Barrel Maintenance

Dr. Christian E. BUTZKE
Associate Professor of Enology
Department of Food Science

butzke@purdue.edu    (765) 494-6500     FS Rm 1261     enology.butzke.com
Outline

- Definitions
- Wood surfaces
- Spoilage environments
- Barrel maintenance
  - Physical cleaning
  - Chemical cleaning
  - Sanitation options
Exciting careers: Bung Hole Engineer
Definitions

- Cleaning
- Sanitation
- Disinfection
- Sterilization
- Disconfection
“Cleaning is an *attempt* to physically and chemically remove food for microorganisms and to eliminate hospitable environments for their growth.”
Sanitation
= Disinfection

“Sanitation is an attempt to reduce the number of spoilage microorganisms on equipment surfaces.”
Clean smell $\neq$ Sanitation
Sterilization

Ouch!
Sterilization

“Sterilization is an *attempt* to kill 100% of a population of spoilage microorganisms.”

**NB:** According to the laws of biological statistics, you CANNOT sterilize anything absolutely, you can only reduce the *probability* of contamination!
DISCONFECT (dis kon fekt') v.

To sterilize the piece of candy you dropped on the floor by blowing on it, somehow assuming this will "remove" all the germs.
Microbiology of Wood Surfaces
Microbiology of Wood Surfaces
Microbiology of Cleaning and Sanitizing a Cutting Board

Unwashed: 205,000 CFU
Water rinse: 3,050 CFU
Reduction: 98.5%

Wood

Unwashed: 205,000 CFU
Water rinse: 3,050 CFU
Reduction: 98.5%
Microbiology of Cleaning and Sanitizing a Cutting Board

Stainless Steel

Unwashed: 40,000 CFU
Water rinse: 120 CFU

Reduction: 99.7%

Log Number of Microorganisms Remaining on Food Contact Surface

- Unwashed: 4.47
- Water: 1.96
- Vinegar: 0.70
- Quat: 2.46
Spoilage Environments

Example Brett:

- Glucose
- Ethanol
- Thiamin $\Rightarrow$ low free $SO_2$
- Amino acids (incl. proline)
- Oxygen

- Warm cellar temperature
- High pH $\Rightarrow$ low molecular $SO_2$
- Low alcohol
Spoilage Environments

**Biofilms**

- Suitable surface (*Gene FLO11*)
- Stress-related adaptation
- Multiple isolated colonies
- Quorum formation
- "Quorum signaling"
- Nutrient channeling
- Protective muco-polysaccharides
- Resistance to cleaning/sanitation
Spoilage Environments

Biofilms

Representative Brett plating possible?
Battle of Trafalgar 1805

'copper bottomed'
Biofilm/Biofouling

1. Polysaccharides
2. Proteins
3. Peptides
4. Bacteria
5. Fungi
6. Sticky
7. Muco-
8. Polysaccharides
9. Surface
10. Penetration

Example: Shiphull

http://www.biosciences.bham.ac.uk/external/biofoulnet/What%20Is%20Biofouling/What%20Is%20Biofouling%20Files/what_is_biofouling.htm
Barrel Maintenance

- Physical Cleaning
- Chemical Cleaning
- Sanitation
- Storage
Barrel Maintenance
Physical Cleaning

- Low/high water pressure sprayers
- Steam cleaners (to ca. 7 oz condensate)
- Dry ice (CO₂) blasting
- Shaving/re-toasting
Physical Cleaning

- Dry ice (CO$_2$) “blasting”

$50-70/bbl$
Barrel Maintenance
Cleaning/Sanitizing w/Water/Steam

Note:

- No chlorine residues in water + soften
- Solubility of K-bitartrate is 10x higher in hot water than in cold
- Cell kill at 180°F = 10x more effective than at 170°F
Sanitizers

Chlorine

Keep out of the cellar!
Heat Conductivity of Wood

- Conductivity of wood is 1/1000 that of copper.
- Conductivity of the wood along the grain is about 3x better than across the grain.
Relative Thermal Conductivity

Cu  32
Alu  17
Iron  4
SS   1
Water  0.04
Wood  0.03
Air  0.002
Barrel Cleaning Systems

Gamajet E-Z 7

Sellers FR1

Chemdet Turbodisc

Tom Beard
BBL Nooks & Crannies!
Barrel Maintenance
Chemical Cleaning

Rinse solutions (averages)

- “Hot” (100-180ºF) water optional 3-5 min
- Soda ash Na$_2$CO$_3$ optional 2 g/L
- Cold water
- Percarbonate optional 2 g/L
- Citric acid = BOD to neutralize 1.6 g/L
Sanitizing agents:
- Steam/hot & cold water
- Soda ash
- Percarbonate
- Surfactants
- $\text{SO}_2$
- DMDC
- UV light
- Accelerated electron beam
- Ozone
“Sanitizers”
Soda Ash Na$_2$CO$_3$

- Strong alkaline (pH 11.3 at 1%)
- Dissolves proteins, fats, oils, carbohydrates, tartrates
- Neutralizes acidic odors (V.A.)
- Neutral pH best for bacteria
- Sanitizing effect?
“Sanitizers”

Percarbonates

- Per(oxy)carbonate $\text{NaO-O-COONa}$
- Release of oxygen radicals via $\text{H}_2\text{O}_2$
- Application at room temperature
- Effective over wide pH range (1 - 8)
- Alkaline
- Degradation to soda ash, water, $\text{O}_2$
- Sanitation effect via $\text{H}_2\text{O}_2$?
“Sanitizers”

Percarbonates

Common uses:

“Chlorine-free” laundry and wood bleach
Sanitizers
Surfactants

Purpose: To reduce the surface tension of water, dispersing dirt particles and aiding the wetting of equipment surfaces.

“Soap principle”

- Non-ionic
- Cationic (eg “Quats”)
- Anionic

Synthetic vs. Natural
Biodegradable?
Sanitation

DMDC

CH₃O-C-O-C-OCH₃

- Instant action; half-life: 60 min @ 50°F
- **Not a preservative** → *Recontamination*!
- Legal limit: 200 mg/L
- Against wine yeast: 40-100 mg/L
- Against lactic acid bacteria: 200+ mg/L!
- Special equipment required
- Can become unstable over time
Sanitation
UV Light

Potential effects on barrel:
- Lignin degradation?
  => volatile phenols?
- Light-struck wine residues?
- No surface penetration
- Against fruit flies in cellar!
Sanitizers
Accelerated Electron Beam

- Penetration: 4 cm
- True sterilization?
  - vegetative cells
  - mold spores
Barrel Maintenance

Chemical sanitation alternatives?

- Vinegar / Peracetic acid
- CuSO₄
- High-proof alcohol
- Salt water
- Ozonated water
Ozone

- Colorless toxic gas
- Very powerful oxidizing agent
- Irritant via inhalation and to skin/eyes
- Odor threshold 0.02 - 0.1 ppm
- Half life: "20 minutes" only in water but 3 days in air
- Vapor density: 1.6 = heavier than air
- Solubility in water: 10 mg/L @ 32+°F
- 1 to 5 mg/L against wine microbes?
RECOMMENDED RESPIRATOR:

When working with this chemical, wear a NIOSH-approved full face positive pressure supplied-air respirator or a self-contained breathing apparatus (SCBA).
Ozone
High concentrations of ozone can cause:

- shortness of breath
- coughing
- wheezing
- headaches
- nausea
- eye and throat irritation
- lung damage
- reduced athletic performance
- weakened immune system
Barrel Storage
Sulfur (Dioxide)

Dry:
• 1.7 - 3.4 g S/bbl
• Every 3-4 weeks!

Wet:
• 225 g Citric/bbl
• 45 g KMBS/bbl
Stop and smell the Barrel!
Rawhide Tanker Truck
Barrel Sanitation

Summary

- No perfect solution => CIP/SIP as in dairy ideal
- Some agents not better than clean water
- Some hazardous to barrel or health
- Cleaning more important than sanitation
- More data on sanitation effects needed
- Biofilm research needed
The Wine Grape Action Team: A cooperation between Purdue University and the Indiana Wine Grape Council to serve the State's winemakers and growers and help propel the Indiana wine/grape industry into world-class competitiveness. The 5-member team is available at any time to troubleshoot emerging issues in your vineyard and winery: 1-800-485-WINE

- 2007 Spring Grape and Wine Workshop (Registration: Jill Blume)
  - Host: Ertel Cellars, Batesville, March 26 - 9:00 a.m.
- 2007 Wine Grape Symposium & Indiana Horticultural Congress & Trade Show
  - Wine Closure and Packaging Workshop (Christian Butzke)
  - Wine Business Monthly's Closure Report (Curtis Phillips)
  - Only the Lone Ranger Had Silver Bullets (Bruce Scatto)
  - Advances in Synthetics Closure Technology (Jim Lachap)
  - Update on Bag-in-Box Packaging (Jannis Radavass, Jr.)
  - Winemaker's Perspective on Screw Caps (Dennis Dushan)
- What can we grow in Indiana? (Bruce Bordinon)
  - Season Review - Indiana's 2006 Vintage (Bruce Bordinon)
  - Wine Filtration: Review of Methods and Materials (Christian Butzke)
  - Establishing a Basement Winery - Amateur Winemaking Supplies (Ellie Butz) (Jill Blume)

- 2006 Fall Grape and Wine Workshop
  - Winemaking Equipment Info (Christian Butzke)
  - Begin Fermentation (Ellie Butz)
  - Wine Quality Control Basics (Christian Butzke)

- 2006 Spring Grape and Wine Workshop
  - Making More $$ In Your Tasting Room (Jeanette Mutter)
  - IQ - The Indiana Quality Alliance (Christian Butzke)
  - The Projective Winery Lab Quality Management (Jill Blume)
  - Buffer Divide & Borate Management (Christian Butzke)
  - Grape Acreage & Variety Trends (Bruce Bordinon)
  - Training Systems and Canopy Management (Patty Stinkis)

- 2006 Wine Grape Symposium & Indiana Horticultural Congress & Trade Show
  - Grape Pest Management (Bruce Bordinon)
  - Wine Quality – The Science of Funk (Christian Butzke)
  - Exploring the Aroma Potential of Traminer (Patty Stinkis)
  - The Joy of Malolactic Fermentation (Ellie Butz)
  - EPA Worker Protection Standards Compliance (Jill Blume)
  - Winery Safety – A Crash Course (Christian Butzke)

- 2005 Spring Grape and Wine Workshop
  - A Fresh Look at the Science and Art of Winemaking (Christian Butzke)

- Winery Laboratory Information
  - Winery Lab Starter Kit
  - Free SO2 graph Chart
  - Residual Sugar Color Chart

- Grape Production and Pest Management Information
  - Dept. of Horticulture Fruit and Vegetable Connection (Bruce Bordinon)

- Workshops and Services for the Food Industry and Food Entrepreneurs
  - Dept. of Food Science Extension Classes (Christian Butzke)

- Recent Research
  - 2006 Purdue – Silicon Valley Symposium: Tales from a Bailier/Winemaker (Christian Butzke)
  - Wine & Global Warming – The Art of Winemaking in an Ever-Changing World (Christian Butzke)
  - The Science of Closures (Christian Butzke)
Thank You For Hosting!