STONE BREWING CO.

NORTH COUNTY SAN DIEGO

Evolution of a Waste Water Treatment System

My background

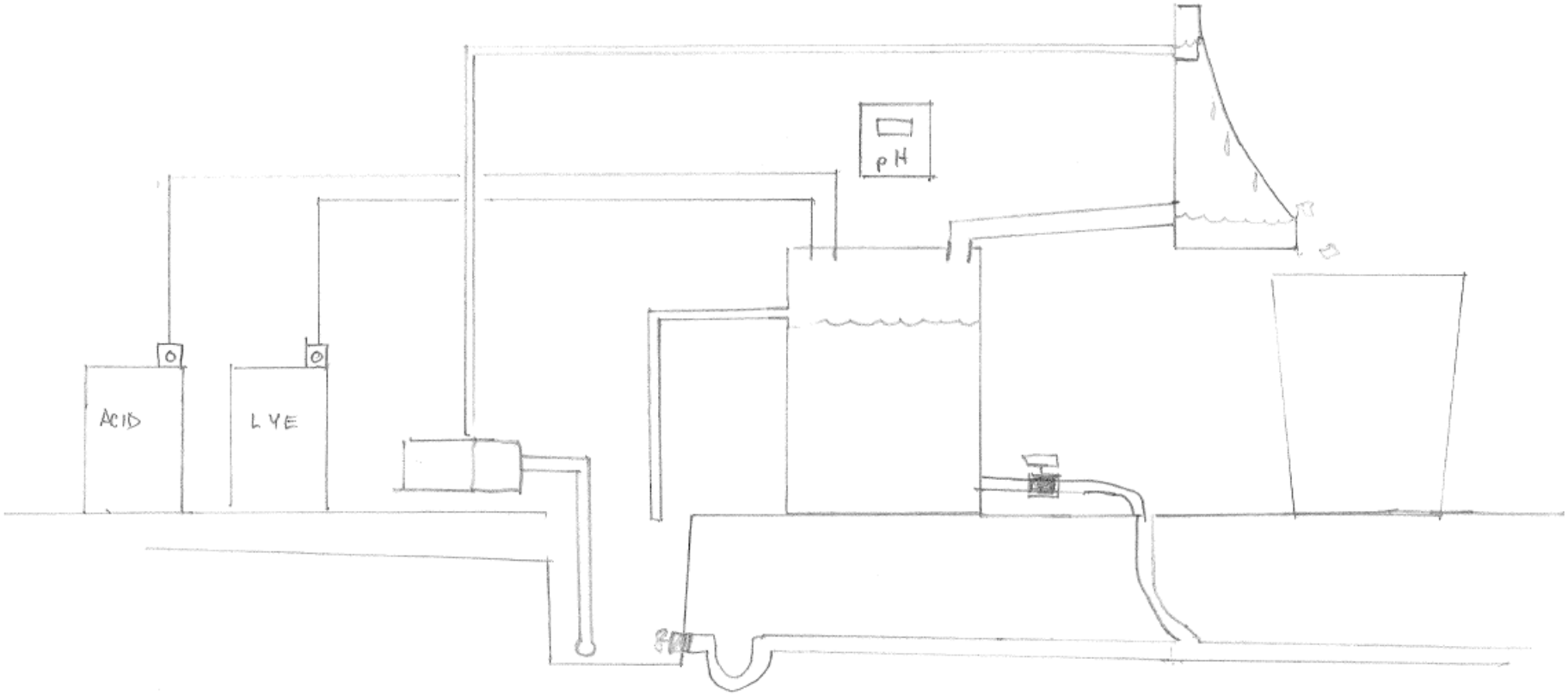
- 15 years construction, carpentry and woodworking
- Began home brewing 1984
- Began brewing professionally in 1990
- Designed and built Oasis Brewing pub brewery 1992
- Designed and built Oasis Annex production brewery and bottling plant 1994
- Began work at Stone Brewing Co 2000
- Expanded existing brewery, designed and built new brewery in Escondido 2005
- Have won 9 GABF and 5 World Beer Cup medals for my beer recipes

Stone Brewing Stats

Stone has been the fastest growing craft brewery in the United States since its founding in 1996. Known for brewing groundbreaking, bold, and immensely flavorful craft beers, Stone has been named "the Top Brewery on Planet Earth, The Most Popular and Highest Rated Brewery—Ever" by BeerAdvocate Magazine. Stone is committed to environmental and social responsibility, from installing one of the largest rooftop solar arrays in California to being the biggest restaurant purchaser of local small-farm organic produce in San Diego County at the Stone Brewing World Bistro & Gardens.

First treatment system

- Waste water limits were brought to our attention in 2004 at our original location in San Marcos. [glass, caps, pH 12.4 found in sewer pipe!]
- We responded by quickly building a crude solids straining and pH correction system.
- That experience gave us some insight into the world of waste water and helped prepare us for designing a proper system for our new brewery.


pH
ACID
LYE

New brewery

- The new brewery was completed in late 2005.
- Waste water treatment is located outside
- All brewing processes drain to floor, floor drains all dump to a 1500 gallon sump
- Lift pump to rotary strainer [0.01” gap] 50 gpm
- Strainer drains to 700 gal. tank w/ mixer, pH monitor, level switches.
- Pipe from tank to drain has a non resettable totalizing magmeter plus auto shut off valve
- pH correction tank also has a lift pump to send overflow to 15,000 holding tank

STONE BREWING CO.

Rotary Strainer

pH Mixing Tank

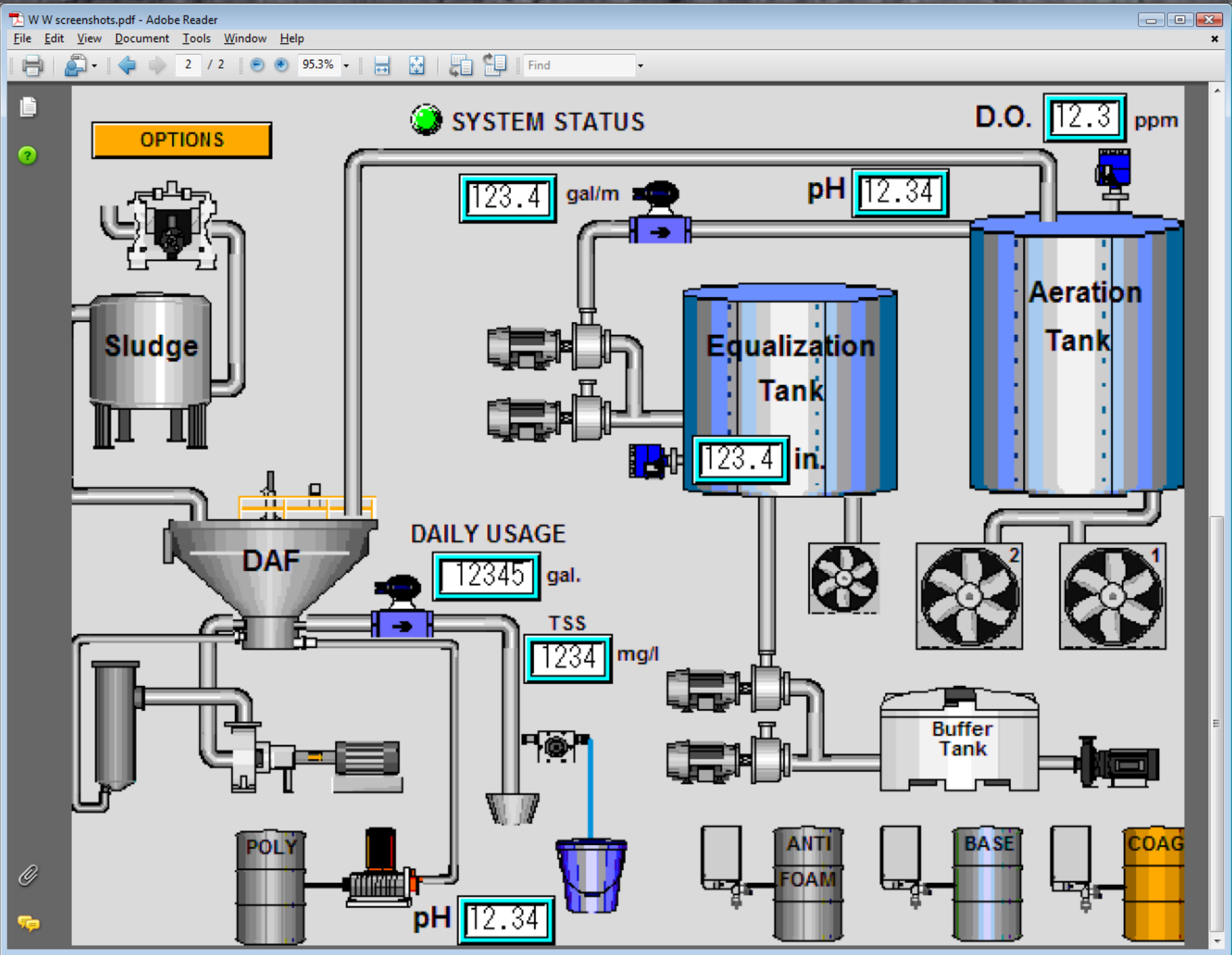
Rotary strainer on a bad day

Need for expansion of waste water

- Our BOD and TSS levels increased with production
- We added a tank and began diverting high strength effluent from the brewhouse
- The city decided to charge based on strength
- Rate increase proposed from $2.70 to $46 /1000 gallons
- We signed a contract with a design build contractor to install a treatment plant
- The city agreed to defer the rate increase.

New system features

- Utilize existing sump, strainer, use pH tank as pump station to EQ
- Add 40,000 gallon EQ tank
- Add 80,000 gallon aeration tank
- Install DAF clarifier
- Install screw press for sludge dewatering
- Utilize existing 15,000 tank as sludge tank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D.O.
12.3
ppm
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Sludge
Equalization Tank
123.4
in.
Aeration Tank
DAF
DAILY USAGE
12345
gal.
TSS
1234
mg/l
Buffer Tank
POLY
pH
12.34
ANTI FOAM
BASE
COAG
2
1

- The new system came on line August 2008
- Reasonable BOD destruction
- Usually had adequate TSS removal
- The system more or less worked but was riddled with problems.
- It was unreliable, consumed huge amounts of expensive polymers, coagulants, was prone to break downs, required a lot of labor and maintenance, was smelly and in general was a nightmare to operate.

Lesson 1

- Never use a DAF system for solids separation when your permit depends on low TSS and BOD. We found the DAF to be very high maintenance, very unreliable, high electrical demand, consuming huge amounts of expensive polymers and coagulants and the slightest glitch can turn it into your worst nightmare within minutes and once repaired, recovery back to clarity can take hours.


FINAL EFFLUENT →

Lesson 2

- As a rule most DAF upsets will occur between midnight and 4 am and the supporting pumps and piping also prefer to rupture and spew massive volumes of sludge around the entire area when nobody is watching. As a rule the waste water inspector will stop by unannounced the morning when both the DAF upset has occurred and the sludge piping has ruptured. Never leave a DAF unattended.

Lesson 3

- Also regarding sludge spills; it is wise to never use a couple feet of gravel to fill in around tanks that could potentially spill massive volumes of sludge that would need to be cleaned up to prevent rotting and stinking and large numbers of maggots and flies to breed.

Lesson 4

- Never put your waste water sludge into a big plastic tank for storage without any aeration or the sludge will immediately go septic, discharging dangerous levels of hazardous hydrogen sulfide gas and other noxious odors that are not conducive to pleasant dining in a nearby beer garden or healthy operation of a sludge press.

Lesson 5

- Never use a screw press to dewater waste water sludge, especially if it is held in a big plastic tank to rot. A screw press is a fine machine to squeeze manure or fruit pulp, or as we happily learned, is also excellent for dewatering spent grain, but is a terrible choice for dewatering brewery waste water sludge. A screw press, dewatering rotting sludge from a dead tank will send vile, stinky liquid back into the treatment system and the entire system will become vile and stinky, ticking off the neighbors and repulsing patrons on the patio trying to enjoy an aromatic Stone IPA.

Lesson 6

- If you do use a screw press and generate loads of smelly, wet, dripping sludge, never try to send it in a dumpster to the landfill; the trash truck will receive it, go to the next stop and then compress his load, squeezing piles of stinky sludge and sludge juice into the next guy’s parking lot.

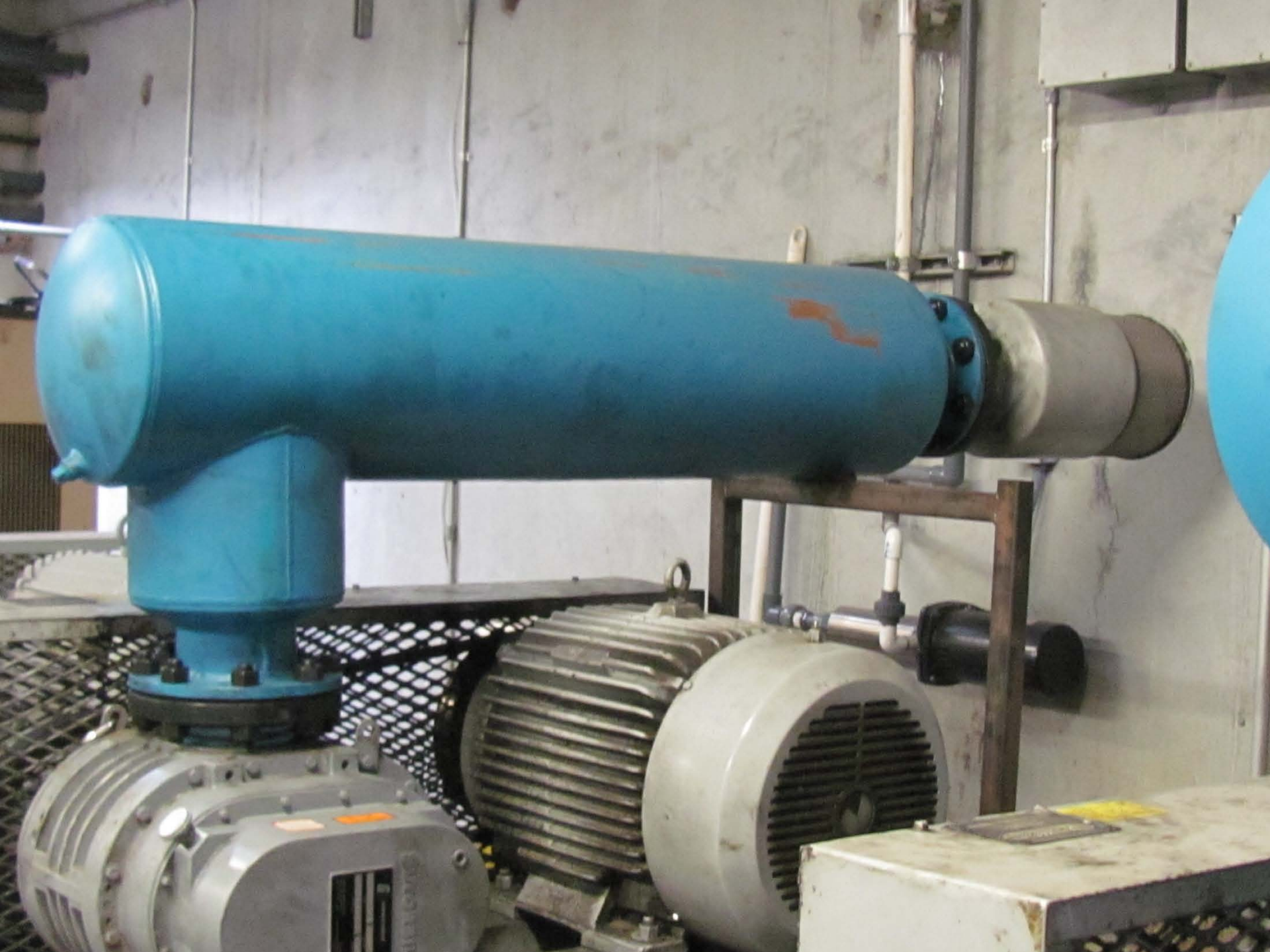

California
8P52149

Lesson 7

- If you decide instead to put your sludge into a roll off dumpster, make sure it can drain to somewhere and place it in a way that when they tilt it to pick it up and several cubic yards of wet, stinky sludge slides into your parking lot you have a way to load it back in besides 2 guys shoveling for 4 hours. And build a big roof over your roll-off so when it rains the EPA doesn’t come after you. They hate to see sludge in the storm sewers and creeks.

Lesson 8

- If you install an aerobic digester requiring rotary lobe blowers for aeration never put them in a sound cabinet in a tightly enclosed area where they will recirculate hot air and burn themselves up. They will also burn up their check valves and isolation valve seals and flange gaskets too. And we have found that high quality intake and discharge silencers cost about the same as a sound insulated cabinet and work much better.



Lesson 9

- Brewery effluent is high strength, composed mostly of carbohydrates and is almost devoid of nutrients. It also contains a fair amount of yeast. Yeast mixed in a tank with sugar and air is really happy and multiplies like crazy. Never underestimate the ability of yeast to compete with the digester microbes for nutrients thereby generating undesirable biomass and contributing to foaming issues that can be challenging to control.

Lesson 10

- Never pump your waste water and return activated sludge into the top of your aeration tank and then draw off your effluent for separation from the top of the same tank. You will wind up processing the same sludge over and over and the high strength BOD will take a shortcut from inlet to outlet, the bugs will not get fed and the BOD of the final effluent will often be out of range of the permit limits.

Lesson 11

- Never install an aerobic only treatment system for brewery effluent without also installing a reliable foam control system. And when it comes to extreme foaming issues from a dense yeast concentration a spray nozzle system isn’t even close to enough control, a high quality antifoam must also be used, preferably on an automatic level control system. We use an E+H ultrasonic transmitter.

Lesson 12

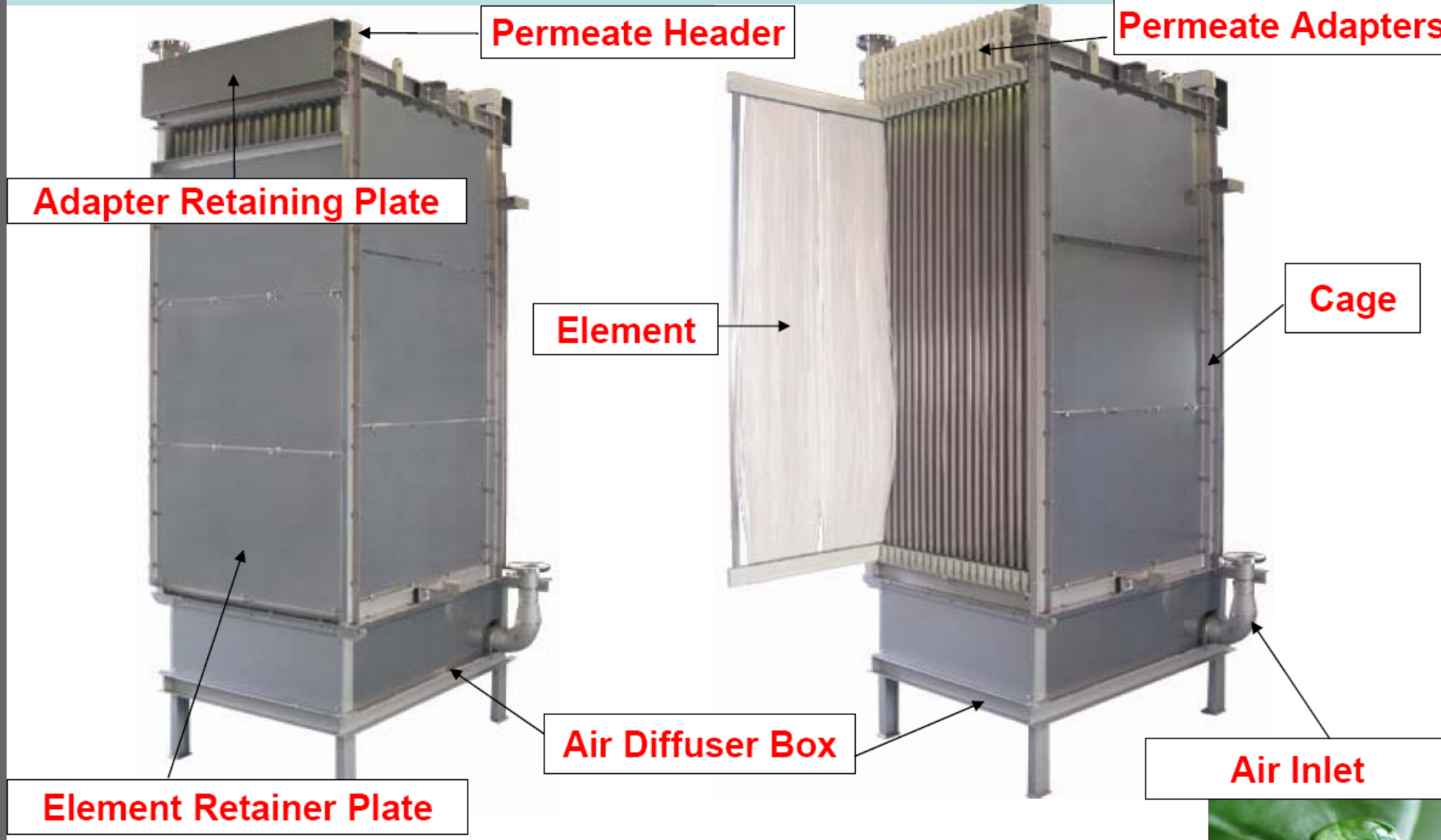
- Never install an aerobic only treatment system in a desert climate without installing a temperature control system. Waste water microbes do not thrive in 127 degree aeration tanks.

- Those are just a few examples of the “challenges” of the system we were provided and things we learned the hard way. Needles to say that was a very long year and the associated stress and midnight repairs probably took five years off my life.
- We spent the following year studying plant design, visiting other treatment plants, consulting with engineers, redesigning, re-piping and working around numerous flow and logistic problems, trying to make the system we had work right

- We ultimately decided the only solution was to just rip the whole thing out and re-build it right. The key to the new system was to:
- Replace the DAF with a microfiltration module
- Replace the sludge press with a decanter centrifuge.
- Add RO filtration to generate a large volume of high quality reclaim water.
- Move the blowers, add silencers and a big fan
- Add a cooling tower to control aeration temperature

- By selecting a microfiltration system as the clarifier we also opened ourselves up to the possibility of reusing this effluent prior to RO for utility purposes in the waste water treatment support systems:
- Decanter polymer makedown: 2 gpm
- Decanter hydraulic cooling: 3 gpm
- Primary strainer rinse bar: 7 gpm

HYDRAsub-MBR HSM500



HYDRAsub® Durability

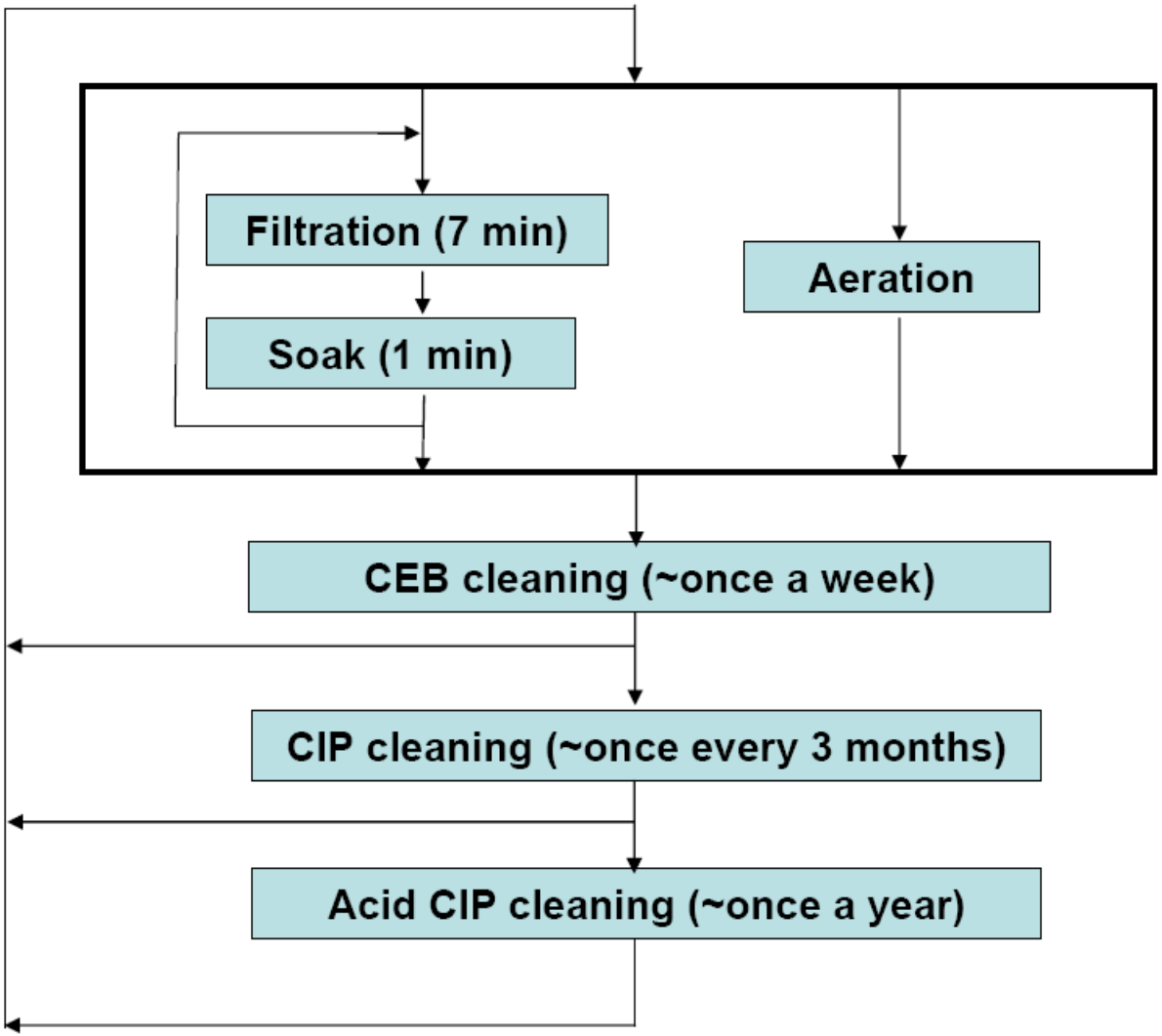
- Membrane elements during inspection after 1.5 years in operation
- No fiber breaks or damage to any part of the modules (cage, air diffusers, permeate adapters, etc.)

Typical Operating Parameters

	Unit	Typical Value[1]
Average Operating Flux	gfd (LMH)	19.6 (33)
Peak Operating Flux	gfd (LMH)	30 (51)
TMP	psi (kPa)	2-4 (13.8-27.6)
Nominal Air Scour Flowrate for a 500-m2 module	scfm (m3/hr)	90 (152)
MLSS in membrane tank	mg/L	8,000-12,000

[1]For municipal applications, at 20 deg C

Process Sequence



- MBR system is generally well suited as a prefilter to an RO filtration system. Our MBR effluent is a bit more challenging than average:
- High phosphate, up to 38 ppm.
- High TOC, up to 41 ppm
- TSS averages 0.10 NTU [mostly due to color and air bubbles]
- TDS 1,100 ppm
- High color
- Odor; organic, earthy aroma
- 1,000 M2 = roughly 70 miles of hollow fiber membrane

- The high phosphate levels necessitated adding pH correction to 6.0 [sulfiric acid] and the use of an antiscale [Avista Vitec 3000] treatment to prevent calcium phosphate blinding the membranes.
- We use a 5 micron prefilter to remove any dust or bugs or algae that might grow.
- We dose 0.4 ppm chlorine to the RO permeate using Hach monitor.
- We also dose brine from the brewing water RO system to maintain TDS of 100 – 125 ppm. [permeate average: 30 ppm] This value is hand checked daily.
- 5/3 array, 6 membranes each vessel.
- 48 membranes for low flux to allow for high feed TDS
- 30 gpm permeate / 10 gpm concentrate
- Low pressure [120 feed] Hydranautics ESPA2 membrane

Weekly RO maintenance

- Shock the feed tank with chlorine, then “de-shock” with sodium thiosulfate
- CIP the RO system using a mild alkaline cleaner, mainly to prevent biological growth.
- Once a month or so we switch to an acid cleaner just for the heck of it.
- Take a manual reading of pre, interstage and post-filter pressures

Distribution

- We use a VFD controlled centrifugal pump and bladder tank to backfeed all brewery piping [except brewhouse brewing water].
- Piping is separated from city water supply with valves and air gap
- Piping is separated from brewing water supply also with valves and air gap.

Daily QA

- pH 6.0
- Chlorine 0.4
- TDS 100
- Conductivity 167
- Sensory mmm, delicious!

Monthly QA from outside lab

This sample was taken before we started adding brine to raise TDS:

- Chloride 0.71
- Residual chlorine 0.4
- Fluoride 0.8
- Hardness 0.6
- TDS 23
- Sulfate 0.4
- Boron 0.05
- Iron 0.05
- Manganese 0.02
- ASAR -5.52
- Heterotropic plate count -1

Reclaim uses

- All CIP systems
- Boiler feed
- Cooling tower makeup
- All washdown hoses
- Keg washer
- Full bottle rinsing prior to packing into cases.
- Beer centrifuge water

Decanter centrifuge

- Andritz Bird w/ Viscotherm scroll drive [factory reconditioned]
- 4000 RPM, 30 hp. Drive, 10 hp scroll pump
- 45 gpm feed.
- Runs about 6 hours a day, 4 days a week
- Very dry solids; typically above 18% [tiny dry crumbs]
- No sludge odor, no drips from dumpster
- Saves about $2300 a month in hauling fees
- Seepex polymer pump, no check valves to fail
- Extremely reliable, start it and walk away.
- Very low polymer use; from $10,000 per month to supply the DAF/sludge press to about $500 per month current use. [less than one drum/month]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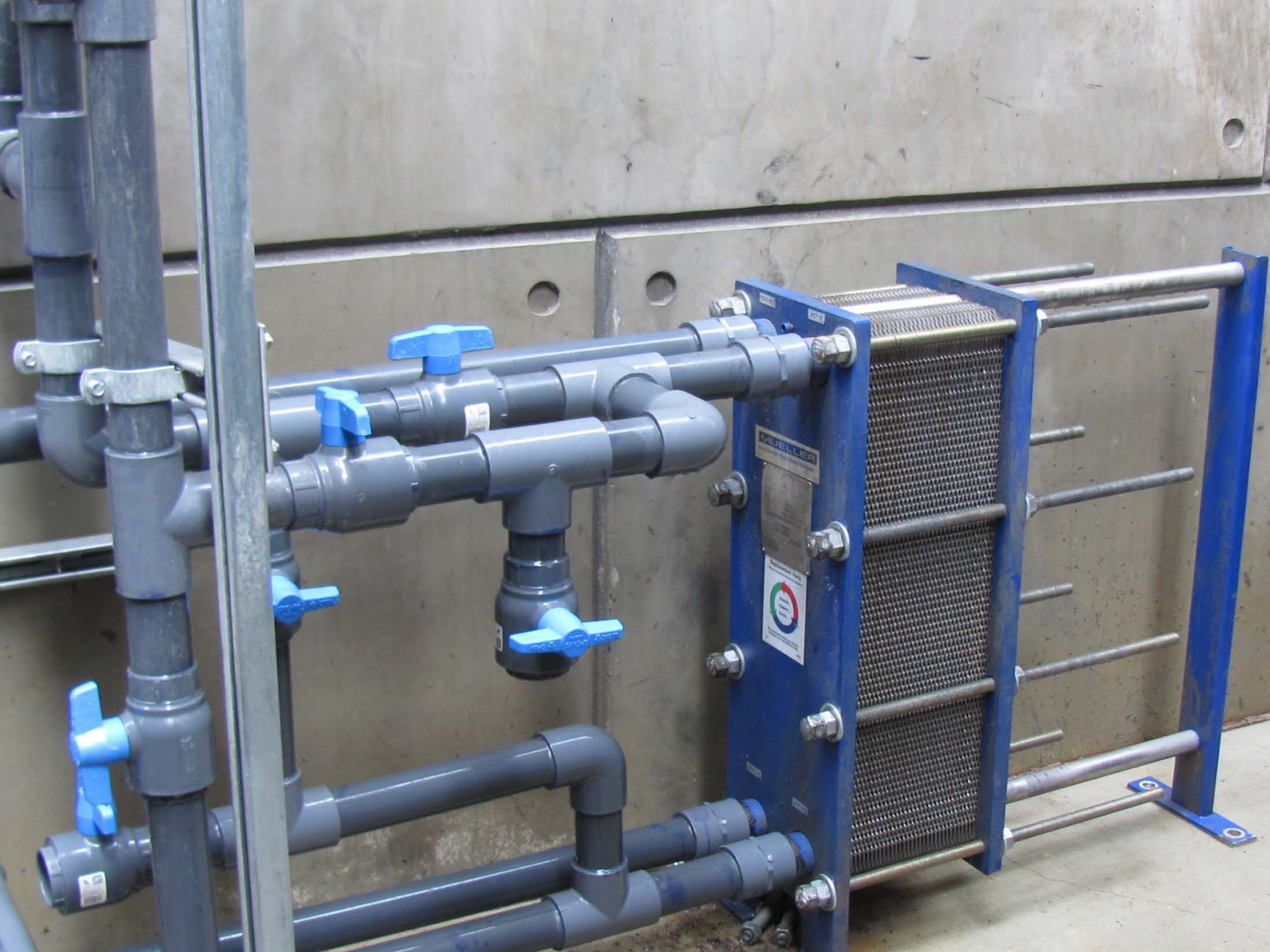
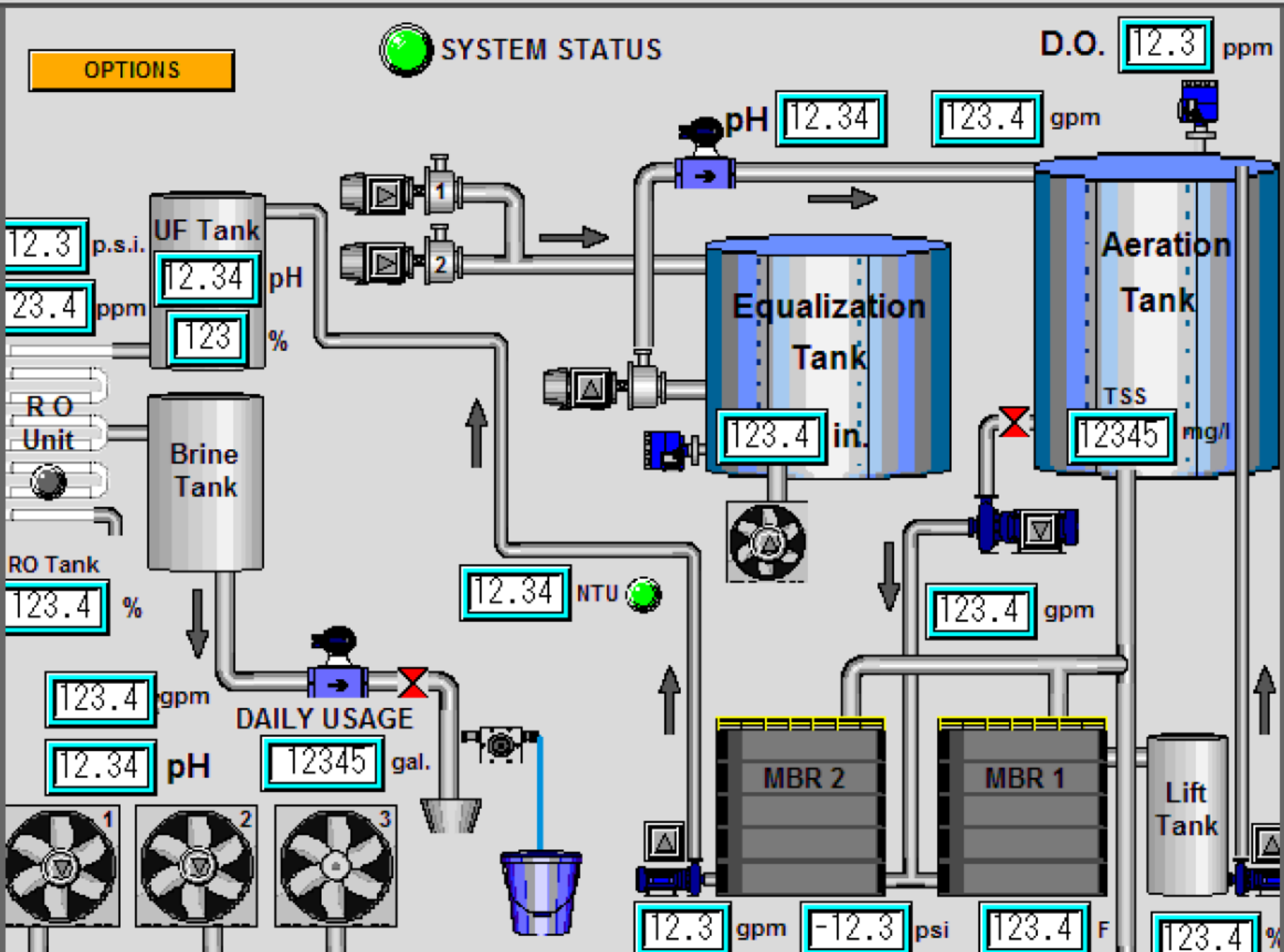
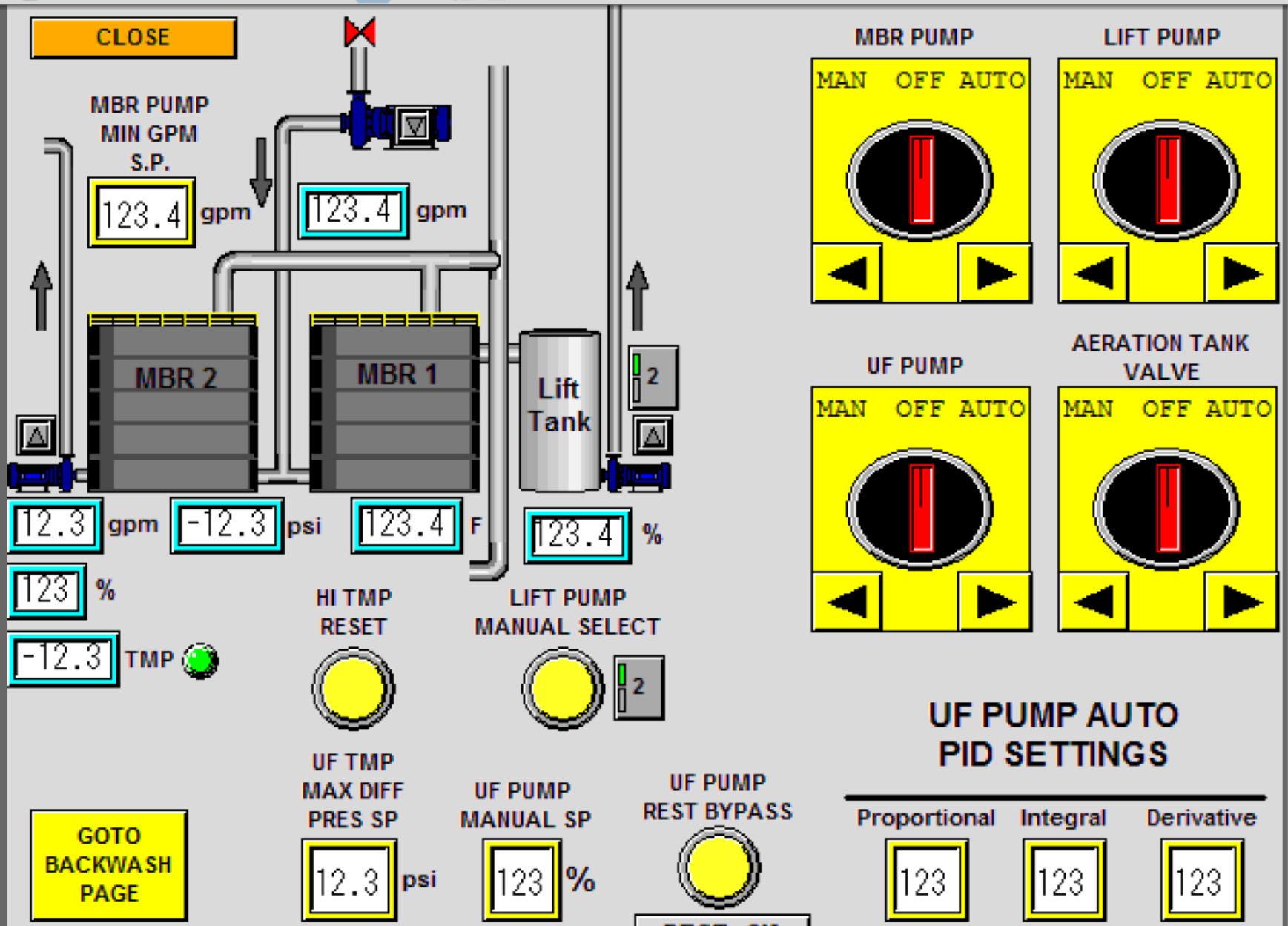
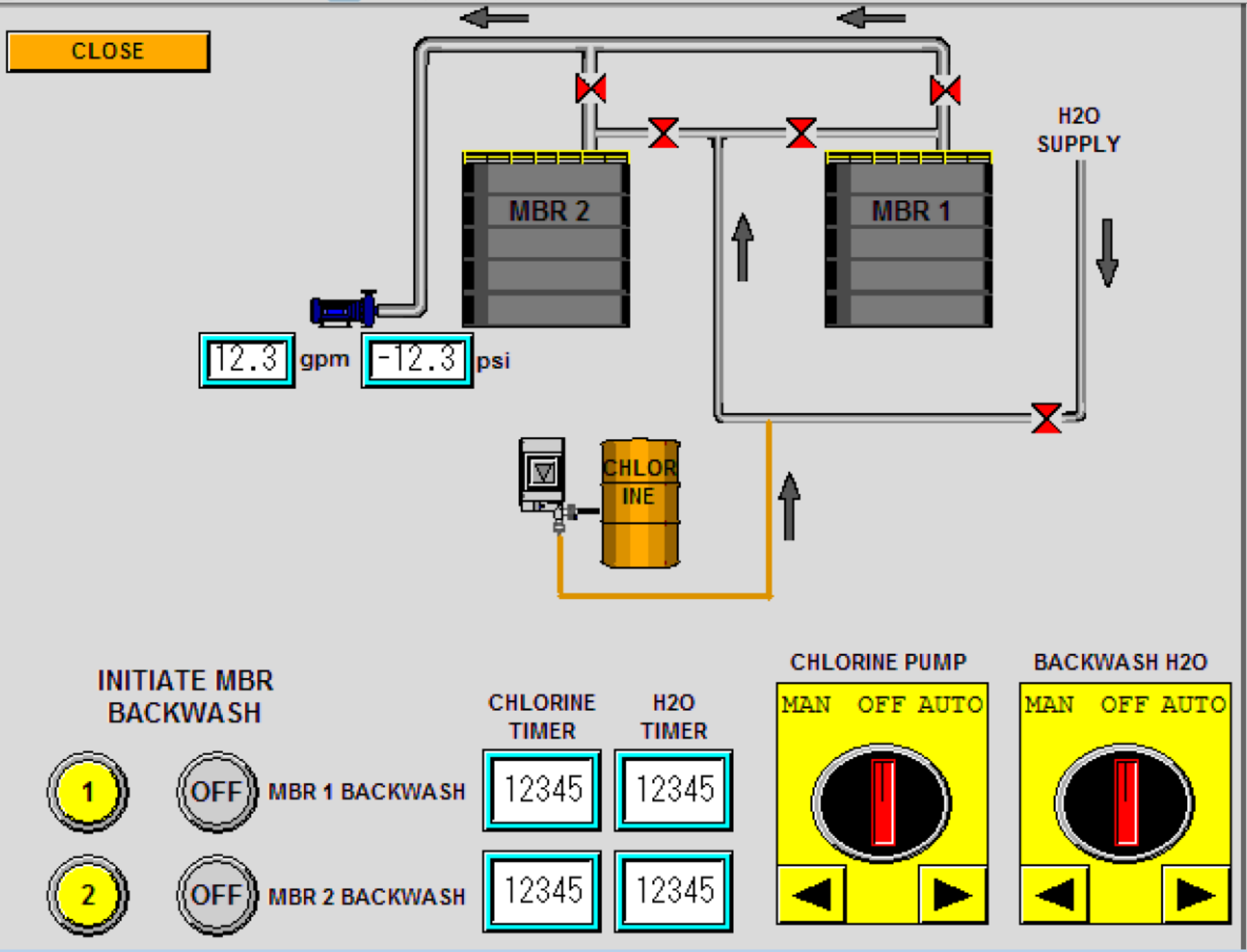

MUELLER

Overall system highlights

- Extreme reliability, no possibility of TSS, BOD violation
- No sludge tank, no odors, no drips, system smells healthy, organic, earthy.
- Very low chemical use
- Very low labor
- MBR diffusers actually increase DO with less blower power.
- Blowers relocated, cabinets removed, silencers added, blowers run cool and quiet.
- A cooling tower and heat exchanger has been added to the aeration tank, temperature maintains steady 92F, water is disposed of by evaporation.
- Decanter centrifuge is very simple to use.
- Prior to the reclaim system we discharged our limit [25,000 gpd] plus we spent approximately $8,500 per week in fees to haul surplus water off site.
- Currently we're discharging approximately20,000 gpd of RO brine and surplus waste water and recycling an average of 30,000 gallons per day back into the brewery.

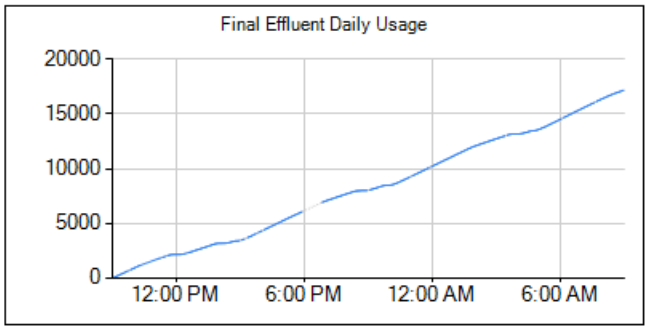

SYSTEM STATUS
OPTIONS
D.O.
12.3
ppm
pH
12.34
123.4
gpm
1
2
UF Tank
12.34
pH
123
%
12.3
p.s.i.
23.4
ppm
Equalization Tank
123.4
in.
Aeration Tank
TSS
12345
mg/l
R O Unit
Brine Tank
RO Tank
123.4
%
12.34
NTU
123.4
gpm
123.4
gpm
DAILY USAGE
12345
gal.
12.34
pH
MBR 2
MBR 1
Lift Tank
1
2
3
12.3
gpm
-12.3
psi
123.4
F
123.4
%

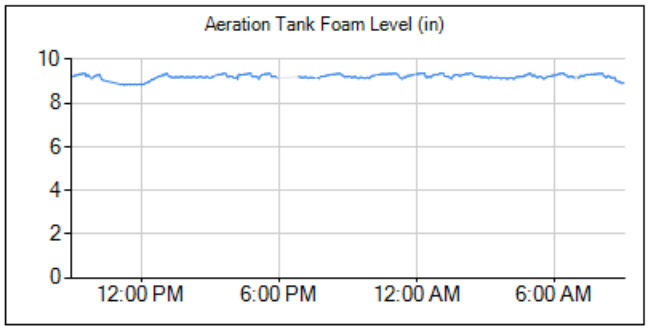


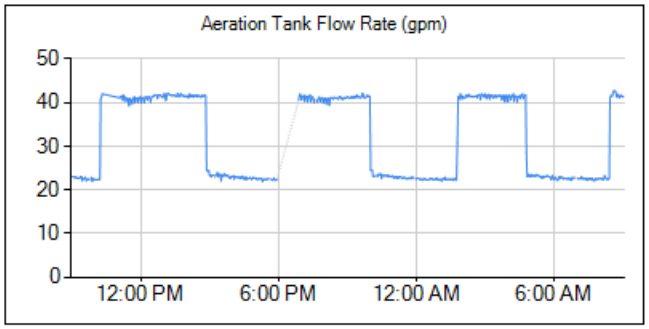


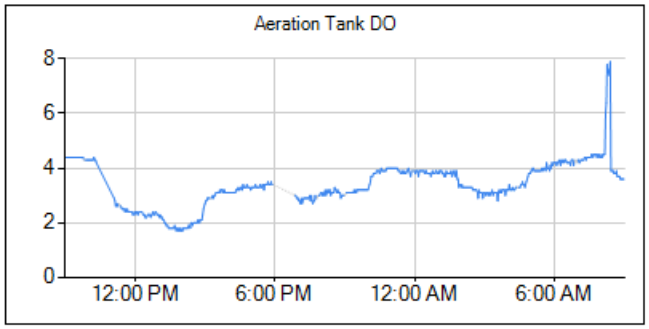
Waste Water Summary [10/13/2010]

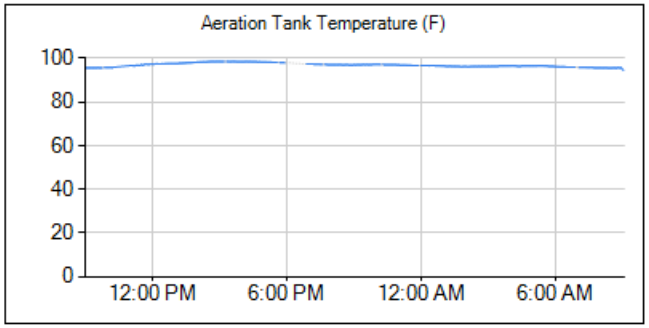
Aeration Tank Foam Level	8.88 in.	Equalization Tank Level	36.20 in.
Aeration Tank DO	3.40 ppm	Equalization Tank pH	5.87
Aeration Tank TSS	7330.00 mg/l		
Aeration Tank Flow Rate	27.80 gpm	Spent Yeast Tank Level	2.10%
Aeration Tank Temperature	95.90 F		
Aeration Tank Pump Speed	84.00%	UF Tank Level	100.00%
		UF TSS	0.02 NTU
Final Effluent Daily Usage	536 gallons	UF Flow Rate	20.80 gpm
Final Effluent pH	6.60	UF Pressure	2.30 psi
Final Effluent Flow Rate	10.20 gpm	UF Trans Membrane Pres.	0.30 psi
		UF Pump Speed	55.00%
Drip Tank Level	68.30%	UF Tank pH	5.91
Lift Tank Level	23.90%		
MBR Flow Rate	143.10 gpm	Last 24-Hours Waste	16985
		Last 24-Hours pH	6.84
Sump Temperature	88.10 °F	Last 24 Temp	96.20

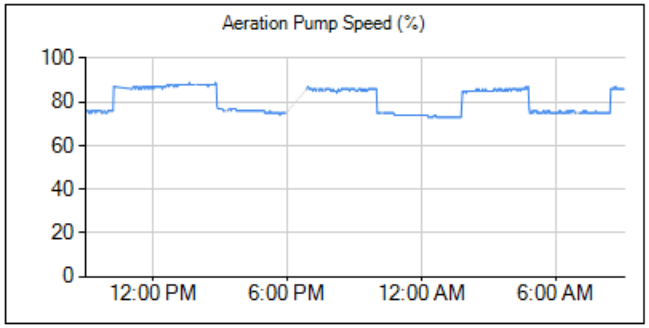


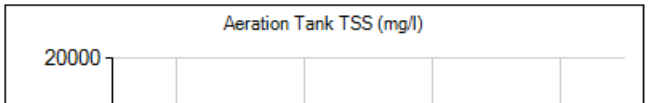


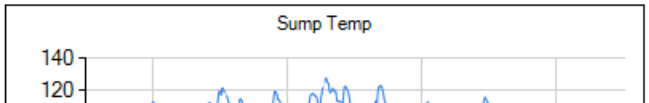


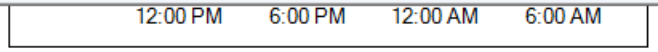


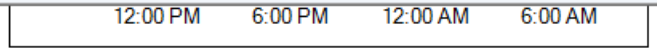


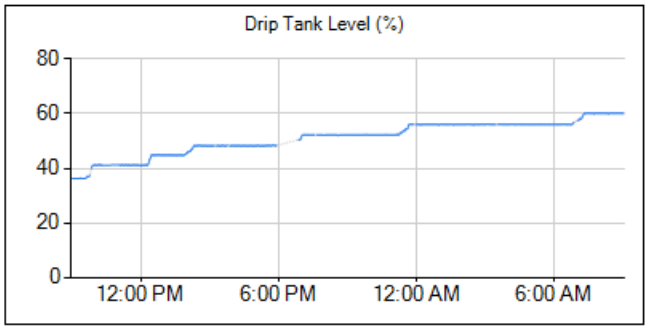


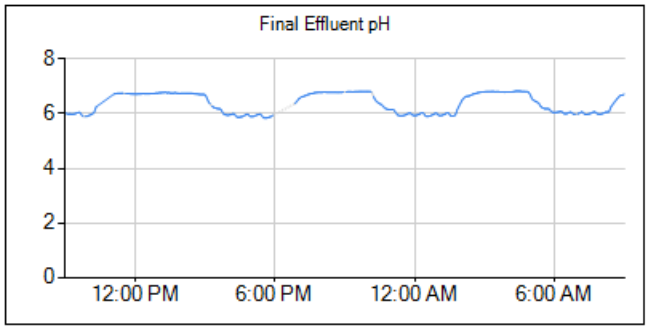


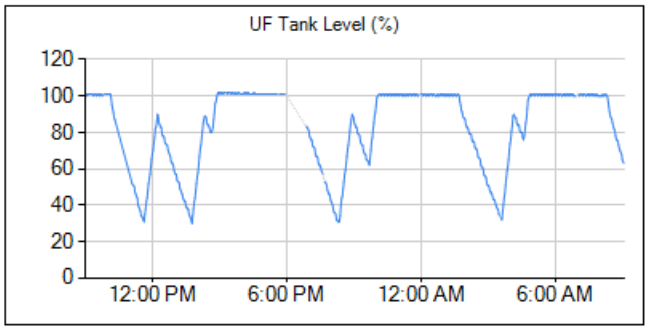


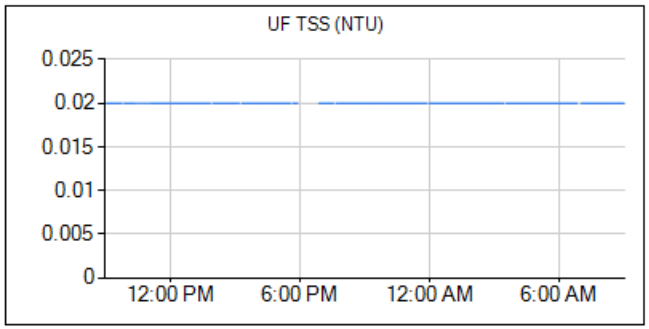


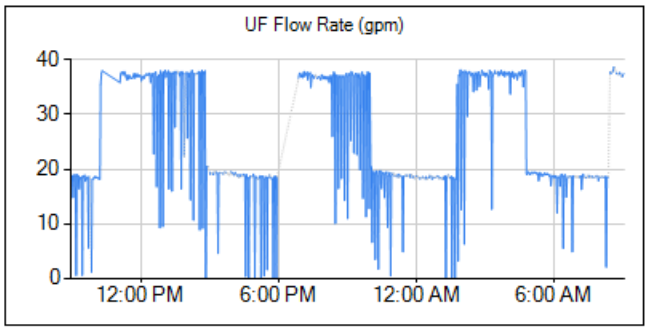


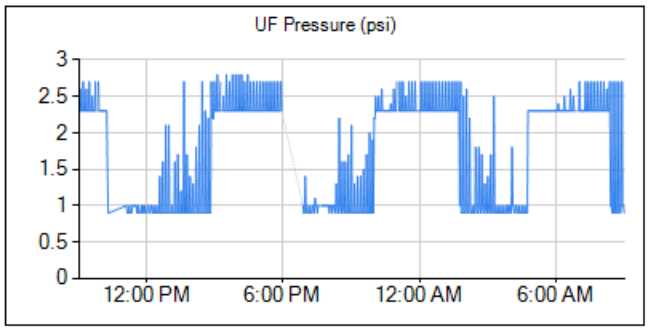


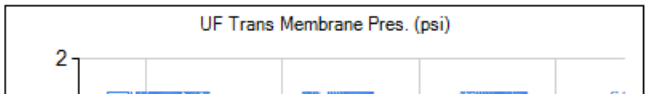


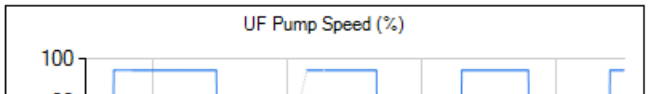


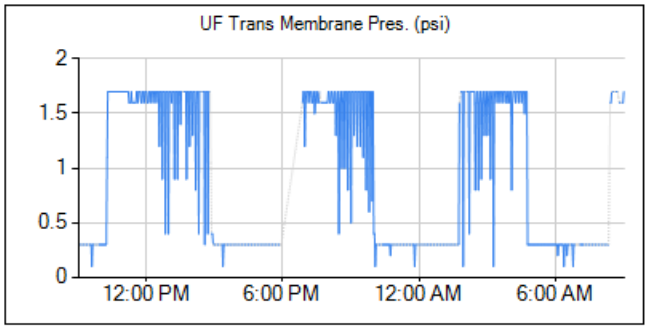


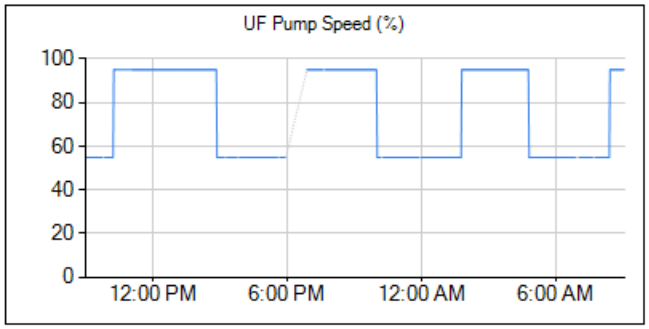


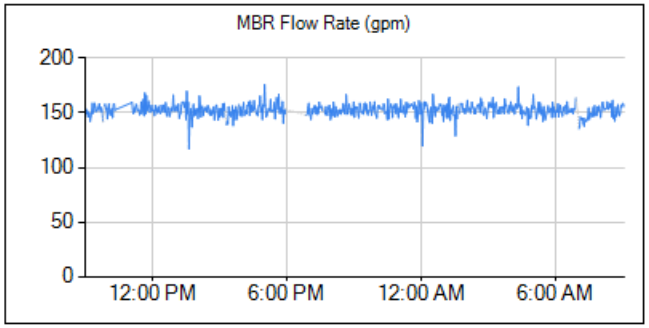


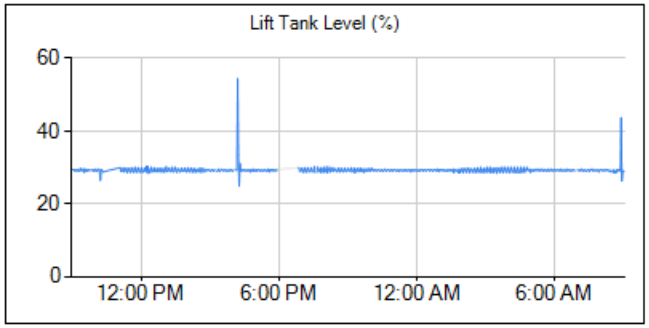


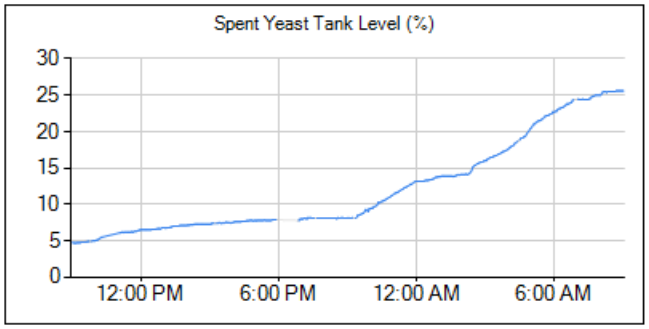


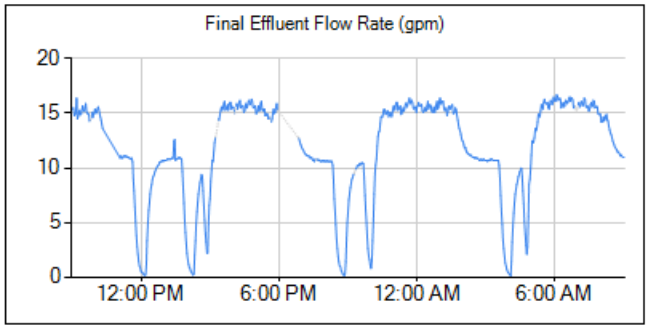


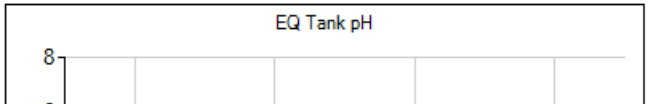


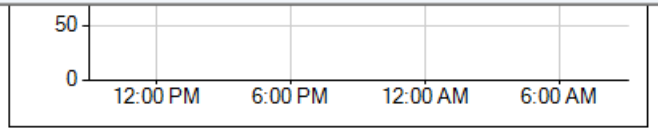


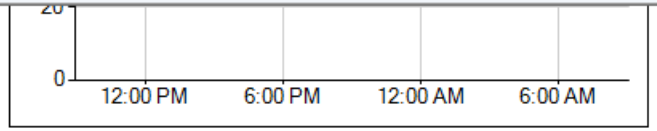


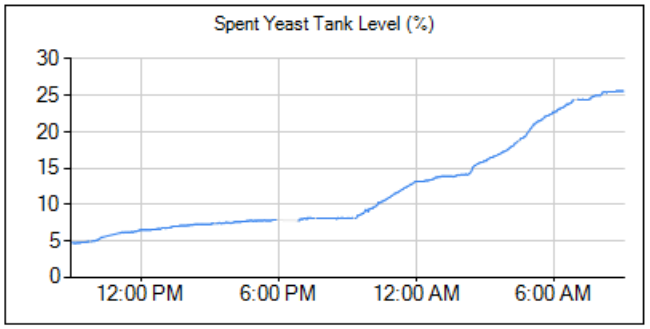


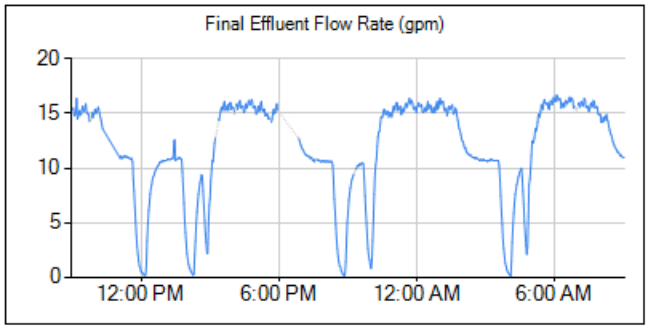


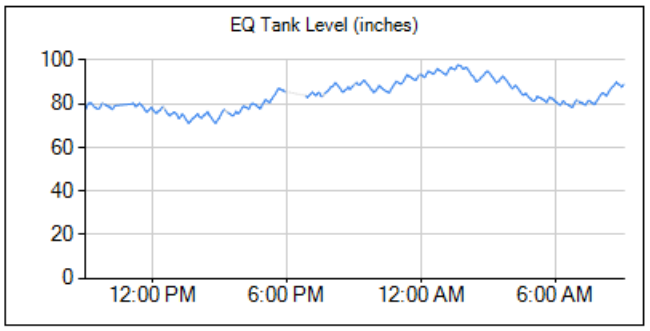


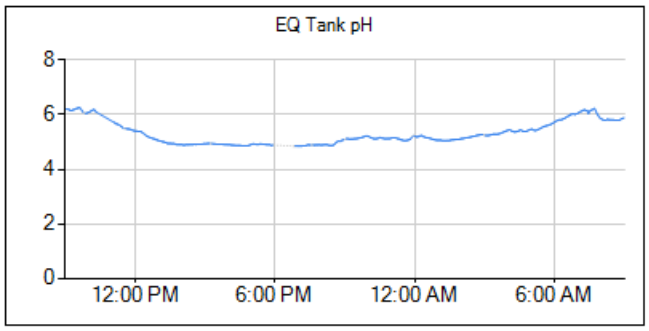




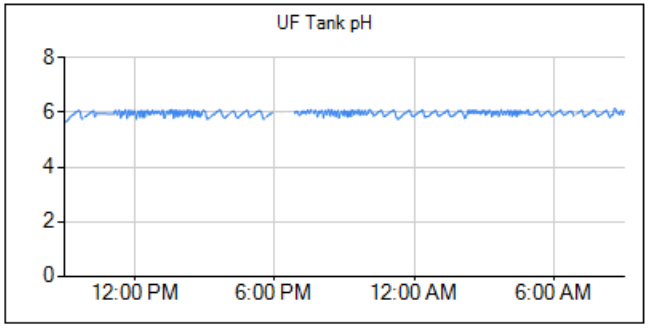








Mean EQ Tank pH: 5.2987951807229



Waste Water Summary [10/14/2010]

R.O. H20 Tank Level	88.70%
R.O. H20 Pressure	63.60 psi
R.O. H20 Feed TDS	35.10 ppm
R.O. H20 Free Cl	0.59 ppm