Water, Barley, Hops, Yeast
(and Coordination With Your Local Brewery)

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NC AWWA-WEA 97th Annual Conference

November 13, 2017
Grain Bill

- Introduction
  - Scale of the Industry Growth

- Beer Production 101
  - The Brewing Process
  - Water: Quantity, Quality, and Consistency
  - Cleaning: 90% Janitorial
  - Waste Streams: Side Streaming Practices

- Coordination: Actions and Examples
  - Raleigh’s “Brewer’s Corner”
  - Charlotte Water’s “Home Brewing” Site
  - MSD-Buncombe’s Pretreatment Program
The State of Craft Beer in North Carolina

2017 North Carolina
200+ Craft Breweries | 3 Major Expansions | 10,000 Jobs

Nationwide
5,301 U.S. Operating Breweries in 2016 | 5,234 Craft | 67 Other
- Scattered all across the state
- Three large clusters in metro:
  - Asheville
  - Charlotte
  - Raleigh
Craft Brewery Definitions
Per the Brewers Association

Craft Brewery: small, independent, and traditional

- **Small**
  - Annual production of 6 million barrels of beer or less

- **Independent**
  - Less than 25 percent of the brewery is owned by an alcohol industry member that itself is not a craft brewer

- **Traditional**
  - The majority of its total beverage alcohol volume in beers whose flavor derives from traditional or innovative brewing ingredients and their fermentation
Craft Brewery Definitions

- **Beer Barrel**: 31 U.S. gallons (BBL)
- **Brewery Size**: by batch volume produced (a 10 barrel system would brew 310 gallons at a time)
- **Microbrewery**: typically produces less than 15,000 barrels of beer per year
- **Mash**: a steeping process to convert grain starch to fermentable sugars
- **Wort**: the liquid extracted from the mash
- **Trub**: the hop debris left after the boiled wort has been transferred, also the sediment layer at the bottom of the fermenter after the yeast has finished fermentation
Beer Production 101

- The Brewing Process
  - Incoming water is filtered
    - Sediment and / or carbon filter
    - Held in the Cold Liquor Tank
  - Brewing water is heated in the Hot Liquor Tank
  - Water adjustments (calcium, gypsum, pH, etc.)
  - “Mashing In” combines grains and hot water to steep the grains in the Mash Tun, converting starch to sugar
  - At the end of the mash, the sweet wort is separated from the spent grains and moved to the Boil Kettle
Beer Production 101

- The Brewing Process
  - The grains, stripped of their sugars, are removed
  - Hops are added to the wort during the boil
  - After the boil, wort is transferred to a **Fermenter** and yeast is added
  - Following a week or so in the fermenter, the yeast trub is drained off and the beer is transferred to a **Bright Tank** for carbonation and eventually packaging
Beer Production 101

- Water:
  - Consistency
  - Quantity
  - Quality
Beer Production 101

- Water:
  - Quantity: Water to beer ratio: typically 4 to 10 times

<table>
<thead>
<tr>
<th>Water to Beer Ratio</th>
<th>5,000</th>
<th>10,000</th>
<th>15,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>620,000</td>
<td>1,240,000</td>
<td>1,860,000</td>
</tr>
<tr>
<td>7</td>
<td>1,085,000</td>
<td>2,170,000</td>
<td>3,255,000</td>
</tr>
<tr>
<td>10</td>
<td>1,550,000</td>
<td>3,100,000</td>
<td>4,650,000</td>
</tr>
</tbody>
</table>

Estimated Gallons per Year

Brewers Association, Water and Wastewater: Treatment/Volume Reduction Manual
# Beer Production 101

## Water Profiles From Notable Brewing Cities: (How to Brew by John Palmer)

<table>
<thead>
<tr>
<th>City</th>
<th>Calcium (Ca²⁺)</th>
<th>Magnesium (Mg²⁺)</th>
<th>Bicarbonate (HCO₃⁻¹)</th>
<th>SO₄⁻²</th>
<th>Na⁺¹</th>
<th>Cl⁻¹</th>
<th>Beer Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilsen</td>
<td>10</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>Pilsener</td>
</tr>
<tr>
<td>Dortmund</td>
<td>225</td>
<td>40</td>
<td>220</td>
<td>120</td>
<td>60</td>
<td>60</td>
<td>Export Lager</td>
</tr>
<tr>
<td>Vienna</td>
<td>163</td>
<td>68</td>
<td>243</td>
<td>216</td>
<td>8</td>
<td>39</td>
<td>Vienna Lager</td>
</tr>
<tr>
<td>Munich</td>
<td>109</td>
<td>21</td>
<td>171</td>
<td>79</td>
<td>2</td>
<td>36</td>
<td>Oktoberfest</td>
</tr>
<tr>
<td>London</td>
<td>52</td>
<td>32</td>
<td>104</td>
<td>32</td>
<td>86</td>
<td>34</td>
<td>British Bitter</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>100</td>
<td>18</td>
<td>160</td>
<td>105</td>
<td>20</td>
<td>45</td>
<td>Scottish Ale</td>
</tr>
<tr>
<td>Burton</td>
<td>352</td>
<td>24</td>
<td>320</td>
<td>820</td>
<td>44</td>
<td>16</td>
<td>India Pale Ale</td>
</tr>
<tr>
<td>Dublin</td>
<td>118</td>
<td>4</td>
<td>319</td>
<td>54</td>
<td>12</td>
<td>19</td>
<td>Dry Stout</td>
</tr>
<tr>
<td>Raleigh</td>
<td>6</td>
<td>2.5</td>
<td>34</td>
<td>47</td>
<td>33</td>
<td>12</td>
<td>Pretty much any!</td>
</tr>
</tbody>
</table>

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This table provides the water profiles of notable brewing cities, showing the concentrations of various minerals and the corresponding beer styles. The concentrations are in milligrams per liter (mg/L) for Calcium (Ca²⁺), Magnesium (Mg²⁺), Bicarbonate (HCO₃⁻¹), Sulfate (SO₄⁻²), Sodium (Na⁺¹), and Chloride (Cl⁻¹). The beer styles are indicated for each city, reflecting how water composition affects beer production.
Beer Production 101

- **Water:**
  - **Quality**
    - Critical to maintain a consistent flavor profile from batch to batch or with a parent brewery elsewhere
    - In general, softer water allows more options
Cleaning: 90% of the brewer’s duties are janitorial

- CIP: Clean-in-Place
  - High pH (caustic based) cleaning
  - Low pH (acid based) sanitizing
- Everything that touches the beer
  - Vessels
  - Hoses
  - Pumps
  - Packaging (primarily kegs and bottles)
- Other things: Propylene glycol, label glue, defoaming agents, temperature (<140° F)
Beer Production 101

- Waste Streams:
  - Mash Tun: rinsing, cellulose, sugars, amino acids, ~3,000 ppm BOD
  - Boil Kettle: hot trub, proteins, sludge, ~85,000 ppm BOD
  - Fermenters: rinsing, yeast, ~6,000 ppm TSS, ~85,000 ppm BOD
  - Storage Tanks: rinsing, beer, yeast, protein, ~4,000 ppm TSS, ~80,000 ppm BOD
  - Bottle Washer: high pH, paper pulp
  - Miscellaneous: discharge of cleaning and sanitation materials, floor washing, high/low pH

* Most breweries will not have a pretreatment system (pH adjustment and solids settling)
Beer Production 101

Waste Streams: Brewery Size Versus Wastewater Generation

<table>
<thead>
<tr>
<th>Annual Beer Production</th>
<th>ww @ 2bbl ww/bbl beer</th>
<th>ww @ 4bbl ww/bbl beer</th>
<th>ww @ 10bbl ww/bbl beer</th>
</tr>
</thead>
<tbody>
<tr>
<td>bbl</td>
<td>gallons</td>
<td>bbl/year</td>
<td>gallons/ day</td>
</tr>
<tr>
<td>5,000</td>
<td>155,000</td>
<td>10,000</td>
<td>850</td>
</tr>
<tr>
<td>15,000</td>
<td>465,000</td>
<td>30,000</td>
<td>2,550</td>
</tr>
<tr>
<td>300,000</td>
<td>9,300,000</td>
<td>800,000</td>
<td>51,000</td>
</tr>
<tr>
<td>1,000,000</td>
<td>31,000,000</td>
<td>2,000,000</td>
<td>170,000</td>
</tr>
</tbody>
</table>

Brewers Association, Water and Wastewater: Treatment/Volume Reduction Manual
Beer Production 101

- Side Streaming:
  - Spent grains used to feed livestock
  - Yeast added to spent grains
  - Weak wort, trub, and spoilt beer
  - Hot liquids

- Pre-Treatment Requirements
  - 140° F Limit
  - 5.0<pH<9.5 or other corrosive property
  - BOD in “sufficient quantity” (flow or concentration) to cause interference with the POTW
  - Any wastes containing detergents, surface active agents or other substances which may cause excessive foaming in the POTW
  - Prepare, process, or serve food (fats, oils, and grease - FOG) with average water flows over 1,000 cubic feet or > 200 mg/liter of FOG
Coordination: Actions and Examples

- Raleigh: Brewer’s Corner
  - https://www.raleighnc.gov/services/content/PubUtilAdmin/Articles/WaterQualityReports.html
  - Same page as their Consumer Confidence Reports, Finished Water Quality Reports, and Wastewater Reports
  - Average finished water concentrations for:
    - Calcium, Sodium, Magnesium, Potassium, Hardness (as CaCO₃), Hardness (grains per gallon), Alkalinity (as CaCO₃), pH, Sulfate, and Chloride
  - Information on the periodic switch from chloramine disinfectant to free chlorine
  - Map to local breweries (greater Raleigh Beer Trail) (www.visitraleigh.com)
Coordination: Actions and Examples

- Charlotte: **Home Brewing**
  - [http://charlottenc.gov/Water/Pages/ HomeBrewing.aspx](http://charlottenc.gov/Water/Pages/ HomeBrewing.aspx)
  - Average finished water concentrations for:
    - Calcium, Magnesium, Alkalinity (as CaCO₃), Sulfate, Chloride, Sodium, pH,
  - Updated twice a year
Coordination: Actions and Examples

- Metropolitan Sewerage District of Buncombe County, NC
  - Nearly 60 Breweries, Meaderies, Cideries, and Distilleries
  - More per capita than Seattle and have not reached saturation
  - Sierra Nevada and New Belgium
  - 300,000 GPD from breweries
Coordination: Actions and Examples

- Metropolitan Sewerage District of Buncombe County, NC
  - Pre-treatment visits / surveys each new brewery
    - Local permits for systems over 10 BBL
    - Discusses best management practices
    - Spill planning (especially glycol)
    - Authorized releases (i.e., 3 fermenters each with 6,000 hectoliters (158,500 gallons) over 3 days)
    - GIS mapping relates breweries, pump stations, and travel times
Coordination: Actions and Examples

- Metropolitan Sewerage District of Buncombe County, NC
  - Best management practices – communications
    - Surveys
    - Spill management planning
  - Best management practices – side streaming:
    - Screens over drains
    - pH monitoring and adjustment
    - Equalization tanks
    - Separate tanks for yeast, trub/hops, and liquid wastes
    - Turbidimeter on drain hose for fermenter to route waste to the correct tank
Summary

- Water Demands
  - Consistency: Produce the same beer experience every time
  - Quantity: Water to beer ratio: typically 4 to 10 times
  - Quality: Lower alkalinity and hardness allows more options

- Waste Stream Potential:
  - High and low pH from cleaning and sanitation
  - High TSS, COD, and BOD
  - High Temperatures
  - Yeast and grain disposal by side streaming
  - Bad brew or returned/recalled beer disposal

- Communications:
  - Water quality monitoring, disinfectant residual, and local flushing
  - Coordination on high strength waste discharges
Special Thanks

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  - Head Brewer
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- Erik Myers
  - Mystery Brewing / NC Craft Brewers Guild
  - CEO/Founder/Head Brewer
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- Thomas Vincent
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  - Head Brewer

- Les Stewart
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