An Innovative Approach to Brewery Wastewater Treatment

Presented by:

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THE ALCHEMIST BREWERY
Stowe, VT

What is Craft Brewing?

- Craft brewers are ***small*** brewers yet currently make up 24% of the beer market which is over $114B/year.
- 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 BREWERY

- Building new brewery

- Domestic strength wastewater discharge
- Town requested State of Vermont involvement
- Pilot study required to prove concept

Brewery Wastewater - What's in it?

- Spent Grains
- Trub
- 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

Basic Guidelines:

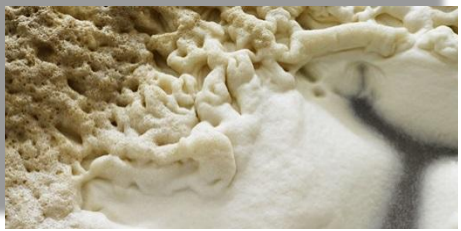
- Well managed brewery: 2 bbl ww / bbl of beer brewed **(*Alchemist HERE*)**
- Moderately well managed brewery: 3 bbl/bbl
- Not well managed / no water conservation: 4 bbl/bbl
- Start up breweries: 5+ bbl/bbl

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 Production

Internal Best Management Practices:

- First rinse management system
- Condensate diversion
- Segregate Solids:
  - ✔ Spent grains
  - ✔ Trub
  - ✔ Yeast

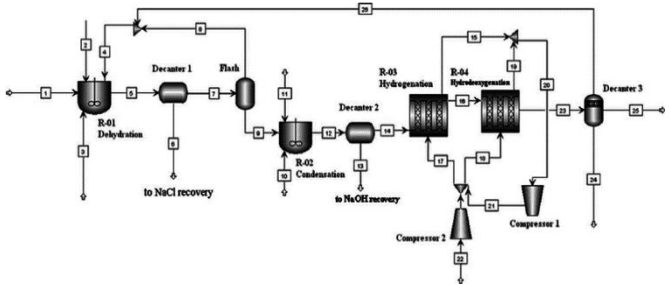


Goal is to knock down strength prior to biological pre-treatment for stable operations.

Pre-treatment Alternative Selection

- Evaluated multiple biological technologies
- Anaerobic - not cost effective below 150,000 bbl/year production
- MBBR was chosen:
  - ✔ Small Footprint
  - ✔ Buffering Capacity
  - ✔ Reliability
  - ✔ Flexibility
  - ✔ Ease of Operation

World Water Works
Oklahoma City, OK

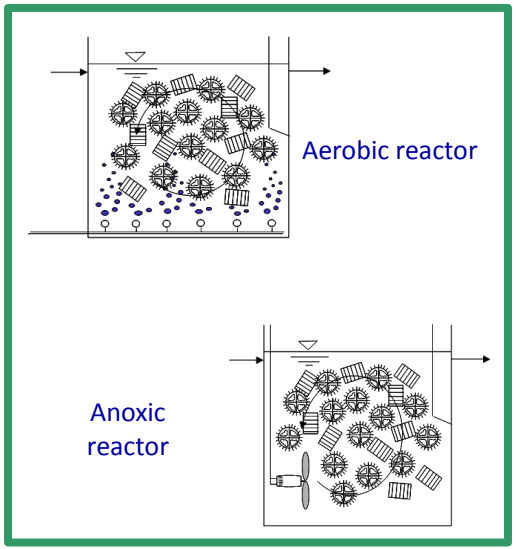


MBBR Treatment System

MAJOR COMPONENTS:

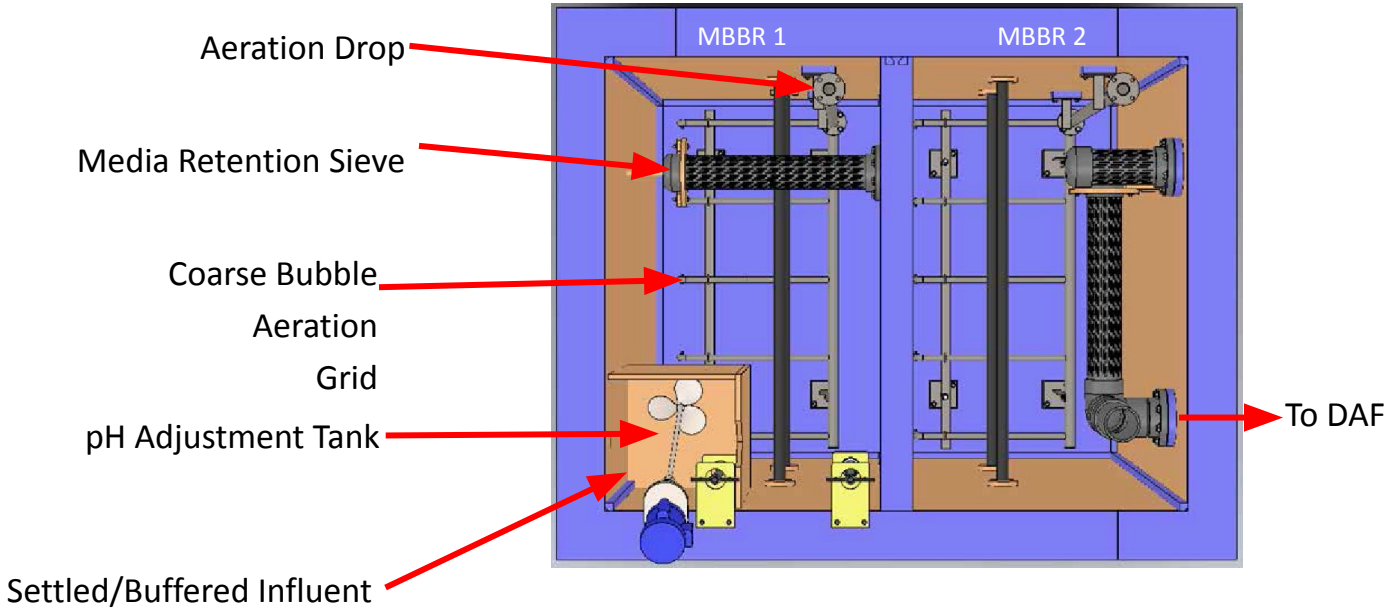
- Media
- Stainless Steel Aeration System
- Stainless Steel Sieve Assemblies
- Tank
- Blowers

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 MBBR



Dissolved Air Flotation (DAF)

Design Features

- Water Extraction
- Polypropylene Fabrication
- Sludge Removal
- Microbubbles
- Sludge Thickening
- Flocculation

Benefits

- High Performance
- Low Operational Costs
- Small Footprint

Proving MBBR Technology
Waterbury Brewery Pilot Test

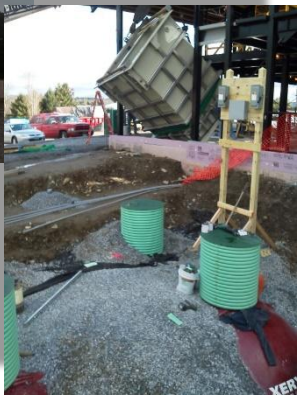
- Pilot System Skid:
  - Flow Rate: 0.4 gpm
  - Volume: 580 gallons
  - HRT: 24 hours
- Original Influent Design Conditions:
  - BOD: 1,850 mg/L
  - COD: 3,000 mg/L
  - TSS: 86 mg/L
- Ran for 1 month on already seeded media
- Exceeded 90% BOD Removal

Proving MBBR Technology
Waterbury Brewery Pilot Test

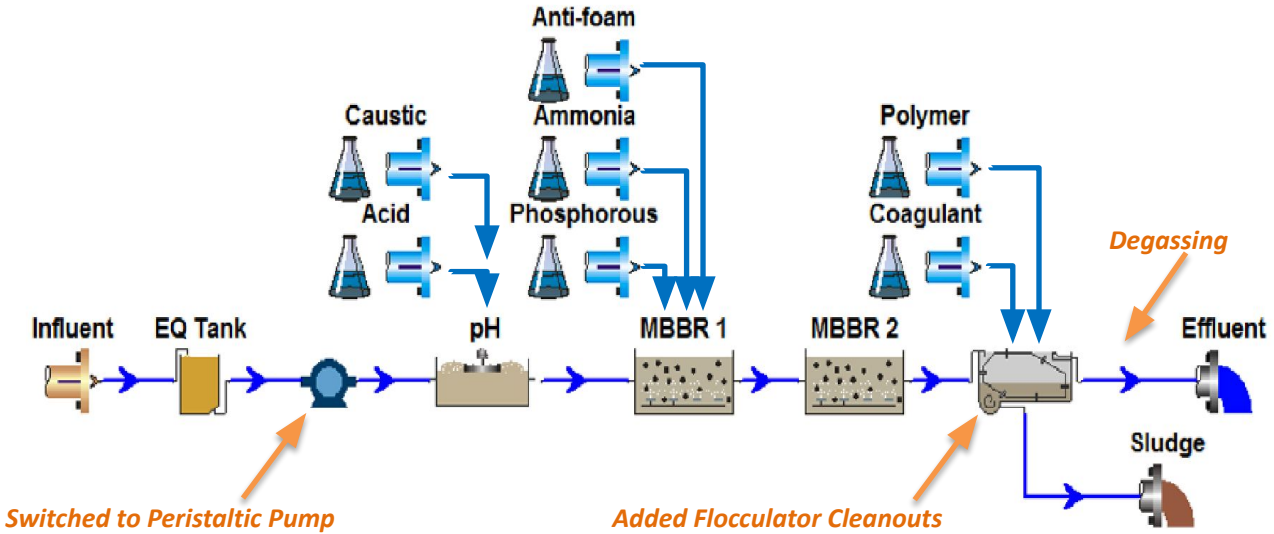
Lessons Learned for Full Scale Design:

- Good Buffering Capacity
- Nutrients are Key (N&P)
- Foam Control is Key
- Primary Solids Removal
- Will need to truck effluent until permit can be met by new system

Alchemist Construction

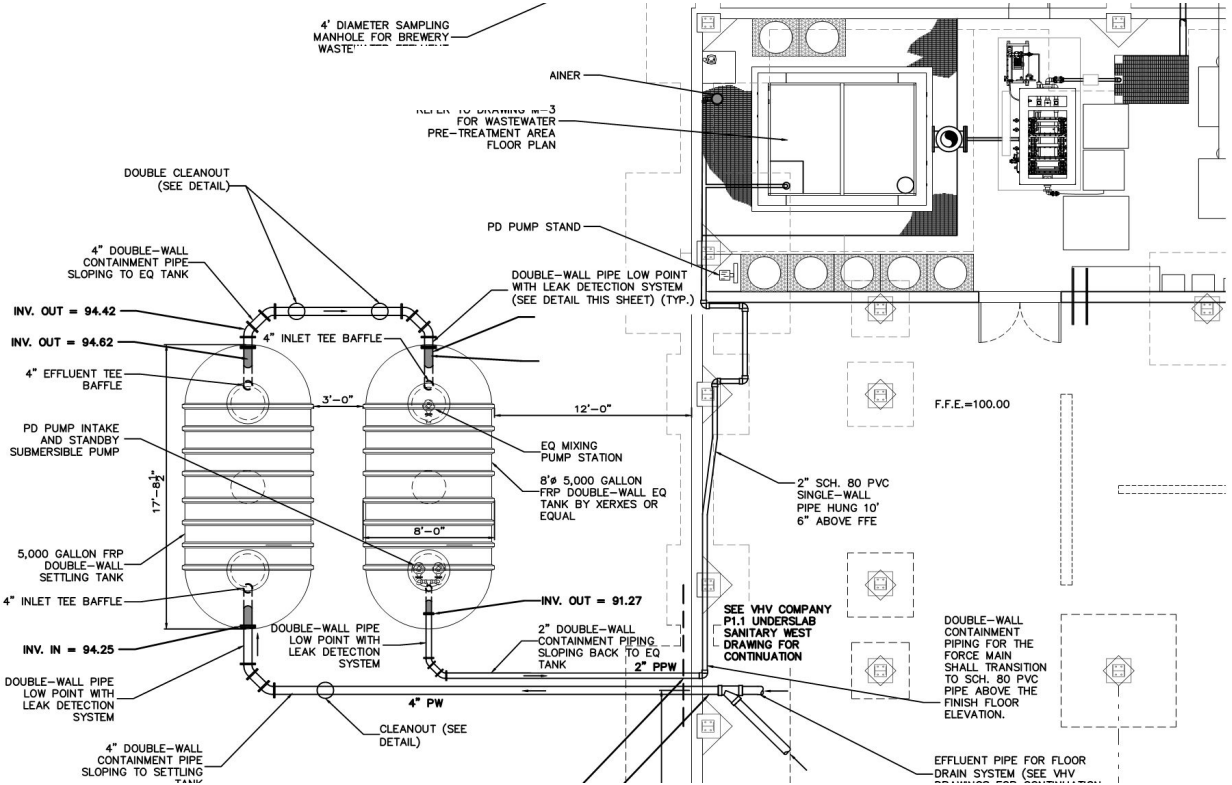


Pre-treatment Process Flow Diagram

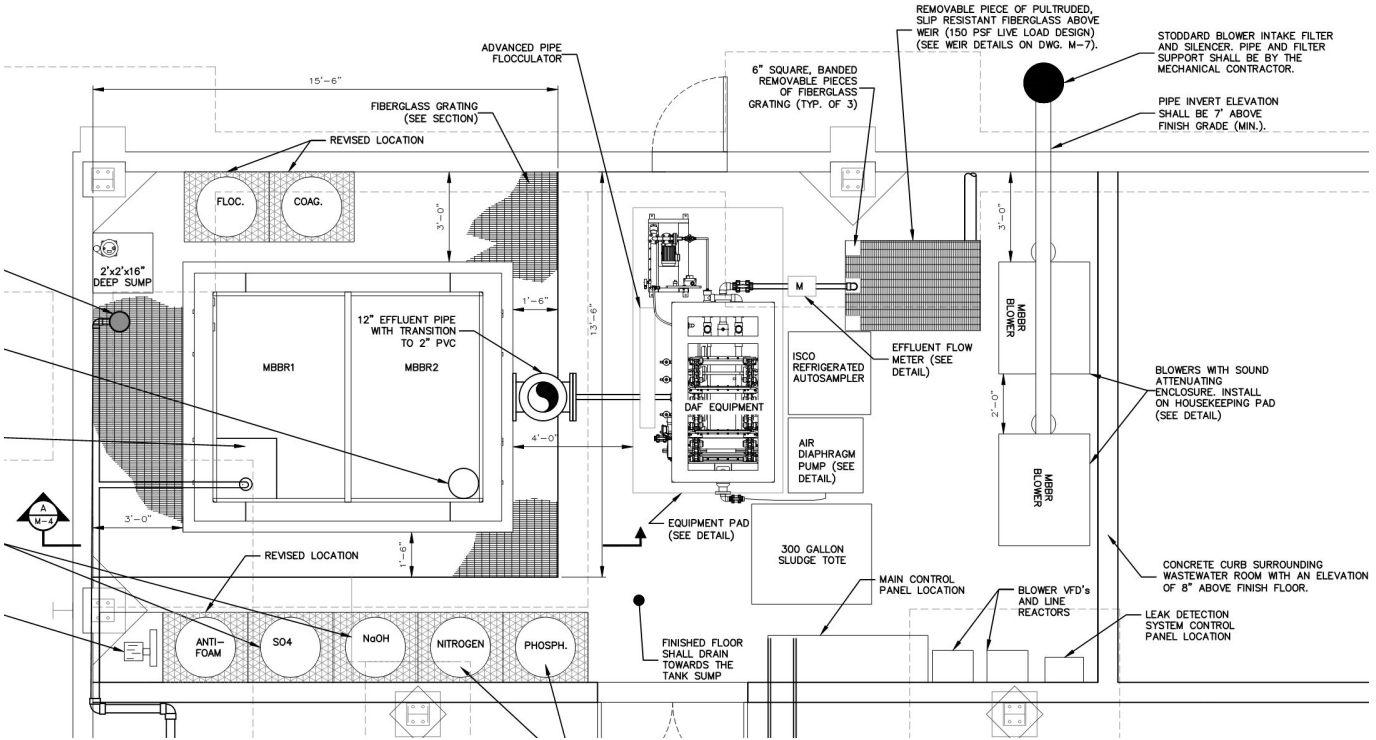


** Post Construction Modifications*

Pre-treatment Plan



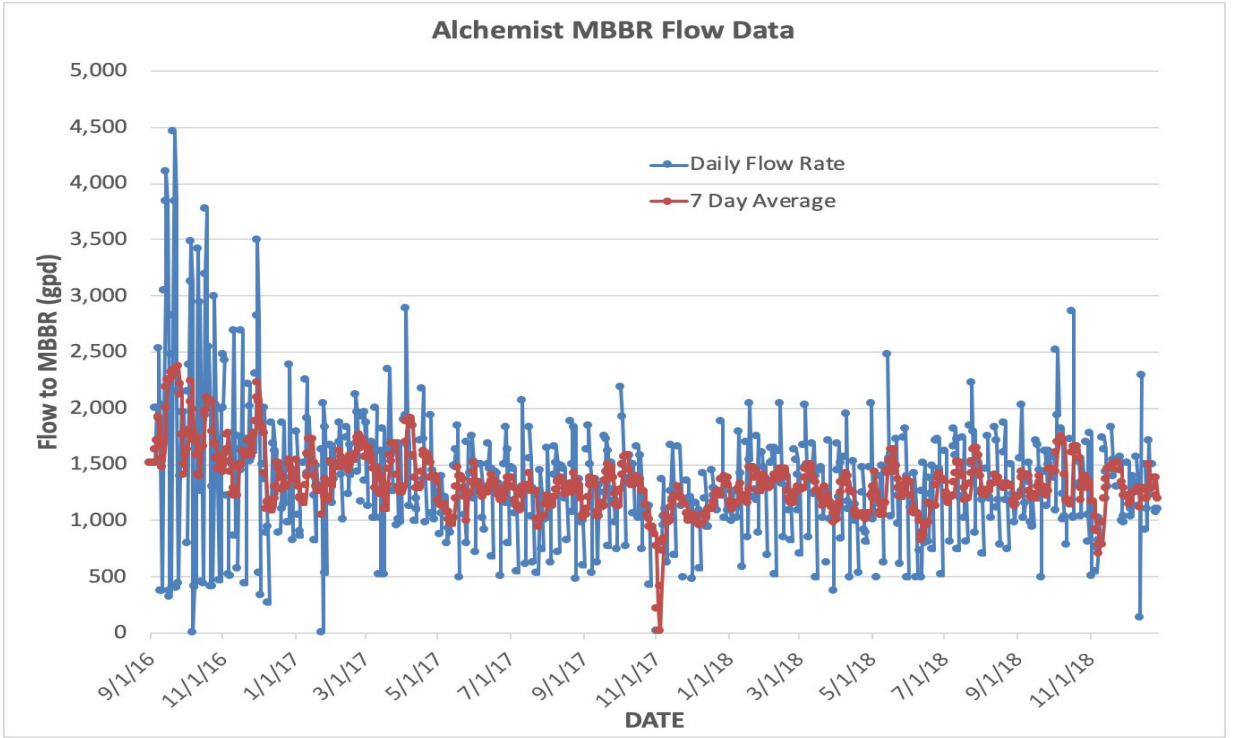
Pre-treatment Room Plan



Pre-treatment 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

Pre-treatment Results



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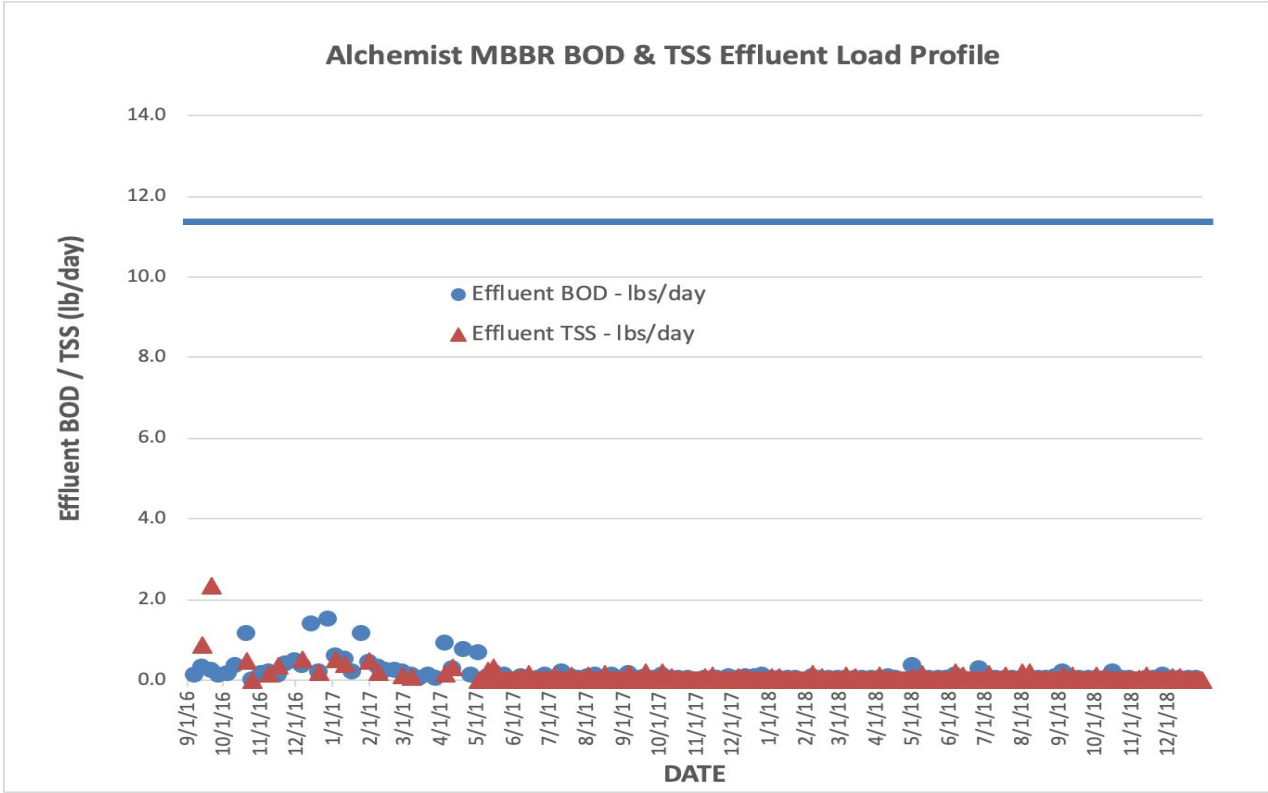

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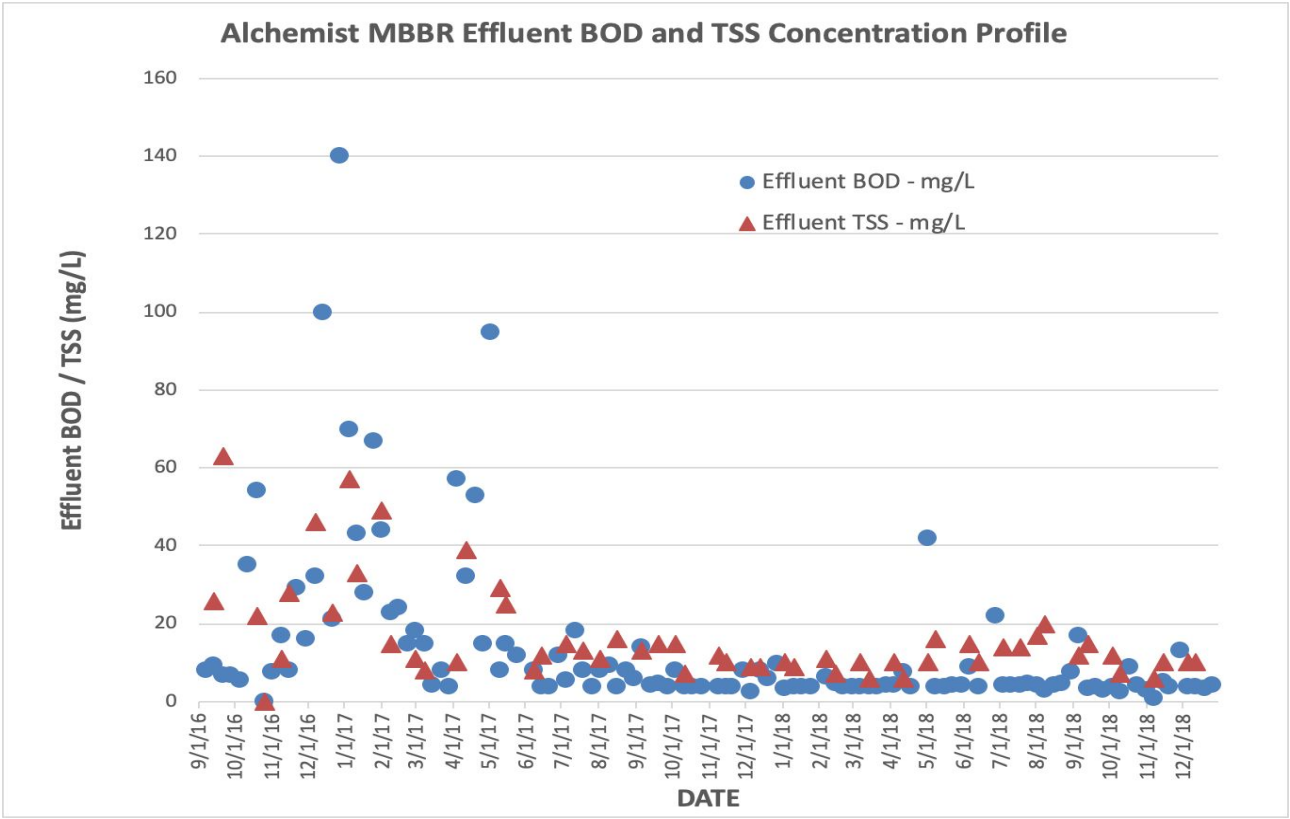

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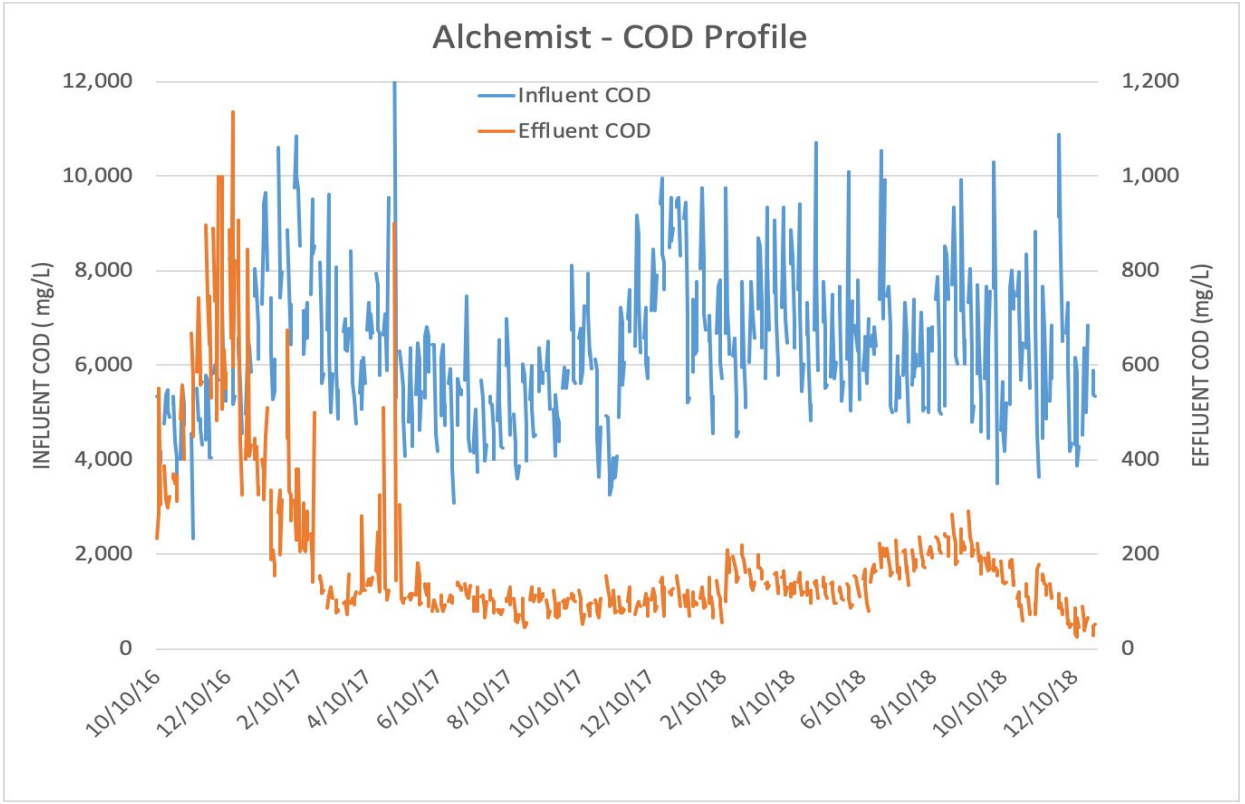

Pre-treatment Results

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

Pre-treatment Results

MBBR Effluent

Post-floccul ation

DAF Effluent

Conclusions

- Flow EQ needed due to intermittent flows
- Additional EQ volume for brewery containment
- Primary settling of solids upstream of biological
- Installation of bypass for re-circulation
- Anti-foam / Nutrient feed systems
- DAF pump dissolved enough oxygen to meet effluent DO limit
- System consistently exceeds effluent requirements for all parameters

Operational Modifications

- 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 better forward flow control
- Installation of degassing chamber after DAF for improved flow measurement

Questions & Discussion

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