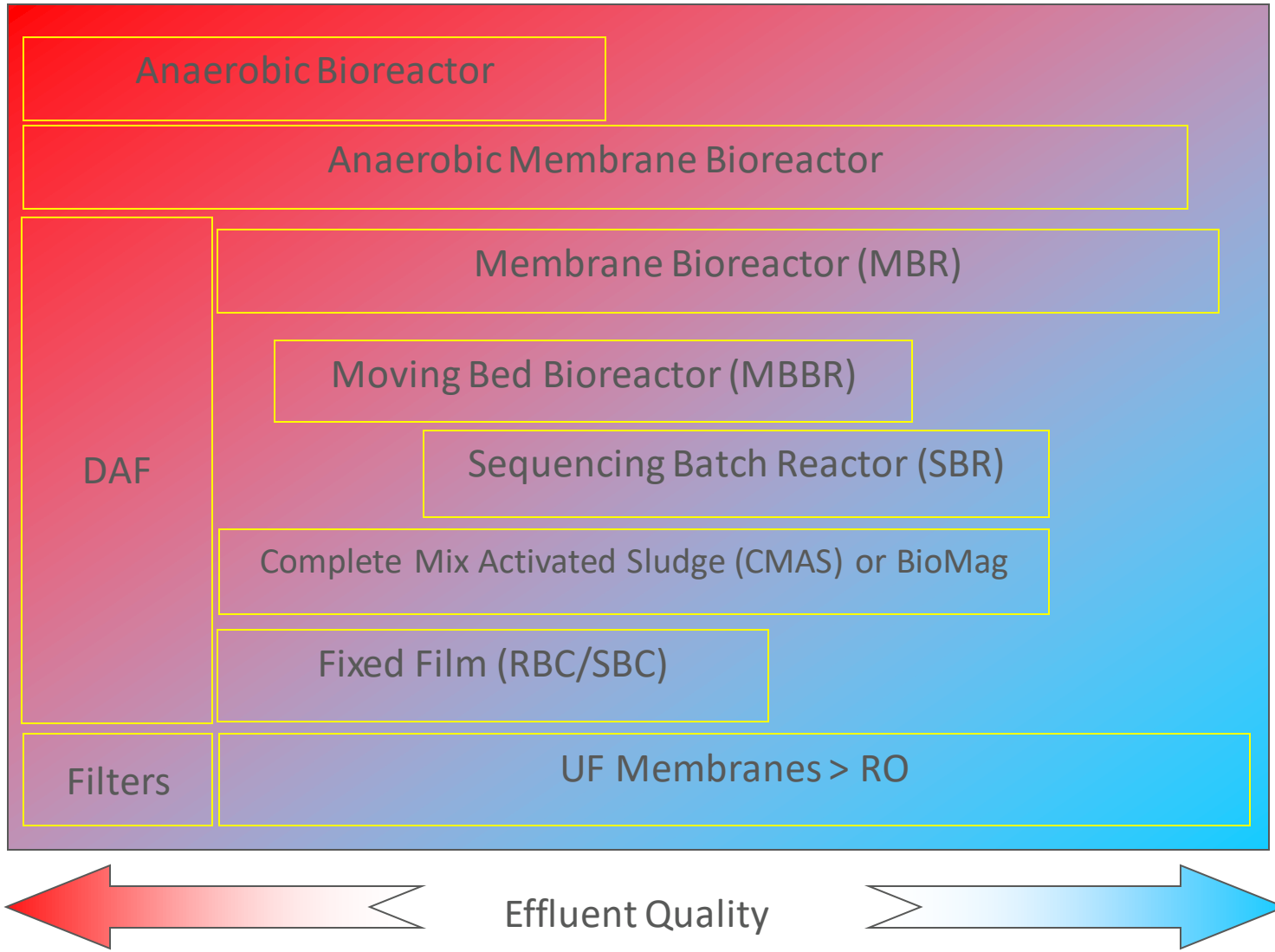
When To Consider AD

- High-strength wastewater
- High operating costs
- Production expansion
- Sustainability goals
- Compliance issues





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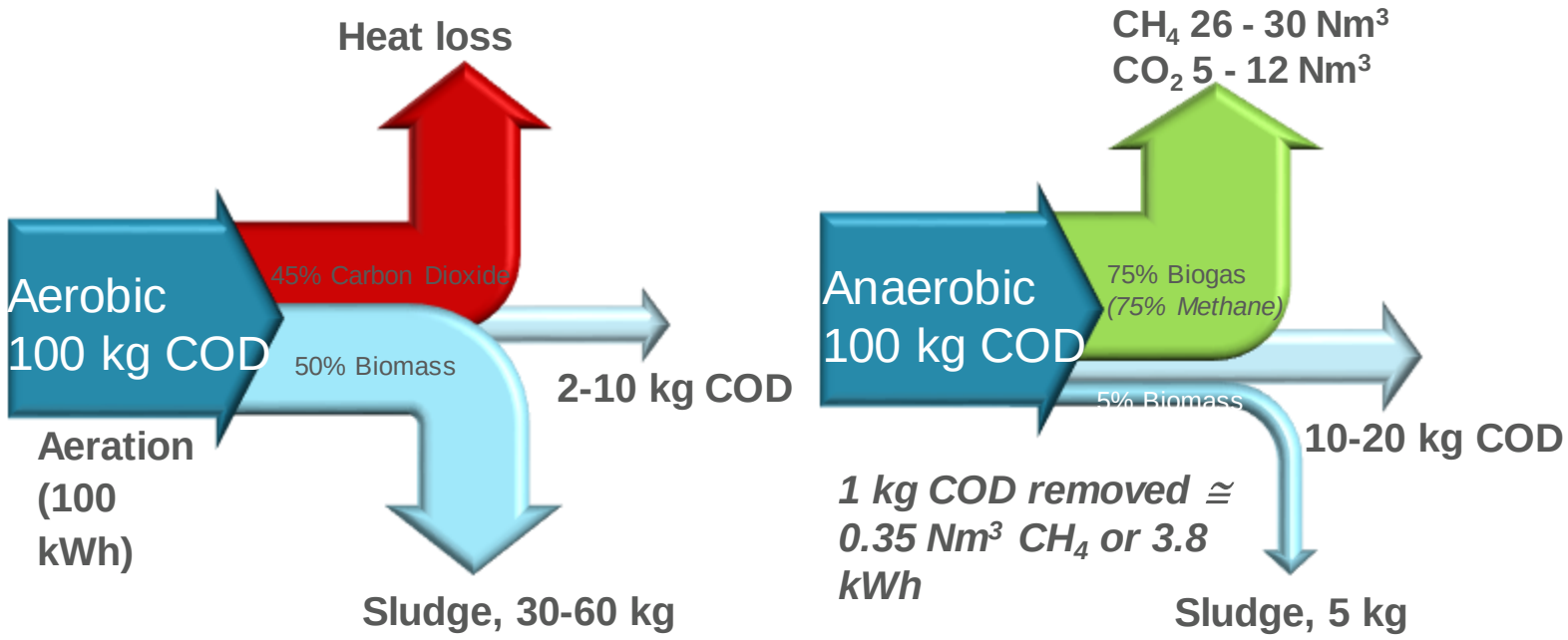
What's The Difference?

Aerobic Treatment:

- Best effluent quality
- Targets soluble BOD and some TSS
- Flexible applications
- High sludge production
- Moderate capital costs
- Highest operating costs

Anaerobic Treatment:

- Most energy efficient
- Targets soluble BOD and significant TSS
- COD is converted to biogas
- Low sludge production
- Highest capital cost
- Lowest operating cost



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AD, OLR and Footprint

Ultra High-Rate	**ECSB**	OLR = 15 – 30 kg COD/m^3/d
High-Rate	**UASB**	OLR = 8 – 16 kg COD/m^3/d
	AnMBR	OLR = 5 – 15 kg COD/m^3/d
Intermediate Rate	**CSTR**	OLR = 2 – 5 kg COD/m^3/d
	Hybrid/AHD	OLR = 3 – 10 kg COD/m^3/d
Low-Rate	**BVF®**	OLR = 0.5 – 3 kg COD/m^3/d

Process selection depends on type of wastewater, operating conditions, site constraints, ease of operation, and economics

ADI® ECSB

ADI® CSTR

ADI® AnMBR

ADI-BVF® Reactor


ADI® ECSB

External Circulating Sludge Bed (ECSB)

Ultra high-rate anaerobic granular sludge technology (15 – 30 kg COD/m3.d)
Developed by HydroThane STP® and offered under license by Evoqua

Technology is ideal for

- Warm wastewater
- High concentrations of soluble COD
- Sites with small available footprint

Not suitable for

- Waste streams with FOG, TDS, TSS
- Variable flows and loads from different production processes

Markets

- Brewery, P&P, ethanol and other industrial condensate streams

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ECSB Operating Principles

Granular sludge bed technology

- Influent must be consistent and strictly controlled

Highest organic loading rate

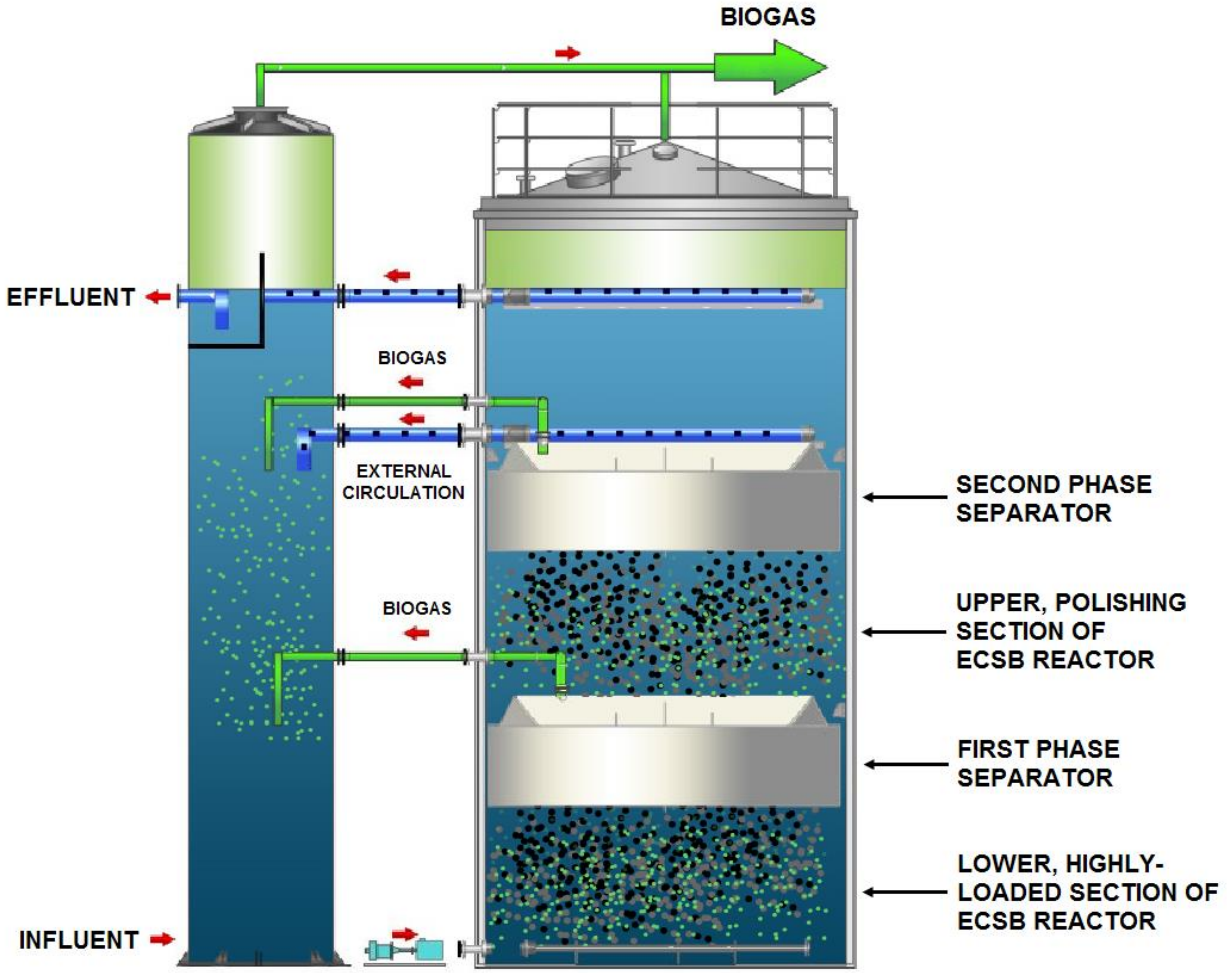
Sealed headspace, eliminating the potential for tank corrosion

External circulation controls reactor mixing independently from system operating and loading conditions

100% GLSS coverage

- Two sets of GLSS's results in better solids retention and lower effluent of TSS

Inherently taller reactors reduce overall footprint



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Case Study: Brewery ECSB

Project Overview

Market: Brewery
Region: Eastern Canada
Year of Start-up: 2014

Wastewater:
- 170k gpd
- High concentration of soluble BOD
- Spent grain and yeast removed upstream
- Discharge to POTW

Customer Objectives

- Compliance
- Reduce surcharges

- Extremely tight footprint in desirable historic downtown location

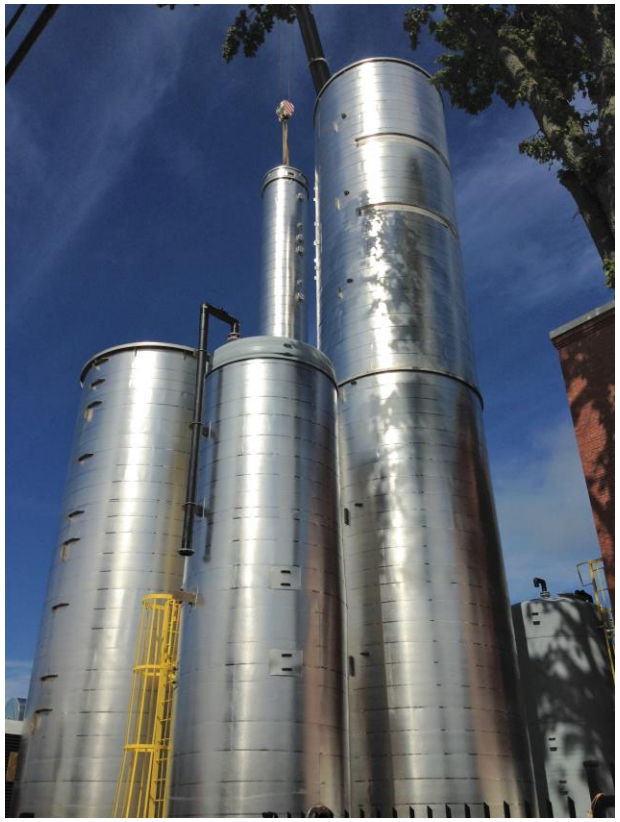
Solution

- Equalization
- Ultra high-rate ECSB
- Odor control

- Delivery: Design-Build

Results

- Consistent removal of over 90% BOD
- Good sludge granulation and retention
- Compliance achieved
- No need to relocate



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Continuously Stirred Tank Reactor (CSTR)

Med – High-rate anaerobic technology (2 – 15 kg COD/m3/d)

Flexible and configurable for a variety of feedstocks depending on the solids separation technology used

- DAF (AnDGF / AnDNF), Membranes (AnMBR), Centrifuge or Clarifier

Technology is ideal for:

- High concentrations of solids and FOG
- Extreme FOG loads (AnDGF)
- Best effluent quality (AnMBR)
- Sites with needs expected to change over time

Not suitable when

Other anaerobic processes are less expensive or perform better

Markets

Food, Brewery, Distillery, Biofuel, Food Waste, Ag Waste

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ADI® AnMBR

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Anaerobic MBR (AnMBR)

Med – High-rate anaerobic technology (5 – 15 kg COD/m3/d)

State of the art AD process with highest quality effluent (11 installations)

Technology is ideal for:

- Very high concentrations of solids
- Moderate concentrations of FOG
- Stringent discharge limits
- Sites with limited footprint
- Retrofits where a biological tank already exists

Not suitable when

- Weak wastewater
- Forgiving discharge limits
- Other anaerobic processes are less expensive or perform better
- Extremely high flows

Markets

- Food, Brewery, Distillery, Biofuel, Food Waste

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AnMBR Operating Principles

Membrane barrier ensures complete solids retention and process stability

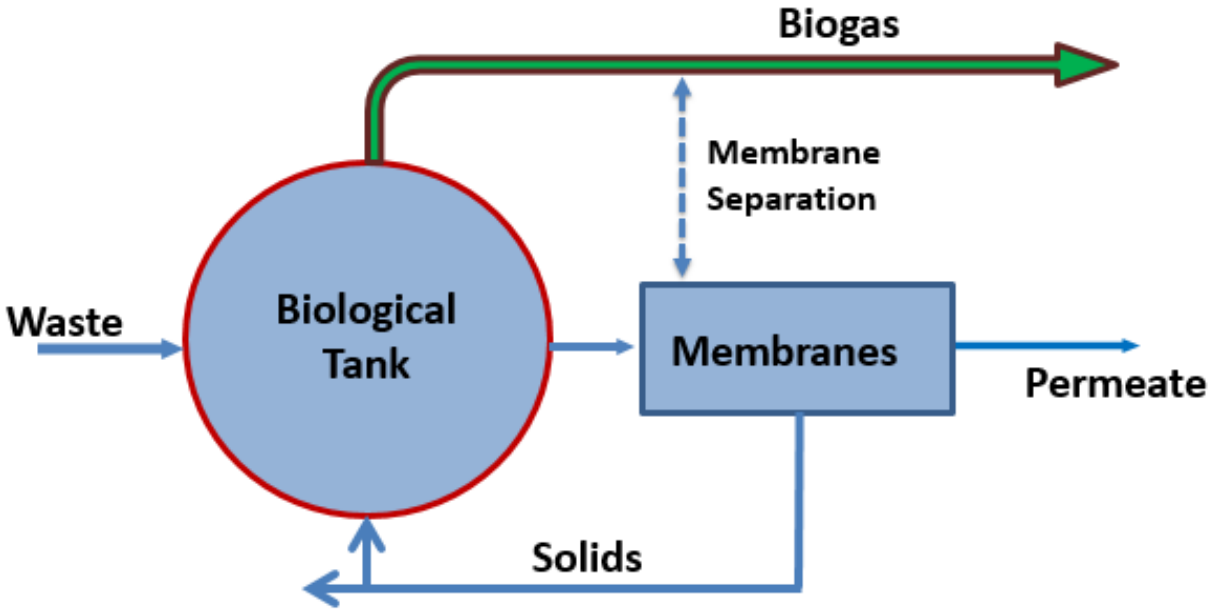
- Decouples SRT and HRT (solids and liquid residence time)
- Provides control over MLSS concentration allowing plant to respond to unplanned production events
- Provides control over wasting RANS
- Maximizes biogas production

Minimal pre-treatment and post-treatment (aerobic polishing) requirements

Handles high organic loadings and mixing intensities

- Highest organic loading rate available without granular sludge
- 99% BOD destruction

Can often meet the POTW regulations in ONE step



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Case Study: Salad Dressing AnMBR

Project Overview

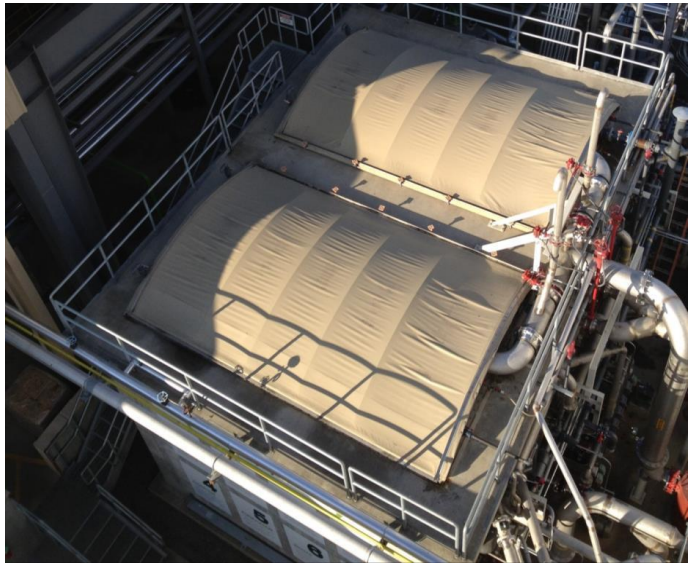
Market: Sauces, Salad dressing
Region: Multiple US
Year of Start-up: 2009, 2016, 2019

Wastewater:
- 130k gpd @ 39,000 mg/l COD
- High concentration of FOG
- Traditionally difficult to treat
- Discharge to POTW

Customer Objectives

- Production expansion
- Compliance
- Upgrade existing infrastructure
- Reduce surcharges

- Reliable wastewater treatment to support fast growing business



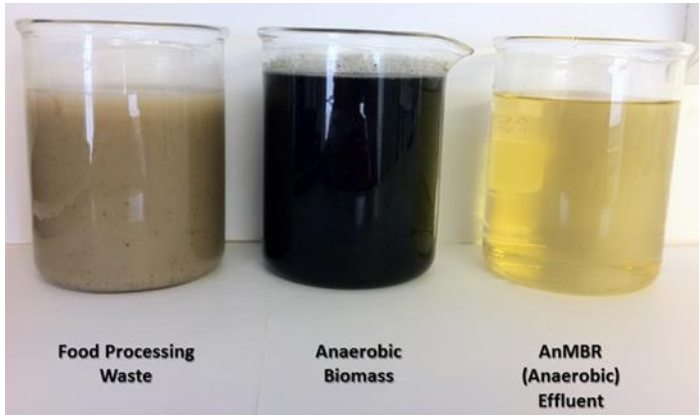
Solution

- Upgrade existing anaerobic system (BVF) to AnMBR

- Delivery: Design-Build

Results

- Consistent removal of over 98% COD
- 12 years without membrane replacement
- Production growth
- Two subsequent AnMBR installations at other facilities



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ADI-BVF Reactor

Proprietary low-rate anaerobic technology developed by ADI Systems (0.5 – 3 kg COD/m3/d)

Most popular AD system in North America known for ease of use and reliability (150+ installations)

Technology is ideal for

- Moderate to high concentrations of FOG and solids
- Variable flows and loads
- Organizations who value reliability and ease of use
- Largest organic loads
- Installation upstream of existing aerobic assets

Not suitable when

- Limited space available for WWTP

Markets

- Dairy, All food, all bev, P&P, pharmaceutical, industrial organic chemicals

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BVF Operating Principles

Conservative up-flow design and low OLR present distinct operating advantages including reduced unit processes

- Large volume provides built in equalization and sludge storage
- Can be used to digest waste biomass and raw waste solids
- Resilient against upsets from variable flows and loads
- No up-front solids and FOG removal required

Long retention time allows breakdown of complex chains

Operates at a wide temperature range

Simplified operations

Few moving parts and little maintenance requirements

Long design life often 25 yrs +

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Case Study: Food Processing BVF

Project Overview

Market: Food Processing, Agri
Region: NE US
Year of Start-up: 2012

Wastewater:
- 2.2 MGD @ 4,700 mg/l COD
- High TSS and FOG
- Variable flows and loads
- Discharge to downstream aerobic

Customer Objectives

- Reduce operating costs
- Sustainability goals
- Increase treatment capacity
- Compliance

- Utilize biogas to create electricity and haul in other feedstocks to increase biogas production

Solution

- 2 x 7.5 MG ADI-BVF reactors
- Biogas utilization w/ CHP

- Delivery: Split Scope

Results

- Consistent removal of over 85% COD
- Sustainability partnership between city and local industry
- Revenue from biogas utilization
- Added revenue from hauled in waste tipping fees

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Summary

- Energy efficient BOD/COD removal
- Valuable biogas produced as bi-product
- Nutrient rich sludge land-applied as fertilizer
- Technology selection function of ww make-up, space available and treatment objectives
- Reducing unit processes reduces cost
- More load means more biogas production
- Invest in characterization
- Think about TCO and future treatment goals
- Definition of sustainability
- Foundation for advanced wastewater treatment and re-use

Questions, Comments and Complaints

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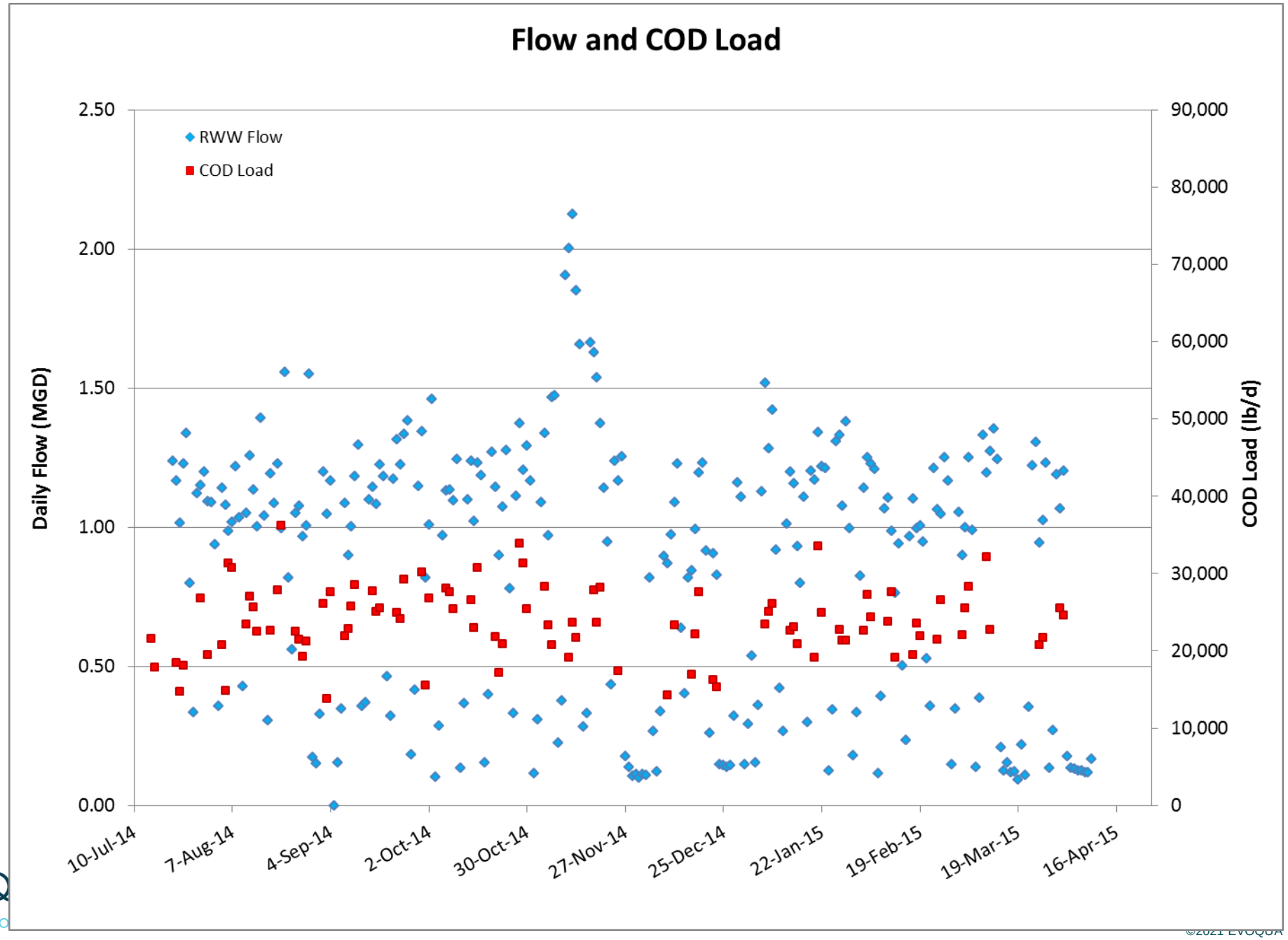
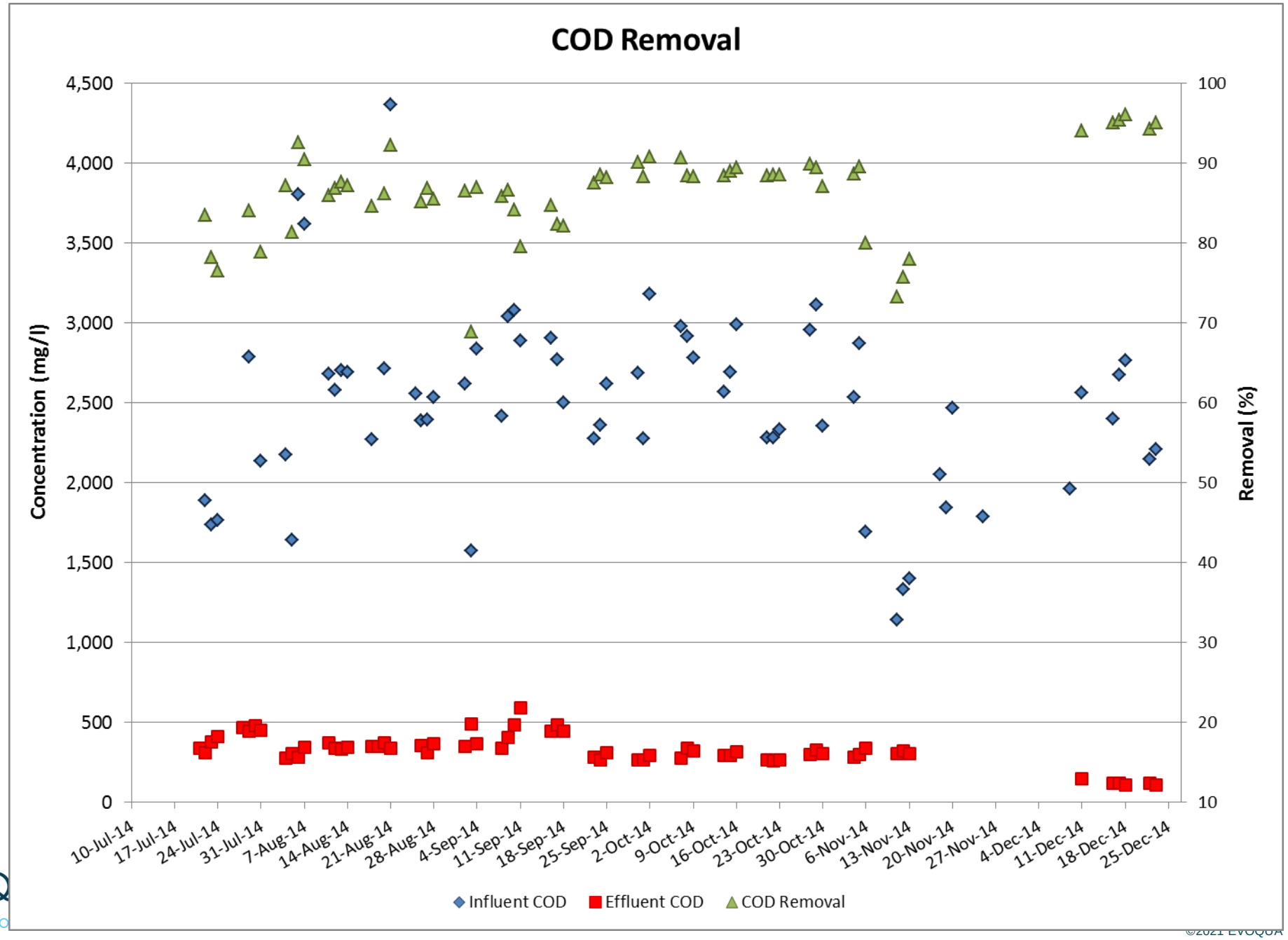
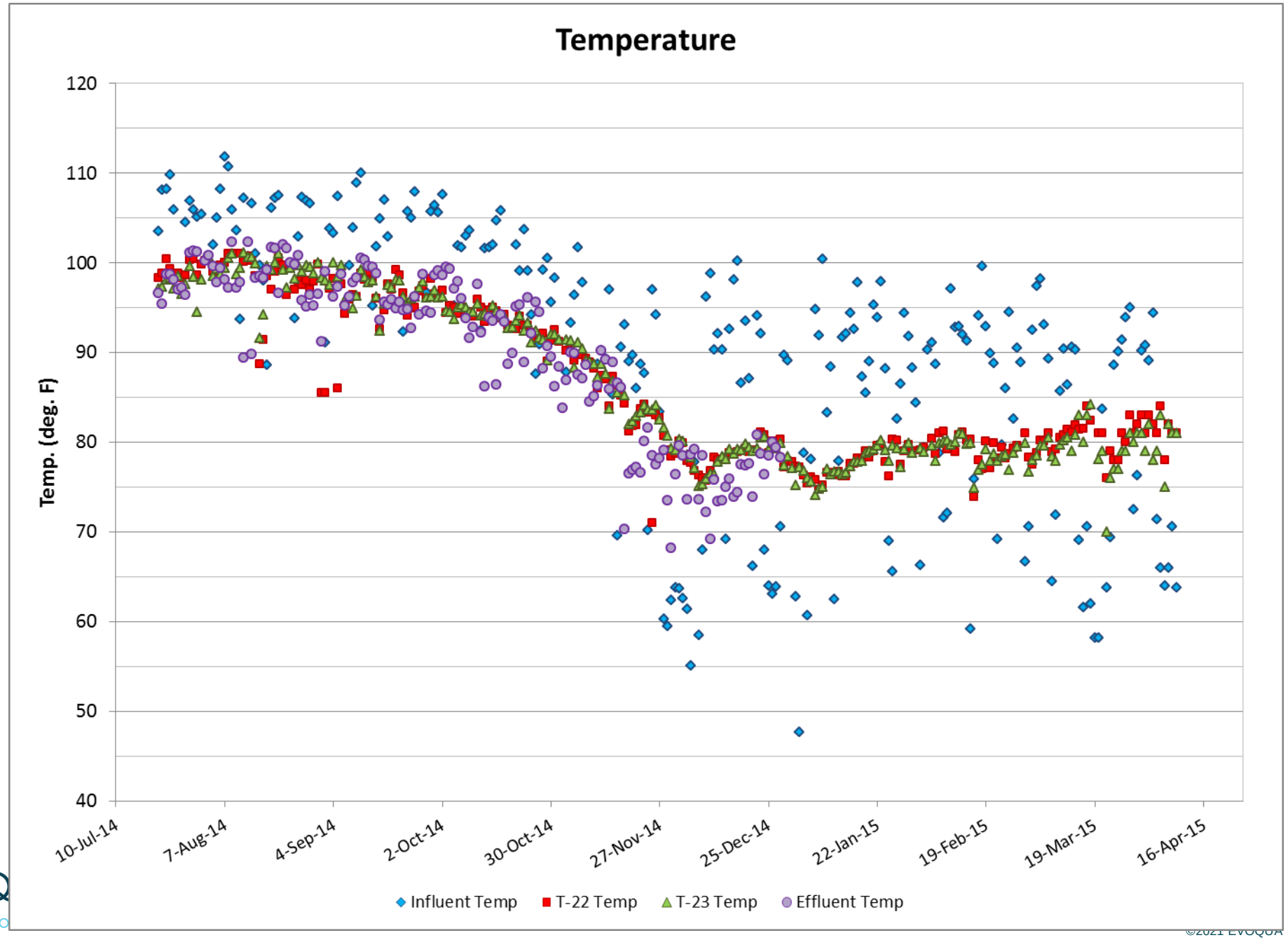
THANK YOU

ADI-BVF Wastewater Characteristics

Parameter	Raw Wastewater	Domestic Primary Sludge	Trucked-in Wastewater	Total Combined Influent	ADI-BVF Effluent
Flow (MGD)	2.10	0.015	0.10	**2.22**	2.22
COD (mg/l)	4,100	34,400	13,100	**4,700**	< 700
BOD (mg/l)	1,900	12,800	3,800	**2,100**	< 200
TSS (mg/l)	1,500	28,800	9,600	**2,000**	< 350
TKN (mg/l)	50	1,450	900	**100**	< 100
NH_3-N (mg/l)	35	890	250	**50**	< 100
TP (mg/l)	9	2	95	**15**	< 15


Flow and COD Load
RWW Flow
COD Load
Daily Flow (MGD)
COD Load (lb/d)
2.50
2.00
1.50
1.00
0.50
0.00
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
10-Jul-14
7-Aug-14
4-Sep-14
2-Oct-14
30-Oct-14
27-Nov-14
25-Dec-14
22-Jan-15
19-Feb-15
19-Mar-15
16-Apr-15


COD Removal
Concentration (mg/l)
Removal (%)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
100
90
80
70
60
50
40
30
20
10
10-Jul-14
17-Jul-14
24-Jul-14
31-Jul-14
7-Aug-14
14-Aug-14
21-Aug-14
28-Aug-14
4-Sep-14
11-Sep-14
18-Sep-14
25-Sep-14
2-Oct-14
9-Oct-14
16-Oct-14
23-Oct-14
30-Oct-14
6-Nov-14
13-Nov-14
20-Nov-14
27-Nov-14
4-Dec-14
11-Dec-14
18-Dec-14
25-Dec-14
Influent COD
Effluent COD
COD Removal


Temperature
Temp. (deg. F)
120
110
100
90
80
70
60
50
40
10-Jul-14
7-Aug-14
4-Sep-14
2-Oct-14
30-Oct-14
27-Nov-14
25-Dec-14
22-Jan-15
19-Feb-15
19-Mar-15
16-Apr-15
Influent Temp
T-22 Temp
T-23 Temp
Effluent Temp

Biogas Capture & Utilization

Gas-tight floating geomembrane cover

Gas can be withdrawn at the rate at which it is produced, or be stored under the covers to optimize usage

Biogas is chemically scrubbed and utilized in a CHP system

Unused gas is burned in a flare

Geomembrane Cover and Vent Stack

Biogas Scrubbing and Flare