To Fear or Not: Wine and Beer
Winery and Brewery Wastewater
Production and Management

Brett M. Converse P.E., Ph.D. Senior Wastewater Engineer
David J. Kliewer, P.E., Area Manager

Outline

• Beer
• Wine
• Discharge Flows and Loads
• Treatment/Disposal – On-site
• Treatment/Disposal – Discharge to Municipality
• Impacts
• Mitigation Strategies
Winery and Brewery Wastewater

**Beer**

- Micro Openings and closings over years 2010 to 2017.

- 25 Million Barrels
- 31 g/barrel
- 775 M gallons

U.S. Beer Sales Volume Growth 2017

- Overall Beer: -1.2%
- Craft: 5.0%
- Import Beer: 3.2%
- Export Craft Beer: 3.6%

- Overall Beer Market: $111.4 Billion
- Craft Beer Market: $26.0 Billion

- Craft Beer Market share: 12.7%
- Import: 482,309 BBLs
- Other Domestic: (138,861,724 BBLs)
Malting

- Seep, Dry, Seep, Dry
- Small Root will Grow
- Germinate Barely next
- Barely in cool moist place
- Internal leaflet grow
- Dry, clean – you have pale malted Barley
- Roast as desired

Making Beer

- Growing Barley
- Malting
- Roasting
- Mashing
- Fermenting
- Bottle / Keg
Why Malt

- The Enzyme Amylase
- Biomolecule - Catalyze Biochemical Reactions
- Starch into Fermentable Sugar

![Amylase Diagram]

http://montessorimuddle.org

Roast

![Roast Image]

Winery and Brewery Wastewater

Mashing

- Use that wonderful Amylase
- Amylase is an Enzyme
  - protein string bent and shaped into a specific 3D shape, catalyze a reaction
- Convert all that Grain Starch into Sugars
- Active at specific temperatures
- Low, not active
- High, denature

Boulton et al., 1999; Pretorius, 2000;

Winery and Brewery Wastewater

Fermenting Sugar to Ethanol

Yeast

Thousands of other enzymes are also located in the cell

Boulton et al., 1999; Pretorius, 2000;
Making Beer Summary

- Growing Barley, off-site by farmer
- Malting, Enzyme Amylase
- Roasting, Flavor
- Mashing, Starch to Sugar
- Fermenting, Sugar to Alcohol
- Bottle / Keg
Beer Wastewater

- 1 gallon of Beer (3-5) gallons of WW
- BOD
  - 1,500 mg/l, Low
  - 4,500 mg/l, average (large SD)
  - 35,000 mg/l, Dump bad batch (3.5%)
  - 55,000 mg/l, Imperial (9%)
- Anytime, Year round
- Grains can’t do down the drain

Beer, Smallish

- 3 Barrel Brew House
- 375 gallons of ww
  - 1.65 EDUs – hydraulic load
- BOD = 4,500 mg/l
  - 14 lb of BOD (~1 hp of air)
  - 24 EDUs – organic load
- Grains don’t go down the drain!
EDU at $50/month

- 1.65 EDUs – hydraulic load
  - $82 / month
  - $0.11 per pint
- 24 EDUs – organic load
  - $1,220 / month
  - $1.64 per pint
- The day discharged, not the next? 80 pounds of biomass

Beer, Larger

- 10,000 Barrels per year
- 21 EDUs - hydraulic
- 310 EDUs – organic
- 4 to 7 days per week
Fear Beer

• To Fear? (Not Fear but address)
  – Relative flow and load
    • 10,000 barrel/yr, 310 EDUs – YES
    • 3 barrel batch, 24 EDUs (day of) - Maybe
  – Existing capacity and ability
  – Growth, domestic and beer

• What to charge

Addressing Flow and Load

• Pre-treatment
  – pH adjustment
  – Flow equalize, over days, over hours
  – Source separation
    • High strength – manage separately
    • Low strength – to sewer with surcharge fee?

• Actual treatment – get to later
Wine Grape
- Smaller than table grapes
- Seeds
- More sugar
- More juice
- Thicker skins
Grape Harvest

- Harvest, what comes into the winery
  - Grapes
  - Stems
  - Seeds
  - Pulp
  - Skins
  - Fresh Water

Grapes

- What Winery Keeps
  - Grapes Converted to Juice converted to wine
    - Must (Fresh Juice with skins, seeds, stems
      - Pomace = Solids
  - Stems
  - Seeds
  - Pulp
  - Skins
Grapes

- What Leaves the Winery
  - Wine
  - Lees (yeast cells, skins, other particles)
  - Wastewater

Making Ethanol

- Glycolysis
- Glucose (Sugar) into pyruvate (1:2)
- And so on to Ethanol
- Complete pathway, 10 reactions
  - 1 molecule of glucose (6 carbons), into
  - 2 molecules of Ethanol (each with 2 C), and
  - 2 molecules of carbon dioxide (each with 1 C)
Making Wine (with apologies)

- Juice
  - 22% sugar (22 gram sucrose in 100 grams juice)
  - $\text{C}_{12}\text{H}_{24}\text{O}_{12} \rightarrow 4\text{C}_{2}\text{H}_5\text{OH} + 4\text{CO}_2$
  - (100g $\rightarrow$ 51g)
  - About 22% sugar turns into ~11% alcohol wine
Making Wine (with apologies)

- Remove Stems
- Crush (more like breaking)
- Pressing (get all the juice)
- Clarification of must (white)
- Condition must
- Ferment
- Press
- Tank
- Barrel
- Filter (clarified/stabilized)
- Bottle
- Age

Clean
And
Sanitize
Throughout
The
Process

Waste

EPA-600/2-77-048

Figure 10. Red wine production diagram.
Summary of Production

- Grapes are an Annual Crop; the industry is cyclic based on the season and winery activity
- Can not store grapes
- Different winemaking processes produce different wastewater
- Seasonal wastewater flows and loads
Normalized Flow

Winery and Brewery Wastewater

Characteristics

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>--</td>
<td>3.85</td>
<td>4.20</td>
<td>4.18</td>
<td>3.85</td>
<td>6.4</td>
<td>7.13</td>
<td>6.65</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>mg/l</td>
<td>3,220</td>
<td>3,090</td>
<td>2,440</td>
<td>1,046</td>
<td>270</td>
<td>198</td>
<td>4</td>
</tr>
<tr>
<td>BOD5</td>
<td>mg/l</td>
<td>27,000</td>
<td>6,600</td>
<td>8,100</td>
<td>1,340</td>
<td>1,130</td>
<td>2,800</td>
<td>373</td>
</tr>
<tr>
<td>Portion of Daily Flow</td>
<td>%</td>
<td>2.5</td>
<td>5</td>
<td>10</td>
<td>7.5</td>
<td>50</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

EPA 600/2-77-048 (60/124)
Characteristics

Winery and Brewery Wastewater

Normalized Flow and BOD$_5$ mg/l
Trends in Industry

- Recover liquid waste, valuable
  - Juice (SBOD)
  - Alcohol (SBOD) Could be distilled
- Technology allows Separation
  - centrifuge, membrane, vacuum systems...
- Strength could be Dropping
- TSS managed on-site, dryer due to separation of liquid (valuable)

Lesson

- Could be Function of Scale
  - Small facility 1 wine : 5 wastewater
  - Large facility 1 wine : 1 wastewater
- Confirm Process
  - How much
  - How strong
  - When
Wastewater Production, Small

- 20,000 cases
  - 9 liters per case, (12 bottles per case, 0.75 liters/bottle)
  - 3:1 wastewater : wine (typical to high)
- 142,000 gallons per year
- 22,000 gallons in September
  - 20 pounds of BOD₅ / day
- 57,000 gallons in October
  - 70 pounds of BOD₅ / day (280 People)
- 22,000 gallons in November
  - 17 pounds of BOD₅ / day
- 41,000 gallons the rest of the year
  - 2.5 pounds of BOD₅ / day

Wastewater Production, Medium

- 300,000 cases
- 2.1 MG gallons per year
- 320,000 gallons in September
  - 300 pounds of BOD₅ / day
- 860,000 gallons in October (28,000 gpd)
  - 1,000 pounds of BOD₅ / day (4,300 People)
- 320,000 gallons in November
  - 250 pounds of BOD₅ / day
- 41,000 gallons the rest of the year
  - 40 pounds of BOD₅ / day (August) (170 People)
Winery Wastewater

- Seasonal Flow
- Seasonal Load
- Load Increases Rapidly
- Confirm
  - Small, not economical to maximize liquid recovery and manage solids
  - Large, economical to recovery

Now What?

- Wine Maker and Brewer
  - Just want to make product, the wastewater will just go away. ?
  - Maybe, some municipal systems take it
  - Others cannot
- Municipality
  - The City - Welcome here
  - WWTP - Don’t cause any issues
Mitigation

• Applicable To:
  – Beer
  – Wine
  – Hard Cider
  – Cheese
  – Yogurt
  – Restaurants
  – Super Stores
  – Labor Camps

Warning!

• Heavy Industry (potato, onion, fruit etc.)
  – Study specifically
  – Get independent help

• Data Center
  – Study specifically
  – Get independent help
  – Low strength
  – 75 degrees
  – 1.3 MGD per center
Treatment and Disposal

- Disposal, Answer this First
- The answer will control level of treatment
  - On site (very little, manage odors)
    - Irrigation, crop, landscaping
    - Drain-field, and other subsurface options
    - Evaporation
  - Off site
    - Surface water discharge (highly treated)
    - Industrial treatment facility (maybe none)
    - Municipal treatment facility (pre-treatment)
    - Irrigation someone else’s crop (very little)

Winery and Brewery Wastewater

On-Site

- Irrigation, Medium Size 2.1 MG/year
  - Seasonal Discharge, irrigation season
  - Winter Storage
  - 3.5 Acres of Crop
  - 1.6 MG of Storage
  - Manage TDS
  - Industrial discharge
  - Facultative pond for treatment, settling basin
  - Aeration for odor control
On-Site

- Evaporation, Medium Size 2.1 MG/year
  - 10 Acre Evaporation Pond
    - Mechanical Evaporation → 2.5 Acres (location)
  - Settling basin to capture solids
    - Dredging plan
  - Aeration for odor control
Winery and Brewery Wastewater

- Local Limits
- BOD < 300 mg/l (match domestic)
- Surcharge
  - Limit BOD < 300 mg/l
  - Not to exceed BOD < 1500 mg/l
  - Pay XX $/ pound discharged
    - $0.25 per pound of TSS
    - $0.30 per pound of BOD₅

Water Balance = 2.1 MG per year
Evaporation from 10 Acres
### Treatment for Disposal to a Municipal Sewer

- Aerobic facultative lagoons
- Anaerobic
  - Granular Sludge?
  - Followed by Aeration
- Activated sludge – Conventional, SBR and MBR
- Fixed film bioreactors
- Moving bed Bioreactors
- Direct Discharge to a Municipality

### Treatment for Disposal to a Municipal Sewer (most likely?)

- Anaerobic
  - Granular Sludge
  - Followed by Aeration
- Activated sludge

- Direct Discharge to a Municipality
Granular Sludge

- Granular sludge
- Settles fast
- Expanded granular sludge bed
- High loading rates are lowering capital cost for digestion.
- Followed by aeration
- Can survive periods without food? Yes.

Biothane
Expanded Granular Sludge Bed

- Up flow Velocity
- Settling Velocity
Winery and Brewery Wastewater

Package MBR

- Activated sludge – Package MBR
- 5,000 gallons per day
- 100,000 gallons per day
- Pre treatment may be required (screen)
Package MBR

- Concentrated Oxygen, dense biology
- High quality reuse water
- Seeded with WAS (discharge to sewer)

City of West Richland

50,000 gpd
Re-use Ready
### Direct Discharge

- Direct Discharge to a Municipality
- Minimum pre treatment
  - Lower TSS, skins settle in the sewer pipe
  - Adjust pH, concrete pipe, neutral pH, (dilution)
  - Generally easy to manage on-site
- What about BOD$_5$

<table>
<thead>
<tr>
<th>Winery and Brewery Wastewater</th>
</tr>
</thead>
</table>

### Direct Discharge

- Example
- Medium Winery (300,000 cased)
- 860,000 gallons in **October** (28,000 gpd)
  - 1,000 pounds of BOD$_5$ / day
  - (4,300 People)
Biology to Treat, Approximate

- Biomass needed for 1,000 pounds of BOD$_5$/day
- 6850 pounds of biomass, about
- Increase in MLSS
  - 0.5 MG reactor $\rightarrow$ from 2000 to 3640 mg/l
  - 2.58 MG reactor $\rightarrow$ from 2000 to 2320 mg/l
  - 6 MG reactor $\rightarrow$ from 2000 to 2140 mg/l
- 55,000 gallons of RAS/WAS (at 1.5%) (at 1.5%)
- 65 pounds of O$_2$ per hour
- 45 horsepower aeration

Managing Winery WW at WWTP

- Can you come up with the biology?
- Can you provide the air?
- Can you manage the extra biosolids?
Managing Winery WW at WWTP

- Can you come up with the biology?
  - Likely, depending on time of day
- Can you provide the air?
  - Likely, depending on time of day
- Can you manage the extra biosolids?
  - 600 to 800 pound per day, dry
  - 2.3 tons per day of dewatered biosolids
  - maybe

Flow Equalization, Load Shift

- Large WWTP, Small initial winery flow
- pH adjustment tanks large enough to provide flow equalization on-site
- Meter discharge into sewer
- As flow increased evaluate performance and the need for pretreatment
- And bank fees
Winery and Brewery Wastewater

Diurnal Oxygen Demand

- Net Oxygen Loss: DO = 0.2 to 6.5 mg/l
- Net Oxygen Gain: DO = 1 to 6 mg/l
- Average Flow: 1.45 mgd
- Average NOG (peak) = 13.5 mgd (ppd)
- DO = 2.0 mg/l

Questions

Signature Brews

- High Desert Hefeweizen
- Pinnacle Porter
- Metolius Golden Ale
- Outback Old Ale
- Elk Lake IPA
Impacts to Small & Medium Size Wastewater Treatment Plants

• Rates and fairness issue.
• Typical strength of waste for small brewery can equal 100 Homes?
• Washington State DOE and citizens expectation for fairness.

DOE Obligation Permit Requirements

• Cities to deal with high strengths waste disposal.
• If your system is close to capacity means possibly ending up at a moratorium on growth of any type.
• ERUs is the approach driver.
• High strength waste disposal agreement and Chuck Zimmerman able to do this.
• Many municipalities have not addressed this with a specialist.
• Is it fair for your grandmother to subsidize wastewater rate increases so others can make and sell beer or wine?