Quality Techniques for Craft Brewers

Kyle Sillars
MBAA District Northern Rockies
May 29, 2015

BIG SKY BREWING CO.
MISSOULA, MONTANA

What is Quality?

“The match between what you want and what you get.” -Charlie Bamforth

•Meeting an expectation consistently and efficiently

•The safety of our product is the most important component of quality

Quality Programs

- **Quality Assurance:**
  - Process oriented
  - QA is proactive and aims to prevent defects through good practices
- **Quality Control:**
  - Product oriented
  - QC is reactive and aims to identify and correct defects before progressing

Key Points of a Quality Program

1. Define your **END GOALS** and work back
   - End goal will dictate program size and expense
2. Identify **CRITICAL CONTROL POINTS** in your process
   - Break brewery into systems and consider where contaminants can enter those systems
3. Develop a **SAMPLING PLAN** to achieve your end goals

BSBC's Quality Program

1. **END GOALS:**
   - Efficient use of resources
   - Minimal bacterial counts
   - Consistent flavor production and yeast performance
   - Maximize product shelf life to meet consumer expectations

BSBC's Quality Program

2. **Systems with Critical Control Points:**
   - Raw Materials and Wort Production
   - Yeast Handling
   - Fermentation
   - Bright Beer
   - Packaging

BSBC's Quality Program

3. **SAMPLING PLAN:**
   - Will dictate the equipment needed and is where your raw data will be collected
   - Three sampling types are used:
     - Physical
     - Analytical
     - Microbiological

Physical Sampling

- Sampling at key points in our systems to provide raw data for quality control systems

- Cell counts
- pH
- Density
- Dissolved Oxygen
- CO_2
- VDK

- Date Codes
- Chemical Titrations
- Fill Levels
- Double Seam Inspections
- Crimp Tests
- Etc.

Analytical Sampling

- Used to track trends and abnormalities in our systems
  - Sensory
  - Supplier Specifications
  - Yeast Generation Tracking

Microbiological Sampling

- Used as a monitoring method for critical brewery systems
  - Bacterial Testing
  - Wild Yeast Testing
  - Giant Colony Morphology

Big Sky Brewing Company's Sampling Plan

- Sampling increases throughout our process
- As process interactions increase, so does the need for sampling

BSBC Sampling Plan

Systems	Control Point	Test
Raw Materials		
	Water	Sensory
		Forced Filtration
		Water Report
	Malt	Sensory
		Supplier Specifications
		Mill Setting
		Sieve Test
	Hops	Sensory
		Supplier Specifications
Brewhouse		
	Wort	Gravity
		pH
		Forced Wort Test
		Micro (aerobic)
		Environmental Micro
Yeast Handling		
	Stock Culture	Supplier Specifications
	Propagation/Pitching	Cell Count
		Viability
		Vitality
		Bacteria (Anaerobic, HLP, SDA/LMDA with Cyclohexamide)
		Wild Yeast (Aerobic, Lysine, LWYM, LCSM)
		Giant Colony Morphology (Aerobic, WLN, YPD)
	Yeast Tracking	
Fermentaion		
	Sanitation	ATP
	Monitoring	Gravity
		pH
		IBU
		SRM
		Dissolved Oxygen
	Micro	Aerobic (SDA/LMDA with Cyclohexamide)
		Anaerobic (HLP, SDA/LMDA with Cyclohexamide)
Bright Beer Tank		
	Sanitation	ATP
	Monitoring	CO2
		Dissolved Oxygen
		Sensory Tank Release
	Micro	Bacteria (Anaerobic, HLP, SDA/LMDA)
	Tank Blending	Volume, ABV, IBU, SRM
Packaging		
	QC Checks	Sensory
		PAA Rinse Concentration
		Package Coding
		TPO
		CO2
		Fill Level
		ABV
		Library Samples
	Micro	Anaerobic (HLP, SDA/LMDA)
	Package Integrity	Double Seam Inspection, Bottle Inspection, Crimp Test, Label Tear

Sampling Examples

- Sieve Test
- ATP Swab
- Yeast Handling Microbiology
- IBU/SRM Measurement
- Total Package Oxygen Test
- Can Double Seam Inspection

Sieve Test

- Manual analysis of grist composition
- Ensure maximum utilization of potential extract with ease of lautering

Sieve Test

- Non-mechanical analysis with low cost
- Monitors mill performance
- Estimate lauter performance through data trends

Sieve Test

- Set of four sieves (US No. 10, 30, 60, 100 and a pan)
- 9, 5/8” rubber balls (3 each on sieves No. 30, 60 & 100)
- 100g grist placed on top of sieve stack
- Top stack covered and sieve stack shaken back and forth for 3 minutes across 18 inch flat surface
- Every 15 seconds sieve stack is sharply tapped against surface
- Each sieve stack is individually emptied and weighed comprising a percentage of the original grist
- Need to establish a baseline for specific brew house

ATP Swab

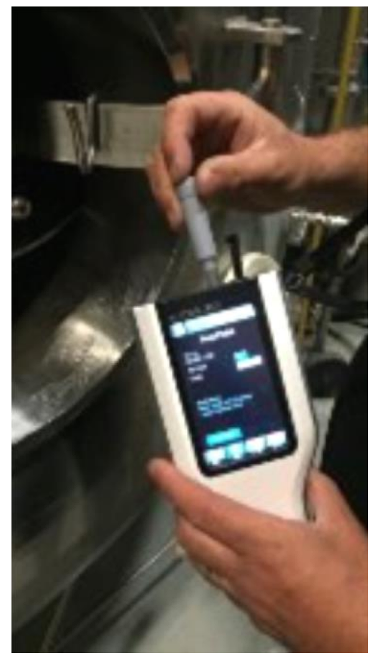
- Rapid detection for surface hygiene
- Objective analysis of sanitation

ATP Swab

- Adenosine Triphosphate present in all organic material
- The universal unit of energy used in all living cells
- Luciferase enzyme (firefly)
- Luicferin
- Release of energy in the form of light, Bioluminescence

ATP Swab

- Swabs are aseptically removed, swabbed on 4”x4” surface in cross hatch pattern, inserted into sampling device and activated
- If surface RLU is >3-5 x background level considered contaminated



ATP Swab

- Versatile around different areas of the brewer. FV, BBT, drains, conveyors
- Provides a simple go/no go indication for sanitation
- Does not specify an issue
- Inhibited by ions, heavy metals

Yeast Handling Microbiology

- Monitors the purity of microbiological cultures
- Confidence in flavor production and yeast performance

Yeast Handling Microbiology

- Cone to cone pitching and propagation
- Any contamination will be magnified on each subsequent generation
- Utilize specific medias to promote growth
- Early detection can mitigate spoilage in some cases

Yeast Handling Microbiology

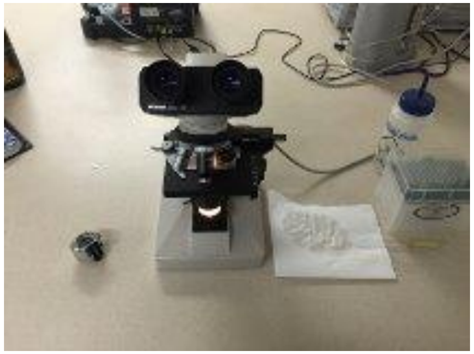
- Bacterial Testing:
  - Primary concern is anaerobic beer spoiling bacteria
    - Lactobacillus and Pediococcus
    - Pectinatus, Megasphaera, Zymomonas
  - Aerobic wort spoilage and beer spoilers
    - Enterobacter and acetic acid bacteria (Acetobacter and Gluconobacter)

- Wild Yeast Testing:
  - Confidence in yeast culture
  - Screen for wild yeast with specialized media and aerobic incubation
  - Lysine, LWYM, LCSM
- Giant Colony Morphology
  - Monitoring your strain/s for strain specific distinctions
  - Differentiation of strains and mutation identification

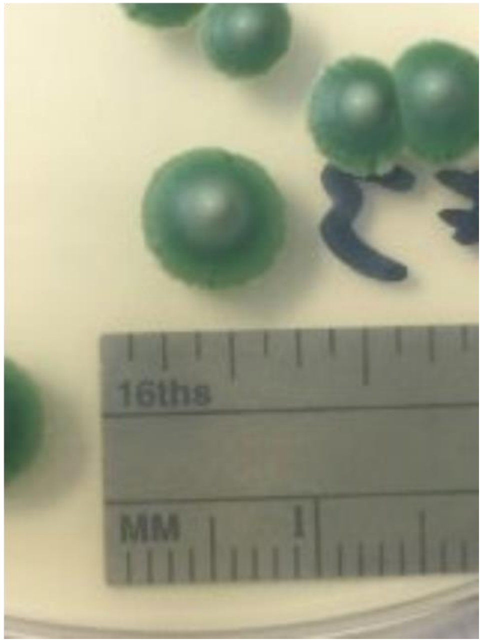
- Sample collected from pitch yeast in line or propagation

- Sample is centrifuged and supernatant used for HLP tube and spread plated SDA/LMDA media with and without Cyclohexamide
  - Anaerobic and aerobic incubation for bacterial growth

- Sterile loop used to dilute yeast concentration to approximately 5 million cells per milliliter via cell count under microscope
  - 200 µl spread plated on Lysine, LWYM and LCSM media
    - Aerobic incubation for 2-4 days and examined for wild yeast growth



- Yeast solution is further diluted to provide 5 cells per drop and spread plated on WLN and YPD media for Giant Colony Morphology
  - Aerobic incubation for up to 21 days
  - Photograph and catalog giant colonies for future generation comparison
  - Analyze for morphological changes and mutations



Yeast Handling Microbiology

- Challenges:
  - Takes time to get results
  - False positives
  - Time consuming

IBU/SRM

- Precise measurement of bitterness and color
- Efficient use of raw materials and product consistency

IBU/SRM

IBU/SRM

- Samples collected from fermentation vessels after crashed and yeast has been removed
- Samples are centrifuged and allowed to degas and chill (50ºF)
- 10ml of sample is pipetted into bottle with 20ml Trimethylpentane and 1ml 3M HCL
    - Shake for 15 min to separate phases
- After separation, the clear, upper (isooctane) layer is transferred to quartz cuvet and measured in spectrophotometer at 275 nm
- Bitterness units = absorbance$_{275}$ x 50
- Decarbonated and chilled beer sample is transferred to glass cuvet and measured at 430 nm
    - Dark samples may need to be diluted with distilled water

IBU/SRM

- Recipe adjustment in the brewhouse
- Blending of tanks to meet QC specifications
- Provides a high level of accuracy for product consistency
- Circumvent using estimation formulas
- High initial expense
- Time consuming

Total Package Oxygen (TPO)

- The measure of all oxygen in a package

- Preserve maximum product shelf life

Total Package Oxygen (TPO)

- Oxidation of fatty acids and other lipids to aldehydes and other carbonyl compounds is associated with classic stale flavors

- Oxygen dissolved in beer assists in the binding of polypeptides (protein) and polyphenols (tannin) material to create particles large enough to form beer haze

Total Package Oxygen (TPO)

- Requires a dissolved oxygen meter, shaker and piercing device
- Four parameters used to calculate TPO:
  - Package Equilibrated dO_2
  - Headspace Volume
  - Liquid Volume
  - Temperature

Total Package Oxygen (TPO)

- Dissolved Oxygen
  - The amount of O_2 dissolved in the beer at the time it is measured
- Equilibrated Dissolved Oxygen
  - The dO_2 in a package after shaking
  - The headspace and liquid gases are at equilibrium and can be used in Z factor equation to calculate TPO

Total Package Oxygen (TPO)

- Fresh packages are measured at line for dissolved oxygen
- Fresh packages are also shaken (5 min) to measure equilibrated dissolved oxygen
- Difference between the shaken and unshaken packages is from headspace pickup



Total Package Oxygen (TPO)

- Equilibrated dO_2 - ppb
- Headspace volume – Within 1 ml accuracy
- Liquid volume – Use average fill volume
- Temperature – Within 1 degree C

Total Package Oxygen (TPO)

- Spreadsheet is used to calculate TPO from the four parameters

$$m\,(t)\left(\frac{mg}{L}\right) = X\left\{\left[\frac{[32 \times 1000 \times HS\left(4.15 \times 10^{-7}T^{2} + 2 \times 10^{-4}T - 0.0701\right)}{0.082 \times T \times 1.0332 \times 100}\right] + 1\right\}$$

Brauwelt International (Volume 1, 1985), 70-77

- TPO
  - Total package oxygen calculated from a shaken dissolved oxygen concentration accounting for all of the oxygen in the package
  - TPO = BBT dO_2 + filler pick up + headspace pickup

C. Benedict. (2012, June 20). Total Package Oxygen 101. Retrieved from http://tapintohach.com/?s=TPO+Calculation&submit=Search

Total Package Oxygen (TPO)

- TPO is critical to package stability
- Sensory test for specific product threshold
  - 150 ppb is working target, 250 ppb is QC specification
- Dissolved oxygen meter can be used to trouble shoot oxygen pickup in other brewery areas
- Requires regular maintenance and calibration
- High initial expense

Double Seam Inspection

- Analyze performance of seaming equipment
- Ensure package integrity, monitor trends, and troubleshoot issues

Double Seam Inspection

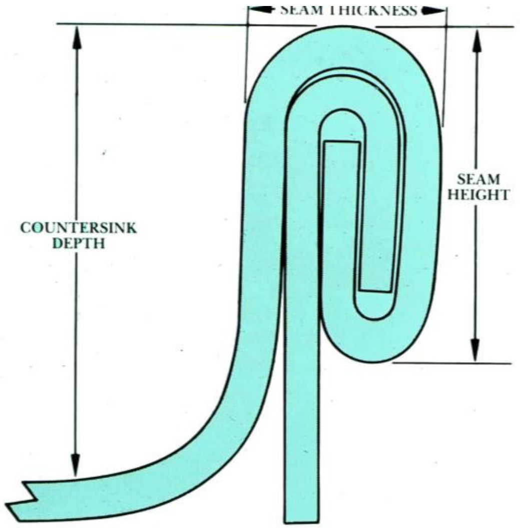
- Double seam inspection provides a quantifiable representation of seaming equipment
- Manufacturer dependent

- Double seams are made up of:
  - External components: countersink depth, seam thickness, seam height
  - Internal components: body hook, cover hook, overlap

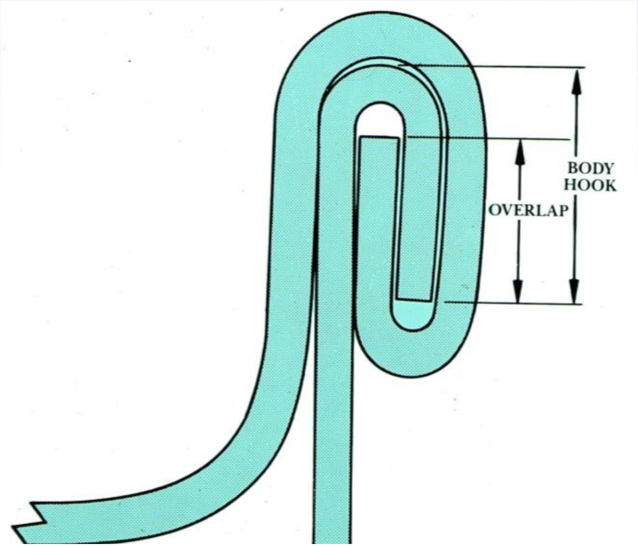
Double Seam Inspection

External Inspection:

- Every 15 min run time:
  - –At-line operator inspection
    - •Looking for misassembles, severe droops, wooling, scuffing, etc.
- Every four hours of run time:
  - –Visual inspection and manufacturer tracking
  - –Seam thickness (micrometer)
  - –Countersink depth (depth gauge)



Double Seam Inspection



Internal Inspection:

- Every four hours of run time:
  - Seam stripper
    - Tightness rating
    - Pressure ridge
  - Seam saw (cross section)
    - Only gives a "snapshot of the seam"
    - Tightness/looseness rating
    - Seam Length
    - Body Hook
    - Cover Hook
    - Overlap

Double Seam Inspection

First Seam Operation Inspection:

- Should be inspected every 40 hours of run time at the end of a run when seaming chucks are warm
- 90% of seam is formed during the first operation
  - Seam thickness and countersink depth are critical components of first operation
  - Cut end of end hook needs to be parallel to body wall

Dynamic Quality Programs

- Quality data must be recorded, reviewed and audited
- Auditing allows the program to evolve and plan for the future
- These programs are dynamic
  - Expect goals and programs to change

Questions?