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PERFORMANCE OF AN MBBR + DAF AT A CRAFT BREWERY IN VERMONT

Presented by:

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Co-Authors

Wish to thank the following people for their efforts in support of this presentation:

Steve Miller – Alchemist Brewing Company

Rob Trzepacz, P.E. – Technology Sales Associates, Inc.

Chandler Johnson – World Water Works, Inc.

Agenda

Section I: INTRODUCTION

Section II: MBBR + DAF TECHNOLOGY

Section III: ALCHEMIST BREWING & WWTP RESULTS

Section IV: CONCLUSIONS

THE ALCHEMIST BREWING COMPANY

What is Craft Brewing?

- Craft brewers are ***small*** brewers yet currently make up 14% of the beer market & shows continued growth.
- The hallmark of craft beer and craft brewers is ***innovation***.
- Craft beer is generally made with traditional ingredients like malted barley; interesting and sometimes ***non–traditional ingredients*** are often added for distinctiveness.
- Craft brewers tend to be very ***involved*** in their communities through philanthropy, product donations, volunteerism and sponsorship of events.
- Craft brewers have distinctive, individualistic approaches to ***connecting with their customers***.
- <u>The majority of Americans live within 10 miles of a craft brewer.</u>

THE ALCHEMIST BREWING COMPANY

- Building new brewery
- Domestic discharge requirements were goal for new WWTP
- Town requested State of Vermont involvement
- Pilot study required to prove concept

Brewery Wastewater Production

- Basic Guidelines
  - Well managed brewery: 2 bbl ww / bbl of beer brewed **(Alchemist HERE)**
  - Moderately well managed brewery: 3 bbl/bbl
  - Not well managed / no water conservation: 4 bbl/bbl
  - Start up breweries: 5+ bbl/bbl

PARAMETER	BREWERY WASTEWATER DISCHARGE REQUIREMENTS
FLOW	4608 GPD
pH	6.5 – 8.0 SU
Biological Oxygen Demand (5-day)	300 mg/l (11.5 lbs/day)
Total Suspended Solids	300 mg/l (11.5 lbs/day)
Total Phosphorus	5 mg/l (0.2 lbs/day)
Ammonia	25 mg/l (1.0 lbs/day)
Dissolved Oxygen	>2.0 mg/l

Brewery Wastewater – What's in it??

- Spent Grains
- Yeast
- BOD – 2,500 - 3,000 mg/L (poor management >10,000 mg/L)
- TSS – 500 – 1,000 mg/L (poor management >8,000 mg/L)
- pH – 5 - 6

Brewery Wastewater Production

Internal Best Management Practices:

- First rinse management system
- Condensate diversion
- Primary solids separation
- Goal is to knock down strength prior to biological system for stable operations.

Brewery Wastewater Treatment Selection

- Evaluated multiple biological technologies
- Anaerobic – not cost effective at low flows
- MBBR was chosen:
  - ✓ Footprint
  - ✓ Buffering capacity
  - ✓ Reliability
  - ✓ Flexibility
  - ✓ Ease of Operation

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Components to the Aerobic MBBR Treatment System

MAJOR COMPONENTS

- Media
- Stainless Steel Aeration System
- Stainless Steel Sieve Assemblies
- Tank
- Blowers

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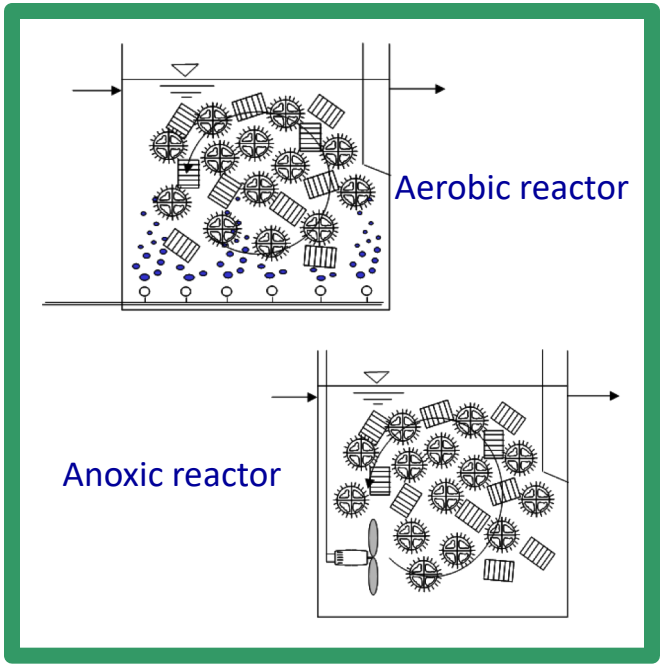
Operation of the MBBR Process



1) Aeration for oxygen & mixing in BOD & nitrification

2) Slow speed mixers for mixing in post-denitrification applications

3) Screens used to retain media in each reactor

4) Multiple reactors used to specialize bacteria for each application

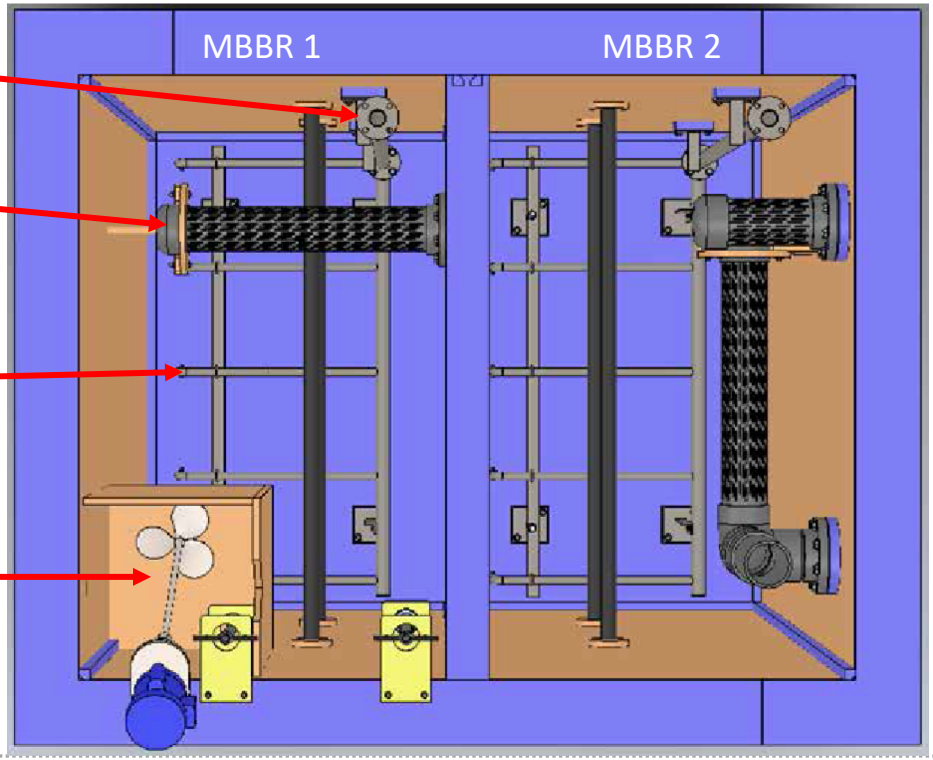
Alchemist Brewing MBBR

Aeration Drop

Media Retention Sieve

Coarse Bubble Aeration Grid

pH Adjustment Tank



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Ideal DAF™ Dissolved Air Flotation

Unique Design Features

- Progressive Water Extraction
- Cross Flow Design
- Polypropylene Design
- DAG™ Microbubbles
- Advanced Pipe Flocculators

Benefits

- High Performance
- Low Operational Costs
- Maximum Longevity
- Small Footprint

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Ideal DAF™ Dissolved Air Flotation

Unique Design Features

- Progressive Water Extraction
- Cross Flow Design
- Plate Separators
- Polypropylene Design
- Cone Bottom Sludge Removal
- DAG™ Microbubbles
- Sludge Thickening Beach™
- Advanced Pipe Flocculators

Benefits

- High Performance
- Low Operational Costs
- Maximum Longevity
- Small Footprint

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Ideal DAF™ - Dissolved Air Generator System

Design Features

- 5 - 12 Micron Bubbles (95%)
- 90%+ Saturation Efficiencies
- Super Duty Construction
- Robust Design
- No Compressed Air Requirement

Benefits

- Consistent Improved Performance
- Reduced Energy Requirements
- Lower Chemical Consumption
- Low Operational Costs
- Low Maintenance

DAG™ Pump
30 HP Model Shaft (28 lbs)

Competitor Pump
30 HP Model Shaft (1 lbs)

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Proving MBBR Technology – MBBR Pilot Test

- Pilot System
  - Flow Rate: 0.4 gpm
  - Volume: 580 gallons
  - HRT: 24 hours

- Original Influent Design Conditions:
  - BOD: 1,850 mg/L
  - COD: 3,000 mg/L
  - TSS: 86 mg/L
- Ran for 1 month on already seeded media

Proving MBBR Technology – MBBR Pilot Test

- Lessons Learned for Full Scale Design
  - Buffering capacity
  - Nutrients are key (N&P)
  - Foam Control
  - Primary Solids Removal
  - Will need to truck effluent until permit can be met by new system

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Alchemist Brewing

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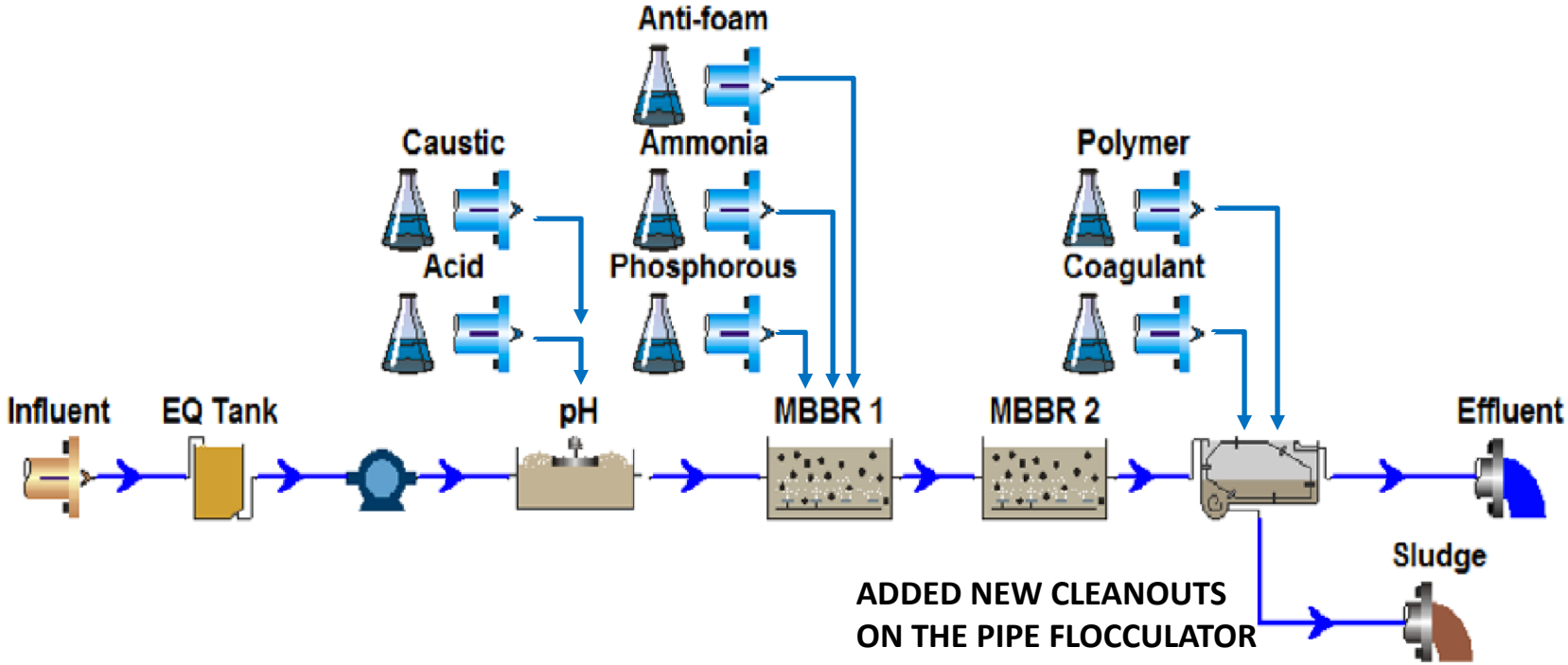
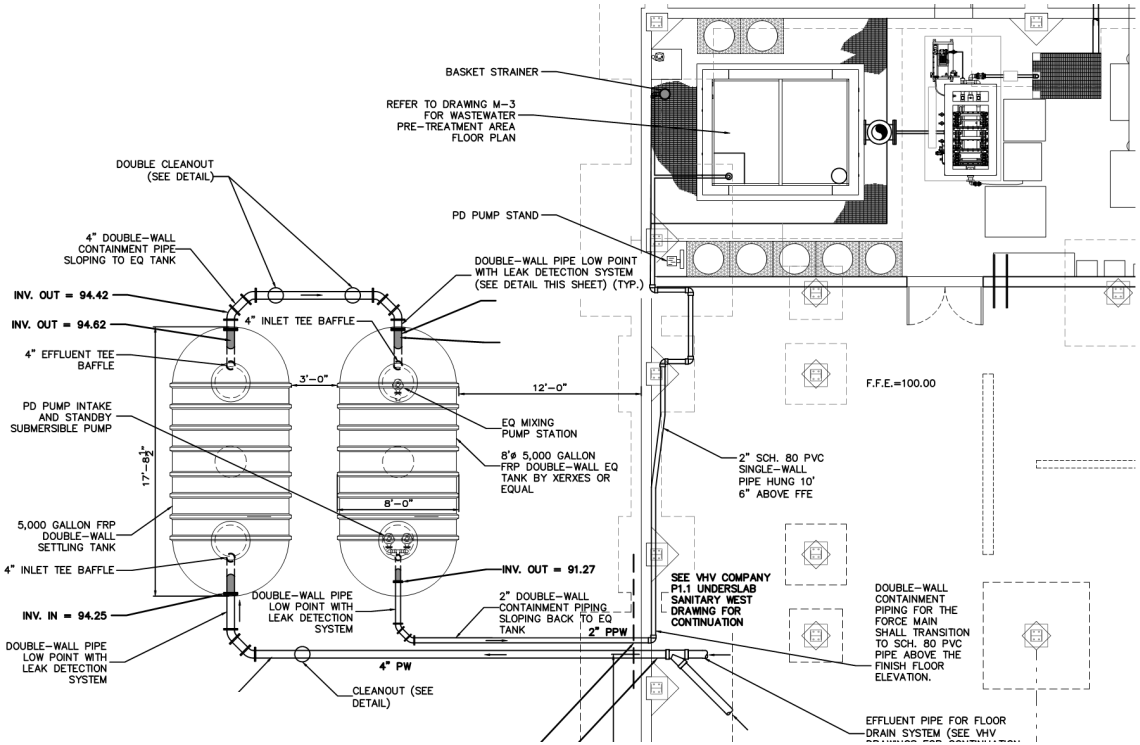
Alchemist Brewing WWTP Process Flow Diagram



Alchemist Brewing WWTP



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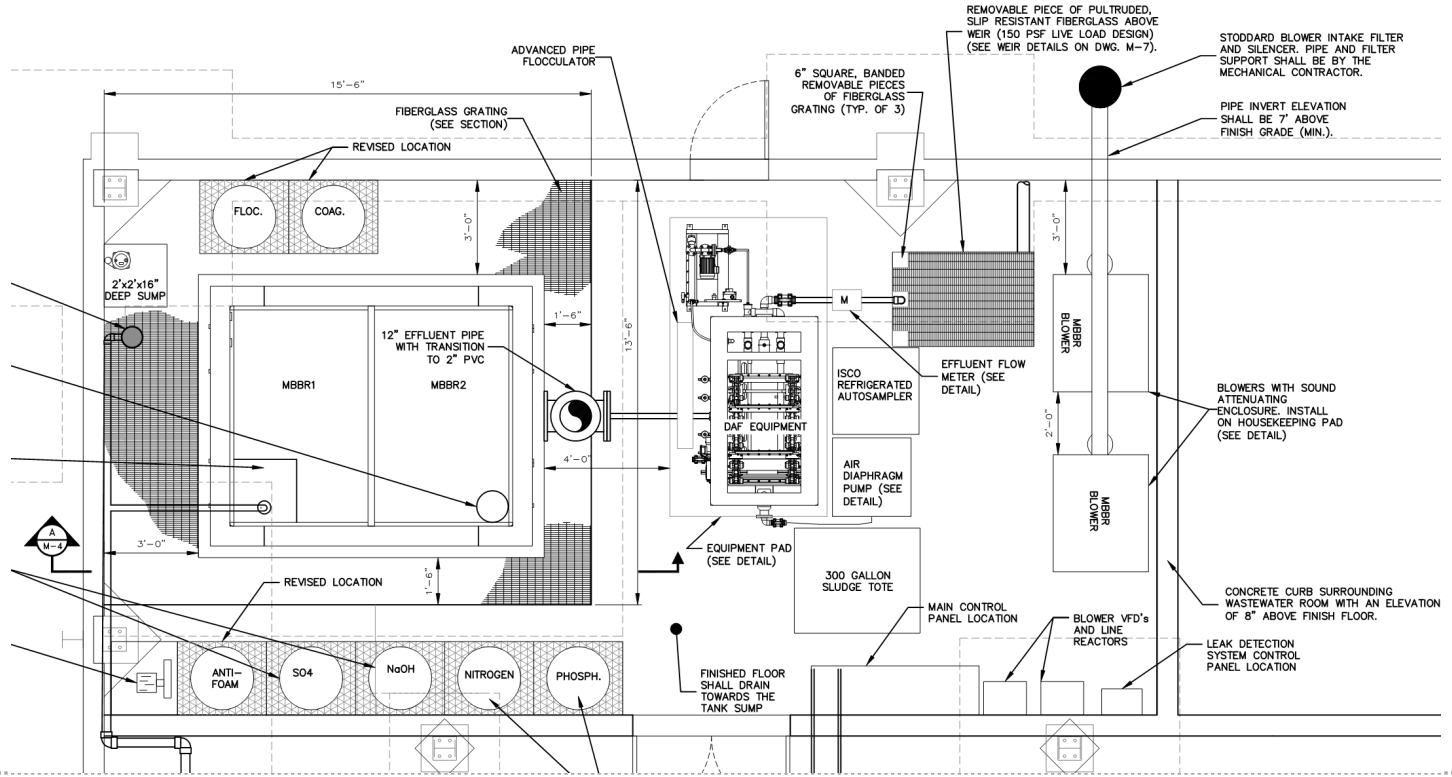
Alchemist Brewing WWTP



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Alchemist Brewery Full Scale Design

Parameter	Design Value	Units	Influent	Effluent
Average Design Flow	Average Design	GPD	2,400	
Max Month Design Flow	Average Design	GPD	2,800	
Peak Design Flow	Average Design	GPM	20	
Total BOD_5	Average Load	mg/L (lb/day)	2,900 (58)	< 300 mg/L
	3 Day Peak Load	mg/L (lb/day)	4,800 (112)	
TSS	Average Load	mg/L (lb/day)	277 (6)	<300 mg/L
	3 Day Peak Load	mg/L (lb/day)	100 (87)	
pH	Range	pH Units	6-8	
Temperature	Minimum	°C	15	
	Maximum	°C	30	
MBBR Effluent Soluble BOD_5*	Concentration	mg/L	2,600 – Average 4,300 - Max	<100 mg/L

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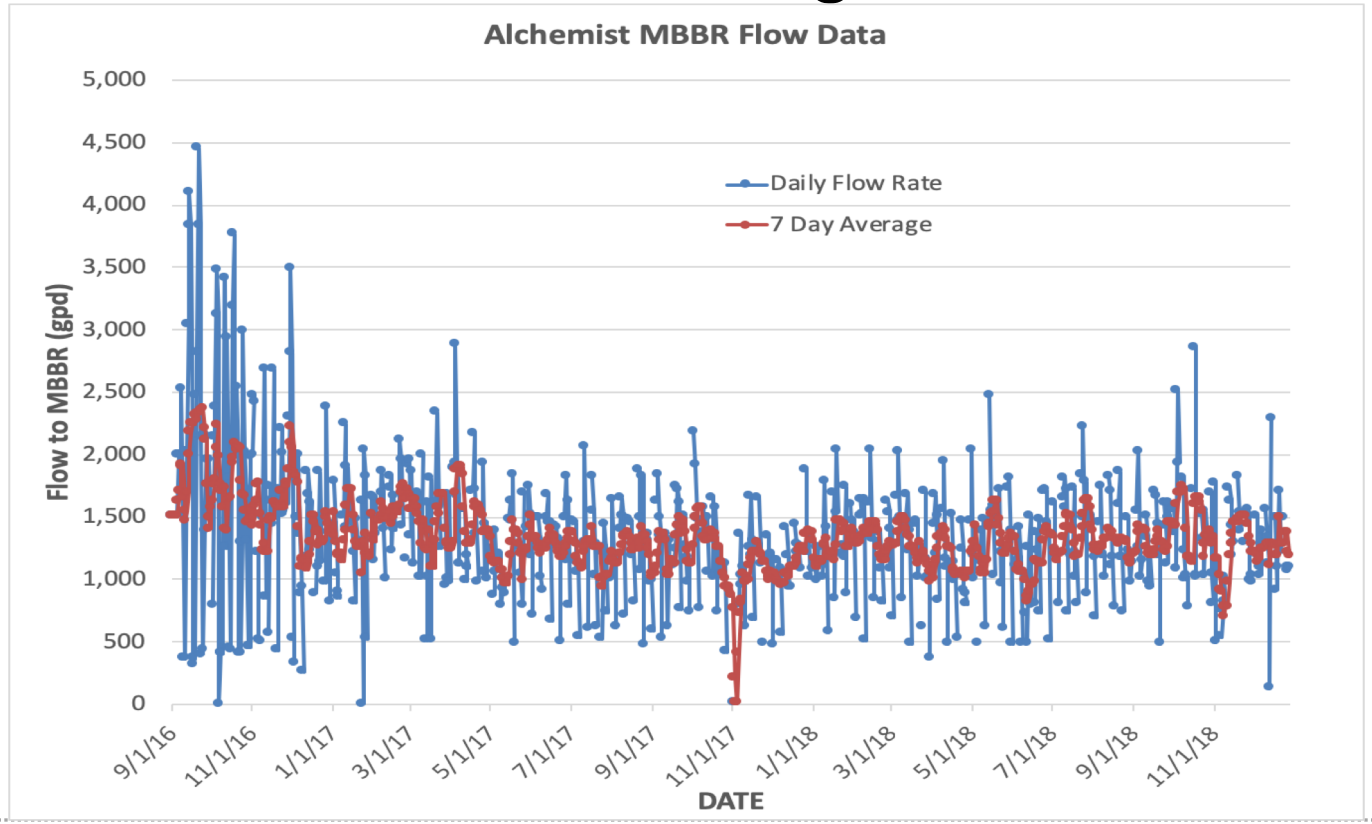
Alchemist Brewing Results



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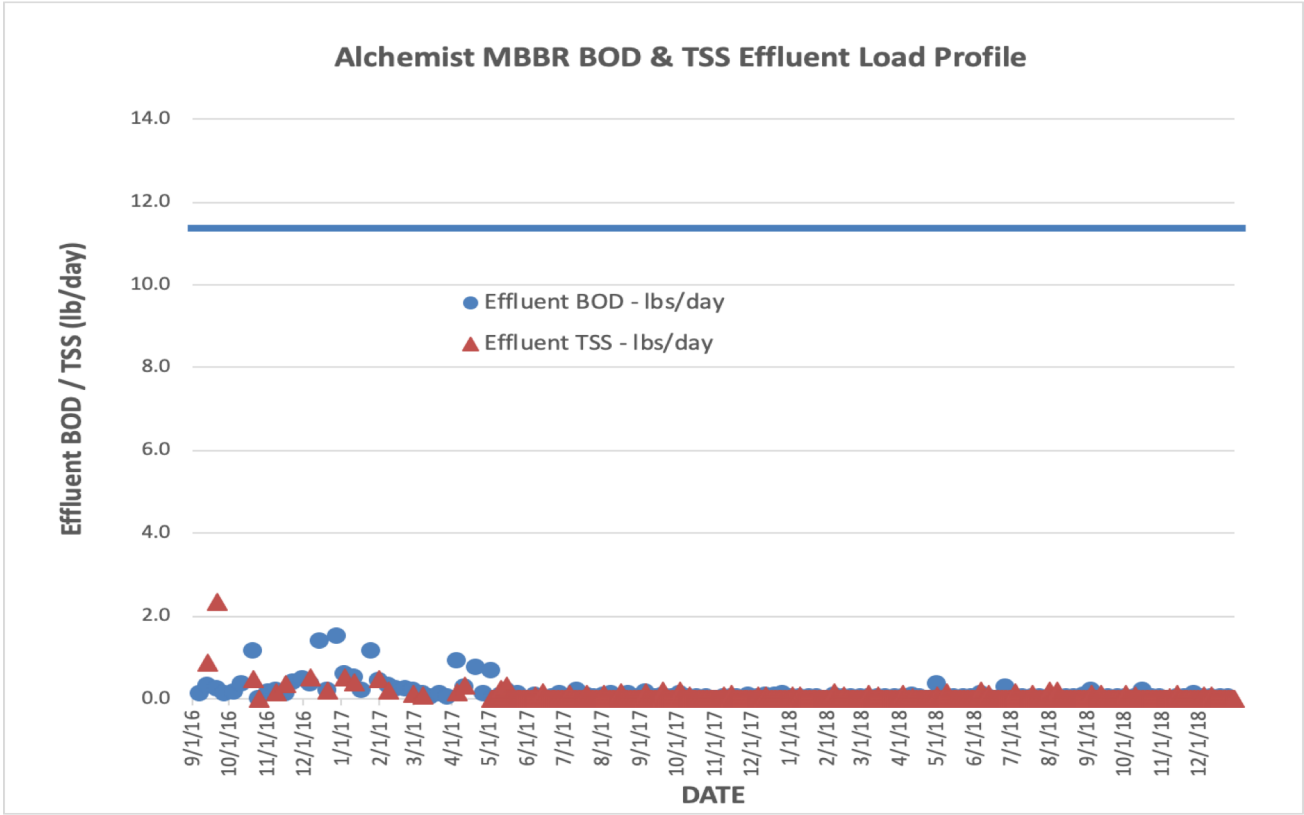
Alchemist Brewing Results



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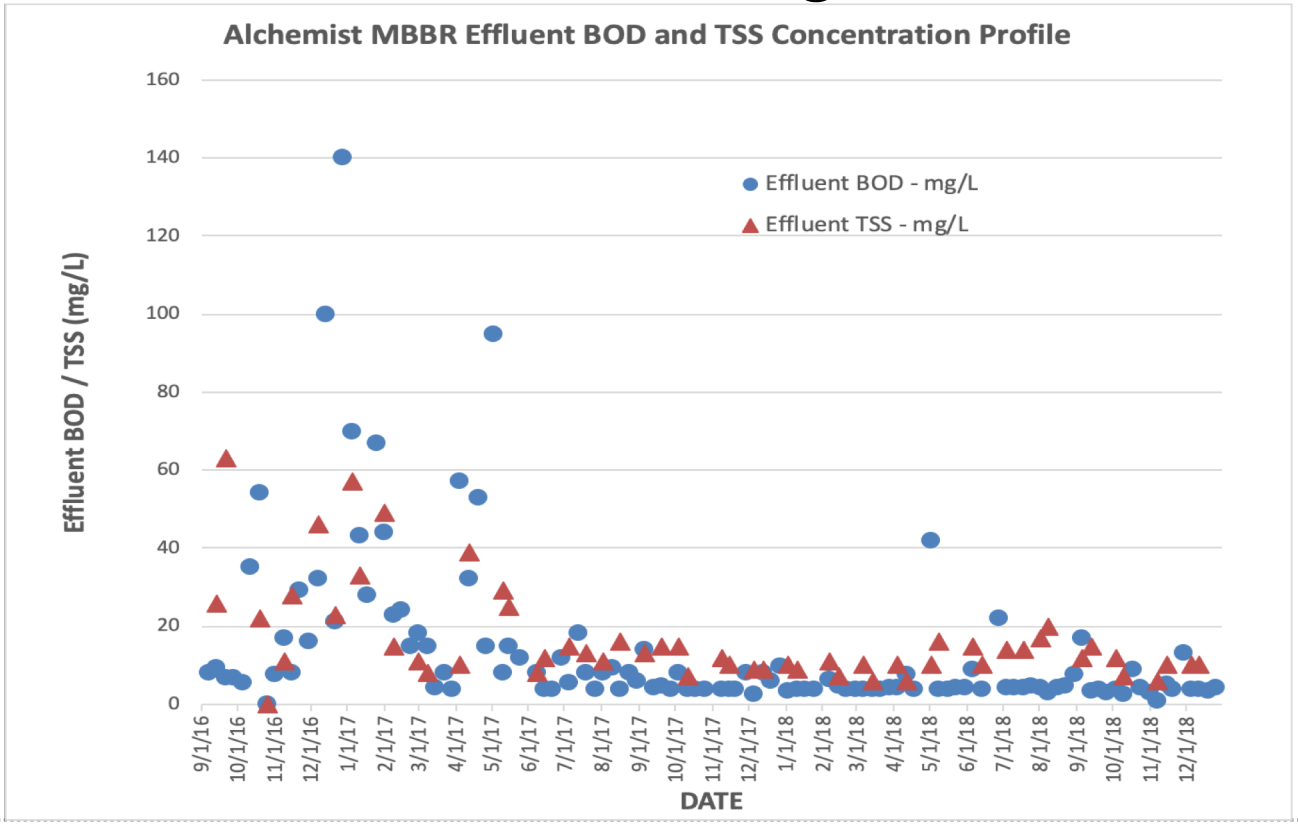

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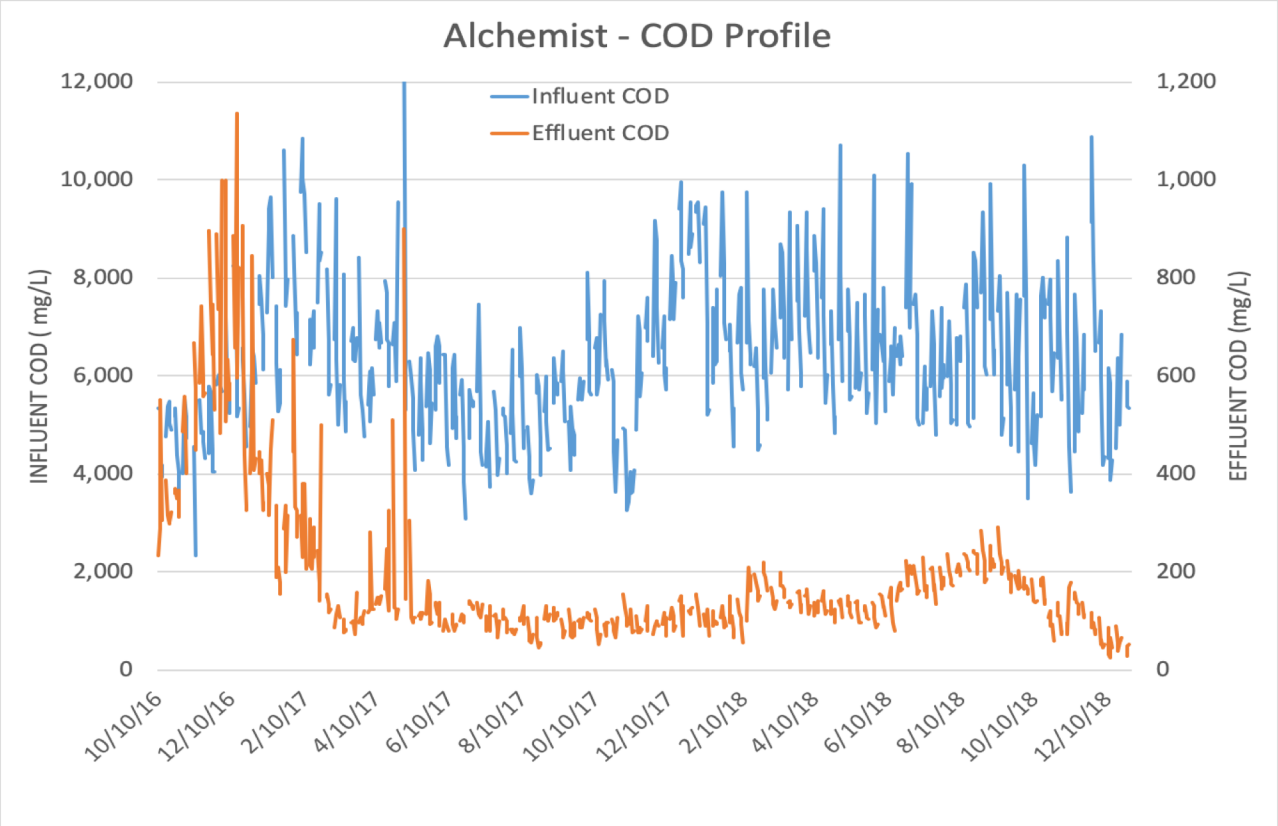

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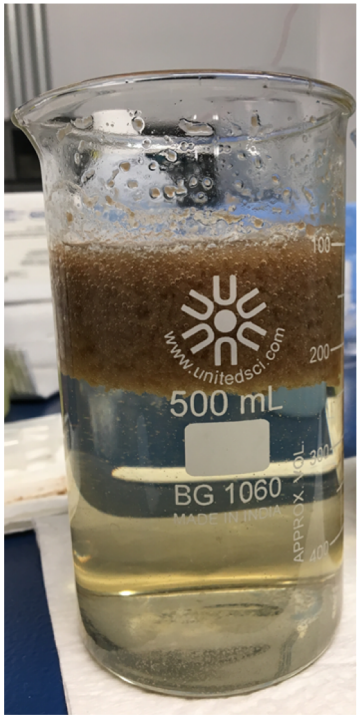
Alchemist Brewing Results

Monthly Avg	FLOW Gallons/day	BOD mg/L	BOD lbs./day	TSS mg/L	TSS lbs./day	TP mg/L	TP lbs./day
TARGETS	(2,800 gpd)	(300 mg/L)	(11.5 lb/day)	(300 mg/L)	(11.5 lb/day)	(5 mg/L)	(0.2 lb/day)
September-16	1,949	7.70	0.21	44.50	1.62	0.07	0.003
October-16	1,697	31.53	0.55	22.00	0.47	0.06	0.001
November-16	1,692	15.58	0.26	19.50	0.24	0.10	0.001
December-16	1,312	73.25	0.87	34.50	0.37	0.32	0.003
January-17	1,368	52.00	0.61	45.00	0.45	1.15	0.013
February-17	1,467	39.25	0.46	38.50	0.39	0.82	0.009
March-17	1,378	9.86	0.10	9.50	0.09	1.13	0.012
April-17	1,539	39.25	0.52	24.50	0.24	0.33	0.004
May-17	1,233	32.50	0.26	27.00	0.27	2.13	0.016
June-17	1,260	6.90	0.07	10.00	0.12	0.92	0.007
July-17	1,174	8.85	0.09	14.00	0.12	0.92	0.007
August-17	1,259	4.80	0.04	18.50	0.19	1.45	0.016
September-17	1,232	6.73	0.08	14.00	0.19	0.81	0.008
October-17	1,286	5.05	0.06	11.05	0.13	1.04	0.012
November-17	1,064	5.03	0.05	11.00	0.10	0.84	0.007
December-17	1,129	6.58	0.06	9.00	0.08	0.93	0.009
January-18	1,288	3.88	0.03	9.50	0.08	0.43	0.004
February-18	1,308	4.70	0.05	9.00	0.11	1.08	0.013
March-18	1,224	4.03	0.04	8.00	0.09	1.91	0.021
April-18	1,186	5.27	0.05	8.00	0.08	0.84	0.009
May-18	1,339	11.68	0.10	13.00	0.12	0.93	0.011
June-18	1,096	11.57	0.13	12.50	0.14	1.79	0.017
July-18	1,397	4.30	0.05	14.00	0.13	2.11	0.025
August-18	1,259	4.80	0.04	18.50	0.19	1.45	0.016
September-18	1,335	6.80	0.07	13.50	0.12	1.32	0.016
October-18	1,419	4.60	0.07	9.50	0.08	1.31	0.016
November-18	1,241	5.65	0.06	8.00	0.07	0.49	0.004
December-18	1,255	3.83	0.04	10.00	0.09	0.26	0.003

Alchemist Brewing Results



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Conclusions

- Flow EQ needed due to intermittent waste generation
- Additional EQ in design for brewery containment
- Primary settling of solids
- Installation of bypass for re-circulation
- Anti-foam / Nutrient feed systems
- Nikuni pump dissolved enough oxygen to meet effluent DO limit
- System exceeds effluent requirements for all parameters

Operational Modifications

- Flow EQ needed due to intermittent waste generation
- Splitter for de-foamer to control foam in both stages
- DrumQuick fittings for improved air quality
- Auto-dialer for alarms
- PD pump replaced centrifugal for forward flow control
- Installation of degassing chamber after DAF for flow measurement

thank you- Any Questions?

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