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Program Book

2015
Annual Conference



October 8–10
Jacksonville, Florida, U.S.A.

Master Brewers Association of the Americas

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Program Overview

Tuesday, October 6			
8:00 a.m.–5:00 p.m.	Pre-Conference Workshop: Hazard Analysis and Critical Control Points (HACCP) Course • <i>City Terrace 12</i>		
Wednesday, October 7			
8:30 a.m.–5:00 p.m.	Pre-Conference Workshop: Hazard Analysis and Critical Control Points (HACCP) Course • <i>City Terrace 12</i>	Pre-Conference Workshop: Beer Steward Seminar • <i>Offsite: AB InBev</i>	
9:00 a.m.–12:00 p.m.	Executive Committee Meeting • <i>Board Room 1</i>		
12:00–5:00 p.m.	Jacksonville Breweries Tour • <i>Departs from Newnan St.</i>		
1:00–4:00 p.m.	Board of Governors Meeting • <i>River Terrace 2</i>	Pre-Conference Workshop: Sour Beer—Styles and Techniques • <i>Grand 6</i>	
1:00–5:00 p.m.	AB InBev Brewery Tour • <i>Departs from Newnan St.</i>		
1:30–3:45 p.m.	Glass Plant Tour • <i>Departs from Newnan St.</i>		
4:00–5:00 p.m.	District Officer Forum • <i>River Terrace 2</i>		
5:00–6:30 p.m.	Meeting of the District Technical Chairs • <i>Orlando</i>		
Thursday, October 8			
7:00–8:00 a.m.	Speaker Breakfast • <i>Daytona</i>		
8:15–9:45 a.m.	Opening Session and Keynote • <i>Grand 6–8</i>		
10:00–11:15 a.m.	Technical Session: Engineering I • <i>River Terrace 2</i>	Technical Session: Hops I • <i>Grand 6–8</i>	
10:00–11:45 a.m.	Workshop: Glass Quality • <i>River Terrace 1</i>		
10:00 a.m.–7:00 p.m.	Open Poster Viewing • <i>Grand Foyer</i>		
11:45 a.m.–1:45 p.m.	Exhibits, Posters, and Lunch • <i>Grand 1–5</i>		
1:45–3:30 p.m.	Technical Session: Packaging (Bottles, Draft, and Cans) • <i>River Terrace 2</i>	Technical Session: Brewhouse Operations I • <i>Grand 6–8</i>	Workshop: Beer Safety from Field to Growler • <i>River Terrace 1</i>
3:45–5:00 p.m.	Technical Session: Engineering II • <i>River Terrace 2</i>		
3:45–5:30 p.m.	Workshop: Flavor First: Innovations in Barley and Malting for Today's Brewer • <i>River Terrace 1</i>	Brewing Fundamentals: Fermentation: Practical Science and Techniques I • <i>Grand 6–8</i>	
5:30–7:00 p.m.	Happy Hour with Exhibits • <i>Grand 1–5</i>		

Friday, October 9			
7:00–8:00 a.m.	Speaker Breakfast • <i>Daytona</i>		
8:00–9:45 a.m.	Technical Session: Yeast, Fermentation, and Microbiology I • <i>Grand 6–8</i>	Technical Session: Enzymes, Finish- ing, and Stability • <i>River Terrace 2</i>	Workshop: Brewhouse Automation • <i>River Terrace 1</i>
8:00 a.m.–3:45 p.m.	Open Poster Viewing • <i>Grand Foyer</i>		
10:00–11:45 a.m.	Technical Session: Brewhouse Operations II • <i>River Terrace 2</i>	Workshop: Brewery Maintenance Success • <i>River Terrace 1</i>	
10:00 a.m.–12:00 p.m.	Brewing Fundamentals: Fermentation: Practical Science and Techniques II • <i>Grand 6–8</i>		
11:45 a.m.–2:15 p.m.	Exhibits, Posters, and Lunch • <i>Grand 1–5</i>		
2:15–3:30 p.m.	Technical Session: Brewery Safety • <i>River Terrace 1</i>	Technical Session: Hops II • <i>Grand 6–8</i>	Technical Session: Malt & Grains • <i>River Terrace 2</i>
3:45–5:30 p.m.	Technical Session: Sustainability I • <i>River Terrace 2</i>	Technical Session: Sensory • <i>Grand 6–8</i>	Workshop: Advanced Extract Options for Brewers • <i>River Terrace 1</i>
7:00–9:30 p.m.	Celebration Reception* • <i>River Deck 2/Lower Deck</i>		
9:30–11:00 p.m.	Afterglow Party • <i>River Terrace 1</i>		
Saturday, October 10			
7:30–8:30 a.m.	Committee Meetings • <i>Daytona</i>		
8:30–9:45 a.m.	Technical Session: Yeast, Fermentation, and Microbiology II • <i>Grand 6–8</i>		
8:30–10:15 a.m.	Technical Session: Sustainability II • <i>River Terrace 2</i>	Workshop: Wort Separation: Mash Filter vs. Lauter Tun • <i>River Terrace 1</i>	
10:30 a.m.–12:30 p.m.	Closing Session: Keynote and Award of Merit • <i>Grand 6–8</i>		

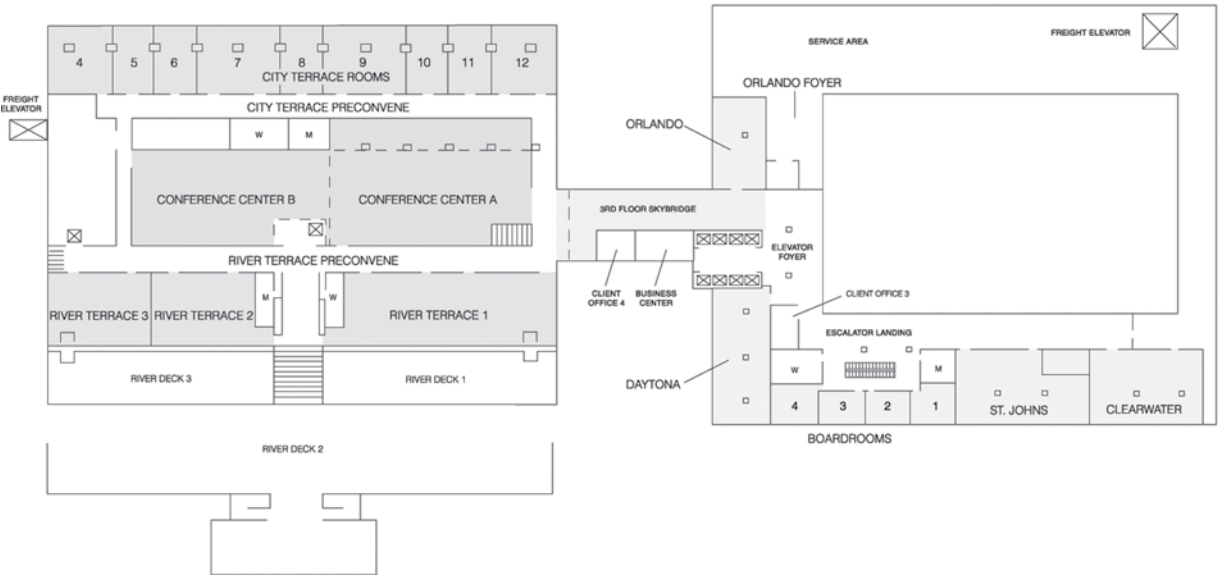
* Guests and Single Day attendees must purchase a ticket to attend

Hyatt Regency Jacksonville Riverfront

2nd Floor



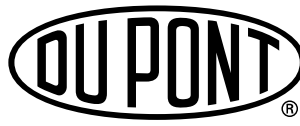
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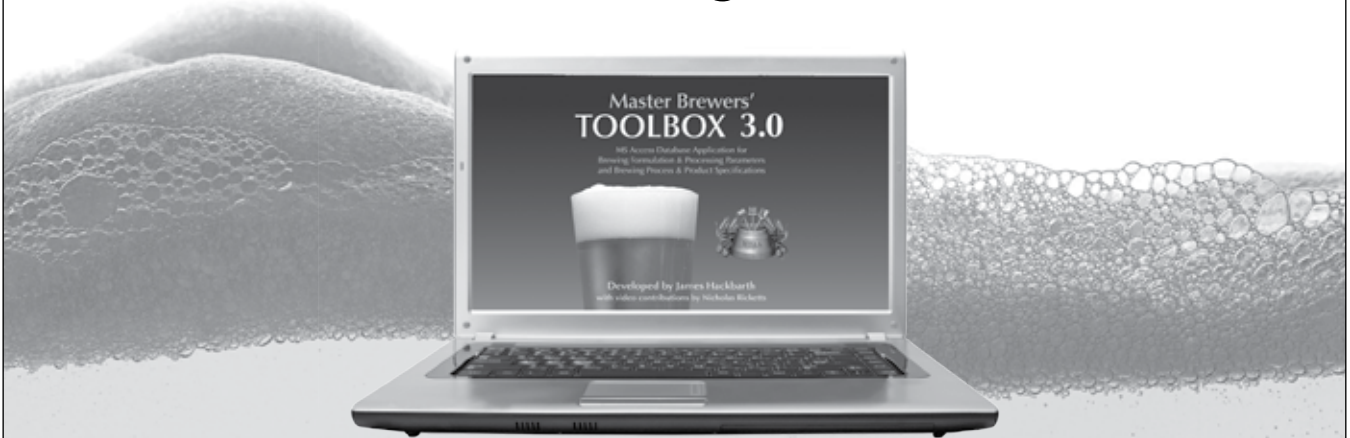
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Master Brewers' Toolbox 3.0 is a powerful database that allows you to easily design and improve beer formulations at every production level, so you can predict how formulation changes affect other brewing variables and achieve the desired goals for your finished product—for small batches or mega-brew roll outs.

Visit the MBAA online bookstore at mbaa.com/store to order this and other brewing titles.



Master Brewers Association of the Americas

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Schedule and Highlights

Tuesday, October 6

8:00 a.m.–5:00 p.m. Pre-Conference Workshop: Hazard Analysis and Critical Control Points (HACCP) Course *City Terrace 12*

Wednesday, October 7

8:30 a.m.–5:00 p.m. Pre-Conference Workshop: Beer Steward Seminar *Off-site: AB InBev*
 8:30 a.m.–5:00 p.m. Pre-Conference Workshop: Hazard Analysis and Critical Control Course Points (HACCP) *City Terrace 12*

9:00 a.m.–12:00 p.m. Executive Committee Meeting *Board Room 1*
 12:00–5:00 p.m. Jacksonville Breweries Tour *Departs from Newnan St.*
 12:00–6:00 p.m. Registration *Grand Foyer*
 12:30–4:00 p.m. Board of Governors Lunch and Meeting *River Terrace 2*
 1:00–4:00 p.m. Pre-Conference Workshop: Sour Beer—Styles and Techniques *Grand 6*
 1:00–5:00 p.m. AB InBev Brewery Tour *Departs from Newnan St.*
 1:30–3:45 p.m. Glass Plant Tour *Departs from Newnan St.*
 2:00–6:00 p.m. Exhibit Set-up *Grand 1–5*
 3:00–11:00 p.m. Bierstube *River City 3*
 4:00–5:00 p.m. District Officer Forum *River Terrace 2*
 4:00–6:00 p.m. Poster Set-up *Grand Foyer*
 5:00–6:30 p.m. Meeting of the District Technical Chairs *Orlando*

Hazard Analysis and Critical Control Points (HACCP) Course

Tuesday, October 6, 8:00 a.m.–5:00 p.m.; Wednesday, October 7, 8:30 a.m.–5:00 p.m. • City Terrace 12
Tatiana Lorca, Ecolab, Inc.; Shawn Theriot, Deschutes Brewery; Karli Smalls, Bell's Brewery; Tim Gossack, Bell's Brewery; Kate Devine, Left Hand Brewery

In this two-day MBAA HACCP course, participants will learn from safety experts to achieve their HACCP certification. Topics include: introduction to food safety and HACCP, hazards and beer, good brewing practices, hazards and their classification, seven principles and 12 steps of HACCP implementation, return on investment, and more.

Beer Steward Seminar

Wednesday, October 7, 8:30 a.m.–5:00 p.m. • Off-site: AB InBev
Rick Seemueller, Your Beer Ambassador LLC; Bill White, Better With Beer

From delivery to serving, attendees will receive an overview on how to properly handle, store, and present a variety of beers to maintain flavor and freshness. This hands-on, intensive course will teach attendees how to showcase beer styles using food pairings and proper glassware through sampling and demonstrations. Presenters will highlight the history of beer, as well as the diversity of beer styles.

Sour Beer—Styles and Techniques

Wednesday, October 7, 1:00–4:00 p.m. • Grand 6
Travis Audet, AB InBev; Jennifer Talley, Auburn Ale House; Jason Perkins, Allagash Brewing Co.; Eric Salazar, New Belgium Brewing Co.; Wayne Wambles, Cigar City Brewing

This workshop will be an excellent opportunity to learn details of successful production of these beers in a renaissance of sour beer creation. Topics include: fundamental techniques for kettle souring, American sour production, sour beer fermentations, selecting the right wooden vessel including refurbishment, brett vs. sour beer, and much more.

Thursday, October 8

7:00–8:00 a.m.	Speaker Breakfast	<i>Daytona</i>
7:30 a.m.–6:00 p.m.	Registration	<i>Grand Foyer</i>
7:30–10:00 a.m.	Poster Set-up	<i>Grand Foyer</i>
8:00–11:00 a.m.	Exhibitor Set-up	<i>Grand 1–5</i>
8:15–9:45 a.m.	Opening Session and Keynote: A Bottle a Day Keeps the Doctor Away: The Facts and Fallacies About the Health Effects of Beer	<i>Grand 6–8</i>
10:00–11:15 a.m.	Technical Session: Engineering I <i>Moderator: Darren Goodlin</i> 10:00 a.m. 1. Henri Fischer. Warm beer filling: An energy efficient concept 10:25 a.m. 2. Kevin McEnery. Considerations for brewery automation 10:50 a.m. 3. Stephen Carter. Long-term system sustainability considerations for small brewing operations when transitioning from operator tended brewing to a semi or fully automated brewhouse	<i>River Terrace 2</i>
10:00–11:15 a.m.	Technical Session: Hops I <i>Moderator: John Bryce</i> 10:00 a.m. 4. Yutaka Yamaguchi. Pretreatment of hop pellets before hop dosage into the brewing process 10:25 a.m. 5. Santiago Gomez. Use of microscopic pressurized shockwaves generated by controlled cavitation as a non-shear method for increased extraction of alpha acids and oils from hops 10:50 a.m. 6. Steven Miller. Hop growing and processing in the northeast United States	<i>Grand 6–8</i>
10:00–11:45 a.m.	Workshop: Glass Quality	<i>River Terrace 1</i>
10:00 a.m.–7:00 p.m.	Open Poster Viewing	<i>Grand Foyer</i>
11:45 a.m.–1:45 p.m.	Exhibits, Posters, and Lunch <i>12:00–12:30 p.m.: Even-numbered poster authors at posters</i> <i>12:30–1:00 p.m.: Odd-numbered poster authors at posters</i>	<i>Grand 1–5</i>
1:45–3:30 p.m.	Technical Session: Packaging (Bottles, Draft, and Cans) <i>Moderator: Bob Seaman</i> 1:45 p.m. 7. Matt Bilski. Overview of can transfers: General knowledge, best practices, and troubleshooting 2:10 p.m. 8. Brian Ornaty. Vapor space tunnel pasteurizer corrosion completely eliminated with the use of a “non-oxidizing” biocide to control pasteurizer bacteria 2:35 p.m. 9. Scott Brendecke. Palletized cans 3:00 p.m. 10. Lauren Torres. The science of packaging quality: The oxygen edition	<i>River Terrace 2</i>
1:45–3:30 p.m.	Technical Session: Brewhouse Operations I <i>Moderator: John Bryce</i> 1:45 p.m. 11. Dirk Loeffler. The importance of maintenance with respect to quality and sanitation 2:10 p.m. 12. Sebastian Kappler. Brewhouse expansions and upgrades—How to avoid trouble and disinvestments 2:35 p.m. 13. Roland Folz. How craft brewers can move from hoses and flow panels to mix proof valves and valve manifolds for a more sustainable operation 3:00 p.m. 14. Luke Erdody. Minimize O ₂ pickup from fermenter to bottle with portable and inline instrumentation	<i>Grand 6–8</i>
1:45–3:30 p.m.	Workshop: Beer Safety from Field to Growler	<i>River Terrace 1</i>
3:45–5:00 p.m.	Technical Session: Engineering II <i>Moderator: Vince Coonce</i> 3:45 p.m. 15. Todd Rausch. Ten things you need to know about your pumps	<i>River Terrace 2</i>

4:10 p.m.	16. Ryan Stockinger. Glycol chiller essentials: A comprehensive look at chiller components, critical design integrations, and opportunities for reducing ownership cost	
4:35 p.m.	17. Johannes Preiß. Technological chances and challenges of a wide product diversification for brewing equipment	
3:45–5:30 p.m.	Workshop: Flavor First: Innovations in Barley and Malting for Today’s Brewer	<i>River Terrace 1</i>
3:45–5:30 p.m.	Brewing Fundamentals: Fermentation: Practical Science and Techniques I	<i>Grand 6–8</i>
5:30–7:00 p.m.	Happy Hour with Exhibits	<i>Grand 1–5</i>
7:00–11:30 p.m.	Bierstube	<i>River City 3</i>

Opening Session and Keynote: A Bottle a Day Keeps the Doctor Away: The Facts and Fallacies About the Health Effects of Beer



8:15–9:45 a.m. • Grand 6–8
Carol A. Westbrook,
Geisinger Health Systems

Beer has long been considered to be a healthy and nutritious beverage, and some of its components were valued for their medicinal properties. Recently, though, many negatives to drinking beer have been advanced in the popular press, much of which is not based on scientific evidence. Our objective is to examine the science behind these claims. We will review nutritional properties of yeast and barley and potential medicinal uses of hops. We will look closely at alcohol, which is responsible for most of the health effects of beer. We will look at alcohol metabolism and its nutrition effects, as well as central nervous system effects of intoxication, hangovers, and chronic alcoholism. We will examine perceived effects on cardiovascular health, cancer risk, and liver damage, differentiating effects due to moderate vs. excessive drinking. We hope to answer whether a beer each day truly keeps the doctor away.

Workshop: Glass Quality

10:00–11:45 a.m. • River Terrace 1
John Mallett, Bell’s Brewery; Brad Rush, Boston Beer Co.;
Norm Jones, Anchor Glass

Explore the essentials of glass bottle quality, from manufacturing through to the end consumer.

Workshop: Beer Safety from Field to Growler

1:45–3:30 p.m. • River Terrace 1
Whitney Thompson, Malteurop NA; Patrick Staggs, Crown Cork and Seal; Tatiana Lorca, Ecolab Inc.

Recent outbreaks in some of the United State’s favorite food groups have heightened media and consumer attention to food safety. Every recall and outbreak affects not only the individual companies implicated, but also the market segment as a whole. Consumers expect products to be safe regardless of what they are and the size of the facility in which they are made. Breweries are not immune from basic food safety expectations. Retailers and restaurants expect brewers to meet minimum food

safety requirements so they can protect their customers and are sending food safety auditors into breweries to audit practices and controls. This session will address requirements and expectations for food safety programs and parameters within key points of the beer supply chain from grower to retail service and will provide insights as to what auditors are looking for within breweries.

Workshop: Flavor First: Innovations in Barley and Malting for Today’s Brewer

3:45–5:30 p.m. • River Terrace 1
Tim Matthews, Oskar Blues Brewery; Patrick Hayes, Oregon State University; Mike Davis, American Malting Barley Association; Andrea Stanley, Craft Maltsters Guild

Innovation is a great word—but what does it mean when it comes to your grain bill? Tim Matthews from Oskar Blues Brewery will lead expert panelists in a deep dive into today’s science, production agronomics, small-scale malting technologies, and the collaboration with brewers that is driving innovation in malting for tomorrow’s great beer.

Brewing Fundamentals: Fermentation: Practical Science and Techniques I

3:45–5:30 p.m. • Grand 6–8
Tom Eplett, MillerCoors; Graham Stewart, GGStewart Associates; Dawn Maskel, International Centre of Brewing and Distilling, Heriot-Watt University; Alex Speers, International Centre of Brewing and Distilling, Heriot-Watt University

In this first of two Brewing Fundamentals sessions on Fermentation, industry experts will cover the following topics: “Introduction to Fermentation,” “What’s on the Menu? Fundamentals of Yeast Nutrition,” and “Yeast Settling—When the Party is Over!”

Happy Hour with Exhibits

5:30–7:00 p.m. • Grand 1–5

Browse the newest innovations and connect with suppliers over a beer. The Exhibit Hall will be packed with resources to fulfill all your brewing needs; don’t miss your chance to find the solutions that are right for you!

The Happy Hour with Exhibits is sponsored in part by Cargill Malt.



Friday, October 9

7:00–8:00 a.m.	Speaker Breakfast	Daytona
7:30 a.m.–5:30 p.m.	Registration	Grand Foyer
8:00–9:45 a.m.	Technical Session: Yeast, Fermentation, and Microbiology I <i>Moderator: Jaime Schier</i>	Grand 6–8
8:00 a.m.	18. Hiroshi Nakamura. Behavior of hydrogen sulfide during late-stage fermentation using all malt wort	
8:25 a.m.	19. Leo Chan. Image-based cytometric analysis of fluorescent viability and vitality staining methods for <i>Saccharomyces cerevisiae</i>	
8:50 a.m.	20. Nick Mader. Preventative measures for cross-contamination in breweries	
9:15 a.m.	21. Konrad Müller Auffermann. Influence of heat treatment for an optimal protein-particle distribution	
8:00–9:45 a.m.	Technical Session: Enzymes, Finishing, and Stability <i>Moderator: Mark Sammartino</i>	River Terrace 2
8:00 a.m.	22. Sylvie Van Zandycke. Reduction of carbon footprint using a proline-specific endoprotease (PSEP) during beer production	
8:25 a.m.	23. Joe Formanek. The use of tannic acid in the brewing process as a stabilizing agent	
8:50 a.m.	24. Iliana Yanez. Commercial enzymes in brewing	
9:15 a.m.	25. Kristen Kahle. Early detection and risk-based analysis of <i>Lactobacillus</i> and <i>Pediococcus</i> contamination enables preventive quality and environmental monitoring programs at the brewery	
8:00–9:45 a.m.	Workshop: Brewhouse Automation	River Terrace 1
8:00 a.m.–3:45 p.m.	Open Poster Viewing	Grand Foyer
10:00–11:45 a.m.	Technical Session: Brewhouse Operations II <i>Moderator: Lars Larson</i>	River Terrace 2
10:00 a.m.	26. Kathryn Kuhr. Optimizing the utilization of brewhouse resources through enhanced data visualization: connecting operations from start to finish	
10:25 a.m.	27. Tobias Becher. Novel approach of a universal milling system considering any brewing grains and each mashing-in strategy and mash filtration system	
10:50 a.m.	28. Jörg Engstle. Surface forces and their effect on lautering	
11:15 a.m.	29. David Schroeder. Scaling and logistics rethought: Multi-function mash-tun, kettle, and whirlpool	
10:00–11:45 a.m.	Workshop: Brewery Maintenance Success	River Terrace 1
10:00 a.m.–12:00 p.m.	Brewing Fundamentals: Fermentation: Practical Science I and Techniques I	Grand 6–8
11:45 a.m.–2:15 p.m.	Exhibits, Posters, and Lunch <i>12:00–12:30 p.m.: Odd-numbered poster authors at posters</i> <i>12:30–1:00 p.m.: Even-numbered poster authors at posters</i>	Grand 1–5
2:15–3:30 p.m.	Technical Session: Brewery Safety <i>Moderator: Al Marzi</i>	River Terrace 1
2:15 p.m.	30. Dave Baughman. Safe boiler operations	
2:40 p.m.	31. Joshua Pringle. CO ₂ safety monitoring in breweries	
3:05 p.m.	77. Mark Carpenter. Keg and valve safety	
2:15–3:30 p.m.	Technical Session: Hops II <i>Moderator: Roy Johnson</i>	Grand 6–8
2:15 p.m.	33. Jörg Engstle. Methods for characterization of different hop products for dry hopping	
2:40 p.m.	34. Andreas Gahr. The behavior of linalool during beer aging	
3:05 p.m.	35. John Paul Maye. Formation of humulinones in hops and hop pellets and its implication for dry-hopped beers	

2:15–3:30 p.m.	Technical Session: Malt & Grains <i>Moderator: John Palmer</i> 2:15 p.m. 36. Steven Edwardson. Barley production: Factors in crop management, business, and risk assessment growers utilize in planting decisions 2:40 p.m. 37. Anna Shimmura. The influence of the combination of malt and yeast on beer characteristics 3:05 p.m. 38. Jordan Geurts. Specialty malt acidity	<i>River Terrace 2</i>
2:15–5:00 p.m.	Exhibit Take-down	<i>Grand 1–5</i>
3:45–5:00 p.m.	Poster Take-down	<i>Grand Foyer</i>
3:45–5:30 p.m.	Technical Session: Sustainability I <i>Moderator: Walter Heeb</i> 3:45 p.m. 39. Alex Wright. New wastewater treatment technology for breweries 4:10 p.m. 49. Jeffrey Van Voorhis. Biogas energy applications that can reduce organic wastes and positively impact your brewery’s sustainability goals 4:35 p.m. 41. Manaf Farhan. High-rate anaerobic digester systems for brewery wastewater treatment and electricity generation: System commissioning and start-up 5:00 p.m. 42. Lee Smith. Observations on sustainability	<i>River Terrace 2</i>
3:45–5:30 p.m.	Technical Session: Sensory <i>Moderator: Lindsay Guerdrum</i> 3:45 p.m. 43. Xiangdong Zhao. Beer fermentative flavor visualization by principal component analysis 4:10 p.m. 44. Matthias Baldus. Formation of dimethyl sulfide during beer storage via bisulfite reduction of dimethyl sulfoxide 4:35 p.m. 45. Kara Taylor. Using the Brix/TA ratio to determine sensory perception in sour beers 5:00 p.m. 46. Nicole Garneau. Bringing modern science into flavor analysis	<i>Grand 6–8</i>
3:45–5:30 p.m.	Workshop: Advanced Extract Options for Brewers	<i>River Terrace 1</i>
5:30–7:00 p.m.	Bierstube	<i>River City 3</i>
7:00–9:30 p.m.	Celebration Reception	<i>River Deck 2/ Lower Deck</i>
9:30–11:00 p.m.	Afterglow Party	<i>River Terrace 1</i>
9:30–11:30 p.m.	Bierstube	<i>River City 3</i>

Workshop: Brewhouse Automation

8:00–9:45 a.m. • *River Terrace 1*

Fred Scheer, Krones Inc.; Matthias Lichtenauer, Krones Inc.; Doug MacNair, Harpoon Brewery; Darren Goodlin, Goodlin Process Solutions LLC

This workshop will begin with insight into brewhouse automation based on the BOTEK process control system. A short overview of the different modules will be followed by some real-life references of recent projects, both in larger breweries as well as craft breweries. Next, the workshop will discuss pure process control versus data/information generation. Will your choice support your business needs down the road? Topics will include in-house management versus outside integrator support, hardware platform choice, and software platform. Finally, the workshop will provide a general overview of the traditional locations of inline instrumentation and analyzers in the brewing process and the challenges each present.

Workshop: Brewery Maintenance Success

10:00–11:45 a.m. • *River Terrace 1*

John Houseman, D. G. Yuengling & Son

A maintenance professional who feels competent is a better worker and is motivated more easily. An expert panel chaired by Master Brewer John Houseman will explore brewery maintenance challenges and opportunities in the context of proven approaches that support system performance and maximize the efficiency of maintenance teams. From the brewhouse to packaging operations, maintenance planning, prioritization, and scheduling are key elements that influence the success of any organization. Metrics and means of measuring results will be discussed. The panelists will make succinct presentations and then close the panel with audience discussion and Q&A.

Brewing Fundamentals: Fermentation: Practical Science and Techniques II

10:00 a.m.–12:00 p.m. • Grand 6–8

Travis Audet, AB InBev; Mark Sammartino, Master Brewers Association of the Americas; Ashton Lewis, Paul Mueller Company; Helmut Kuehnl, Esau & Hueber

In the second Brewing Fundamentals session on Fermentation, the panel of experts will cover the following topics:

“Traditional and Alternative Fermentation Techniques,” “Fermentation and Flavor,” “Fermentation–Physical Plant,” and “Yeast Propagation.”

Workshop: Advanced Extract Options for Brewers

3:45–5:30 p.m. • River Terrace 1

Brian Buffin, Kalsec, Inc.; Mike Babb, Kalsec, Inc.; Mark Schulze, Kalsec, Inc.; Joe Snyder, Kalsec, Inc.; Ross Turner, PureMalt Products, Ltd.; Ron Duszanskyj, PureMalt Products, Ltd.; Jonathan Davis, GLCC Co.

Today’s brewers have a number of options available to help create the perfect beer. This includes a variety of hops, malt, spices, and fruits for specific beer styles. This workshop will examine how advanced extracts and flavors can be utilized to control beer character, often at lower cost. Tasting of beers created with these extracts will be included.

Celebration Reception

7:00–9:30 p.m. • River Deck 2/Lower Deck

Kick back, meet colleagues, and escape to a tropical world at the Celebration Reception. Enjoy food, beer, and hospitality. While you’re there, check out the Taste of Florida area featuring brews from the Sunshine State. Single Day attendees and Guests must purchase a ticket to attend this event.

The Celebration Reception is sponsored in part by DuPont Nutrition & Health.



Afterglow Party

9:30–11:00 p.m. • River Terrace 1

Join your colleagues for a relaxing night with Irish coffee and networking.

The Afterglow Party is sponsored by Malteurop North America.



Saturday, October 10

7:30–8:30 a.m.	Committee Meetings	Daytona
8:00 a.m.–12:00 p.m.	Registration	Grand Foyer
8:30–9:45 a.m.	Technical Session: Yeast, Fermentation, and Microbiology II <i>Moderator: Jason Perkins</i>	Grand 6–8
8:30 a.m.	51. Maximilian Michel. Developing a screening system for the brewing ability of non- <i>Saccharomyces</i> yeasts	
8:55 a.m.	54. David Schleef. Recovering beer from yeast in a large craft brewery using a ceramic membrane cross-flow system with a novel membrane design	
9:20 a.m.	76. Jasper Akerboom. Isolating interesting wild <i>Saccharomyces</i> yeast strain for brewing applications	
8:30–10:15 a.m.	Technical Session: Sustainability II <i>Moderator: Scott Shirley</i>	River Terrace 2
8:30 a.m.	47. Scott Bury. A low-cost, self-contained, and low-attention wastewater BOD5 reduction technology for breweries	
8:55 a.m.	48. Manaf Farhan. Modification of existing digester systems at breweries to handle overloading and production growth	
9:20 a.m.	40. Jaime Jurado. Financial and process design tools applied to brewery effluent treatment	
9:45 a.m.	50. Michael Henk. Practical primary water treatment for breweries	
8:30–10:15 a.m.	Workshop: Wort Separation: Mash Filter vs. Lauter Tun	River Terrace 1
10:30 a.m.–12:30 p.m.	Closing Session: Keynote and Award of Merit	Grand 6–8
1:00–11:00 p.m.	Bierstube	City Terrace 9*

*Note room change

Workshop: Wort Separation: Mash Filter vs. Lauter Tun

8:30–10:15 a.m. • River Terrace 1

Leon Fyfe, Craft Brew Alliance

Both the mash filter and the lauter tun have been around for quite a while now, and lately the mash filter has been making inroads in the craft brewing world. Which system is right for you and your brewery? This panel of brewers and suppliers will discuss the advantages and disadvantages of these two brewing technologies.

Closing Session and Keynote: What Does Scientific Policy Have to Do with a Pint?

10:30 a.m.–12:30 p.m. • Grand 6–8
Joy Dubost, Beer Institute



Does science drive policy or does policy drive science? The current regulatory environment is impacting the beer industry, including the Federal Drug Administration (FDA) menu labeling and the United States Department of

Agriculture (USDA) 2015 Dietary Guidelines. The federal menu labeling law requires alcohol beverages listed on standard drink menus to list calories and provide additional nutrition information upon request. Starting December 1, 2016, if you are a restaurant or retail food establishment with more than 20 locations nationwide, you will be required to list calories on the menu. This impacts the beer industry as we will be expected to provide nutrition information. In addition, the pending Dietary Guidelines are used as the basis for educating consumers, shaping public behavior, and driving policy. This includes guidance on beer consumption, including the so-called “standard drink” and its health impact. We will review the current regulatory landscape on Capitol Hill and how these policies may impact your pint.

The Closing Session will also include the installation of officers and the presentation of the following awards: Award of Honor, Award of Merit, Inge Russell Best Paper, Best Oral Presentation, and Best Poster.

Award of Merit

The Award of Merit is given to an individual who has made an outstanding contribution to the brewing industry.



Mustafa Rehmanji

Mustafa Rehmanji has over 45 years of experience in the malting and brewing industry. His current interests are in the areas of beer stabilization and the commercial treatment of beverages. Mustafa started his brewing career with

Kenya Breweries, followed by a move to Canada where he served as director of technical service with Prairie Malt Ltd., now Cargill Malt. Later, he joined International Specialty Products, which was subsequently acquired by Ashland Inc. Mustafa retired from Ashland Inc. last December. Mustafa holds a B.S. degree in chemistry, a business degree and diploma in brewing technology. He is an active member of the Master Brewers Association of the Americas and the American Society of Brewing Chemists. Mustafa has given a number of technical papers at industry conventions including MBAA, ASBC, and IBD.

Award of Honor

The Award of Honor is given to an MBAA member who has rendered outstanding service to the association.



John Houseman

John Houseman started his brewing career in May of 1965 at the Ortlieb Brewery in Philadelphia, PA. While he was there, he attended the MBAA brewing course in Madison, WI. The following year, he attended the

Lauhauf Good Manufacturing Practices at Illinois State University. John graduated from the Siebel Institute of Brewing Technology in Chicago, IL, in 1979. When the Ortlieb Brewery closed in January of 1981, he accepted a position at the Heileman Brewery in Baltimore, MD. He was promoted to brewmaster in 1987. When the brewery closed at the end of 1996, John was transferred to the Stroh’s Plant in Tampa, FL. He worked for Stroh’s until the end of January of 1999 when they closed the plant. Dick Yuengling purchased the Tampa facility in early April of 1999. He offered John the brewmaster position, which John held until he retired at the end of August of 2015.



Two-Week Training Courses

Registration Opening Soon for 2016 Courses!

- **Brewery Packaging Technology Course**
April 24 – May 6, 2016
University of Wisconsin, Madison, Wisconsin
- **Brewery Engineering and Utilities Course**
Date & Location TBD
- **Brewing and Malting Science Course**
October 23 – November 4, 2016
University of Wisconsin, Madison, Wisconsin

MBAA Members Access Live and On-Demand Webinars for Free!

Are you brewing with questions? Live webinars give you direct contact with expert brewers. The well-rounded on-demand library will help you dive into topics such as:

- **Beer Labels – Part 1 & Part 2**
- **Brewery Safety**
- **District Communication 101**
- **Process Control for Diacetyl: The Why, When, Where & How!**
- **Sustainability in the Brewing Sector – Nice to Do or a Business Imperative?**
- **U.S. Hop Crop Update**

New webinars are added often – stay tuned to the MBAA Communicator and website for updates! *Registration fee of \$49 applies to nonmembers registering for live webinars.*

mbaa.com



Posters

Poster Hours

Posters highlighting the latest research are located in the Grand Foyer, with poster authors available at posted times to answer your questions and discuss their results.

Wednesday, October 7:	4:00–6:00 p.m.	Poster set-up
Thursday, October 8:	7:30–10:00 a.m.	Poster set-up
	10:00 a.m.–5:30 p.m.	Open poster viewing <i>12:00–12:30 p.m.: Even-numbered poster authors at posters</i> <i>12:30–1:00 p.m.: Odd-numbered poster authors at posters</i>
	5:30–7:00 p.m.	Happy Hour with Exhibits
Friday, October 9:	8:00 a.m.–3:45 p.m.	Open poster viewing <i>12:00–12:30 p.m.: Odd-numbered poster authors at posters</i> <i>12:30–1:00 p.m.: Even-numbered poster authors at posters</i>
	3:45–5:00 p.m.	Take-down

Posters

Moderators: Fred Scheer, Kronos USA; Rich Michaels, Matt Brewing Co.

- 55 Jörg Engstle. Succeeding of fines in spent grain cakes—Truth or legend?
- 56 David Schroeder. Reduction of hot-side aeration by way of a whirlpool paddle in a kettle
- 57 Aaron Sprowl. The importance of cleanliness—An overview of CIP and COP systems
- 58 Markus Fandke. Real-time PCR: A multipurpose tool to increase quality of craft beer
- 59 Daniel Gore. Beer monitor basic: A new, economical method for inline alcohol measurement in the brewery
- 60 Kerstin Rudolph. Depletion of ions through freezing concentration for water desalination
- 61 Kenneth Berg. Colloidal stabilization by silica at different temperatures
- 62 Thomas Kunz. Pectin: A natural plant-derived alternative fining agent for the brewing process
- 63 Roland Folz. Optimized beer filtration with the latest generation membrane filter
- 64 Thomas Kunz. Increasing bitter substance yield by recycling hot trub and yeast washing solution
- 65 Royce Dansby-Sparks. A laboratory scale approach for the quantification of whirlpool hop utilization
- 66 Phillip Davidson. Performance analysis of T45 hop pellets usage in late kettle additions in comparison to T90 pellets
- 67 Phillip Davidson. An overview of hop products for the production of wort and beer
- 68 A. J. deLange. Determining mash pH from malt measurement
- 69 Yusuke Aida. Weight reduction of paper-based 6-can and 24-can packages
- 70 Sue Langstaff. Panel demographics: What makes a great panel?
- 71 Jason Cohen. Flaw detection and identification through data science and machine learning
- 72 Zachary Bushman. Identification and prediction of flaw, taint, and contamination causes using machine learning and artificial intelligence on sensory data and bio-chemical and metabolic pathway tracing
- 73 Flavio Reis. Sustainable solution for packaging hall conveyer track lubrication
- 74 Matthew Silver. Independence from utility expenses: Generate clean energy and water onsite
- 75 William Killian. Developing a B.S. degree program in fermentation, an industrial chemistry approach

Exhibits

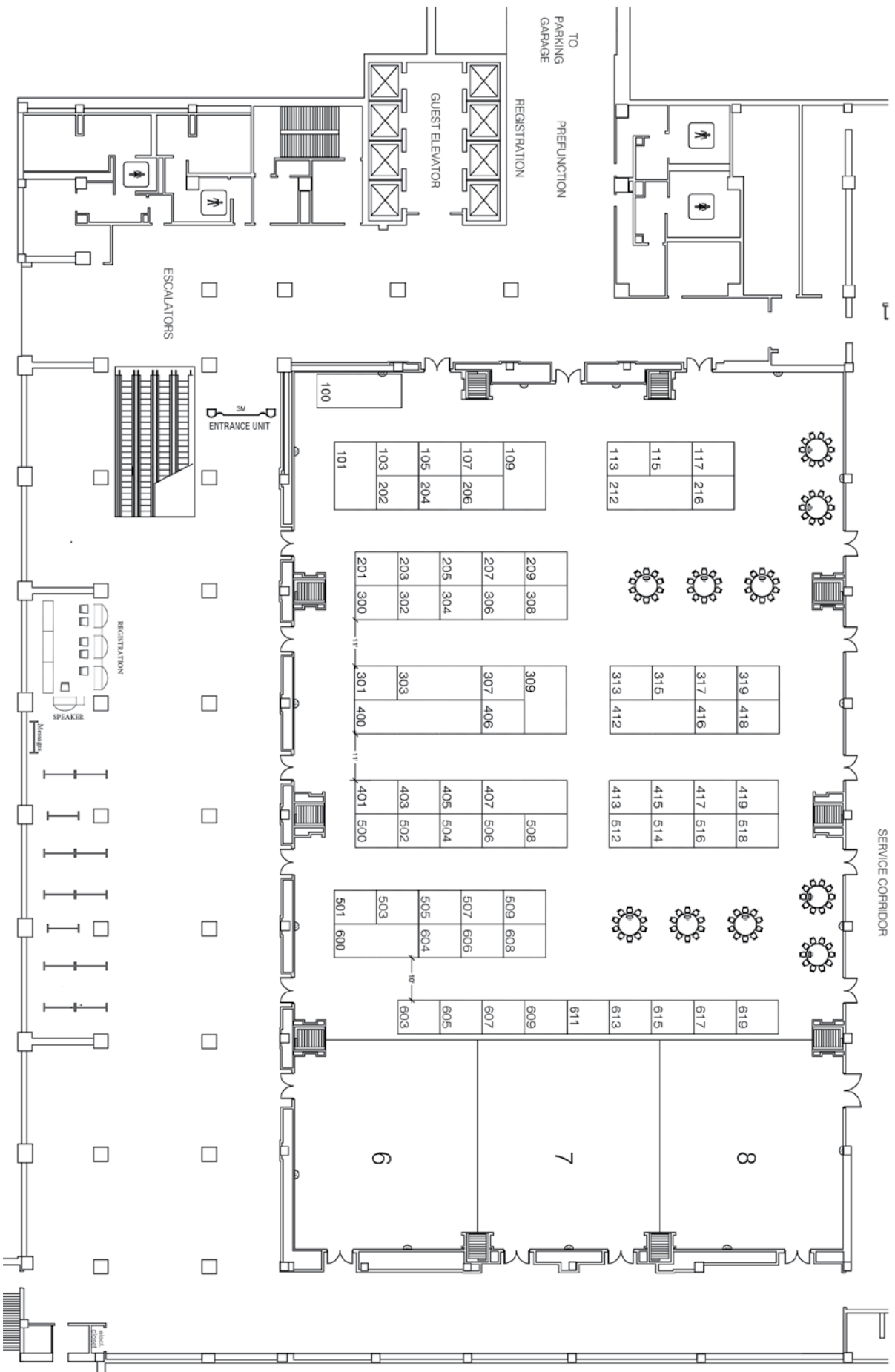
Don't miss the latest products and services offered by industry suppliers! Representatives from leading industry suppliers will be available in Grand 1-5 during the following times to answer questions and share information.

Exhibit Hall Hours

Wednesday, October 7	2:00-6:00 p.m.	Exhibit Setup
Thursday, October 8	8:00-11:00 a.m. 11:45 a.m.-1:45 p.m. 5:30-7:00 p.m.	Exhibit Setup Lunch and Exhibits Happy Hour with Exhibits
Friday, October 9	11:45 a.m.-2:15 p.m. 2:15-5:00 p.m.	Lunch and Exhibits Exhibit Take-down

Numerical Exhibitor Listing

100	AROXA™ – Cara Technology Limited	406	Sealed Air Corporation
101	KRONES	407	GEA Group
103	Hygiena	412	Pentair
105	Anton Paar USA	413	BSG CraftBrewing
107	Heuft USA Inc.	415	Weyermann Specialty Malts
109	ENERVEX Inc.	416	Flottweg Separation Technology Inc.
113	ClearCove Systems Inc.	417	DSM Food Specialties
115	BW Container Systems	418	Rheonix Food & Beverage Testing
117	Symbiont	419	BIOTECON Diagnostics GmbH
201	Bühler Inc.	500	Mettler-Toledo Process Analytics Inc.
202	Esau & Hueber GmbH	501	Kagetec Industrial Flooring
203	Argelith Ceramic Tiles Inc.	502	Furst-McNess Company
204	Gusmer Enterprises Inc.	503	Commodity Specialists Company
205	GKD-USA, Inc.	504	Fulton Companies
206	PONNDORF Anlagenbau GmbH	505	Loeffler Chemical Corporation
207	Weber Scientific	506	Day & Zimmerman
209	Briggs of Burton, Inc.	507	Therma-Stor LLC
212	ABS Commercial	508	ProLeiT Corp.
216	BMT USA, LLC	509	optek Danulat Inc.
300	ChemTreat Inc.	512	CO2Meter, Inc.
301	Handtmann Armaturenfabrik GmbH & Co. KG	514	Pall Corporation
302	Alfa Laval Inc.	516	Nexcelom Bioscience
303	Hopsteiner	518	Flowmation Systems, Inc.
304	Hamilton Company	600	Siemens Industry, Inc.
306	EMG International, Inc.	603	Invisible Sentinel
307	DCI, Inc.	604	Profamo Inc.
308	Malteurop North America, Inc.	605	Zee Company, A member of the Vincit Group
309	Siebel Institute/Lallemand Brewing	606	Separators Inc.
313	Miura America Co., Ltd.	607	Veolia Water Technologies
315	Hansen-Rice, Inc.	608	Wilbur-Ellis Company
317	Palmer Canning Systems	609	Petainer Manufacturing USA Inc.
319	PQ Corporation	611	Cloud-Sellers
400	Cargill Malt	613	Ecolab, Inc.
401	Ziemann International GmbH	615	Prospero Equipment Corp.
403	American Tartaric Products, Inc.	617	Bratney Companies
405	Ashland Specialty Ingredients	619	Providence Process Solutions



Exhibitor Descriptions

Descriptions are listed as supplied by exhibitor, in alphabetical order.

- 212 ABS Commercial**, 3709 Neil Street, Raleigh, NC 27607 U.S.A.; +1.919.400.9087; Web: www.atlanticbrewsupply.com. Atlantic Brew Supply Commercial is a full brewery equipment retailer located in Raleigh, NC. Being co-owned by Raleigh Brewing Company allows ABS Commercial the unique opportunity to use the same equipment that they sell to customers. They design and ship fermenters to whole brewhouses from their NC location.
- 302 Alfa Laval Inc.**, 955 Mearns Road, Warminster, PA 18974 U.S.A.; +1.215.443-4004; Web: www.alfalaval.us/brewery; E-mail: customerservice.usa@alfalaval.com. Alfa Laval partners with breweries of all capacities to help brew the highest quality of beer, with a full range of hermetic, bottom feed high-speed separators, ready-to-use modules and brewery systems, and our new Burst+ tank cleaning nozzle—all backed with proven history of innovation, service, and engineering expertise.
- 403 American Tartaric Products, Inc.**, 1865 Palmer Ave, Larchmont, NY 10538-3048 U.S.A.; +1.914.834.4661; Fax: +1.914.834.4661; Web: www.americantartaric.com; E-mail: atpbeer@americantartaric.com. ATP is proud to present a range of products that includes brewing process aids, antifoams, cleaning chemicals, clarifiers, DE, enzymes, filtration aids, stabilizers, filter sheets, cartridges, filtration equipment, keg lines, pasteurizers, packaging equipment, and analytical equipment. ATP represents well-respected and established companies such as Alfatek, Eaton/Begerow, Birko Corp, E-P Minerals, Ashland/ISP, Lambrechts, Padovan, WeissBioTech, and others.
- 105 Anton Paar USA**, 10215 Timber Ridge Drive, Ashland, VA 23005-8135 U.S.A.; +1.804.550.1051; Fax: +1.804.550.1057; Web: www.anton-paar.com; E-mail: info.us@anton-paar.com; Facebook: www.facebook.com/AntonPaarUSA; Twitter: @WhatsAPNews. Anton Paar is a leading supplier of instrumentation for key analytical parameters within the global brewing industry. With renowned laboratory instruments and process systems, the standard has been set for beer and wort gravity, alcohol, extract, DO / TPO, CO₂, haze measurements, and derived parameters.
- 203 Argelith Ceramic Tiles Inc.**, 103 N. 11th Avenue, St Charles, IL 60174 U.S.A.; +1.630.444.1608; Fax: +1.630.444.0667; Web: www.argelithus.com; E-mail: rudow@argelithus.com; Facebook: Argelith Ceramic Tiles; Twitter: @ski4bob. Argelith's legendary hexagonal floor tiles are specifically engineered for a brewery floor! Argelith tile is designed to withstand the chemicals, physical abuse, slip resistance, and hygienic needs of the brewery environment! That's why so many breweries around the world have our floor. Stop by Booth 203 and say hi!
- 100 AROXA™ – Cara Technology Limited**, Leatherhead Enterprise Centre, Randalls Road, Leatherhead, Surrey KT22 7RY, England; +44 1372 822218; Web: www.aroxa.com; E-mail: valerie.simpson@cara-online.com. Cara Technology has been helping breweries make great-tasting beer for 20 years. We provide AROXA™ Certified Beer Flavour Standards, professional beer taster training courses, and a variety of software tools to help you establish, maintain, and improve your beer taste panel.
- 405 Ashland Specialty Ingredients**, 8145 Blazer Drive, Wilmington, DE 19808 U.S.A.; 1.877.546.2782; Web: www.ashland.com. Ashland is a leading supplier of polyvinylpyrrolidone (PVPP) for beer. With over 50 years of experience providing beer stabilizers and wort clarifiers to the brewing industry, Ashland's Polyclar™ stabilizers are the leading brand in clarification and stabilization technology for beer. Visit booth #405 to learn more.
- 419 BIOTECON Diagnostics GmbH**, Hermannswerder 17, D-14473 Potsdam, Germany; +49 331 2300 200; Web: www.bc-diagnostics.com; E-mail: bcd@bc-diagnostics.com. BIOTECON Diagnostics is a leading partner for molecular and microbiological methods in food, beverage, and pharmaceutical industries. Founded in 1998, we focus on development, production, and marketing of real-time PCR-based, rapid detection technologies, including sample preparation and DNA extraction. Find out why leading companies worldwide rely on our quality products.

- 216 BMT USA, LLC**, 14532 169th Drive SE, Ste 142, Monroe, WA 98292 U.S.A.; +1.360.863.2252; Web: www.bmtus.com; E-mail: jeffh@bmtus.com; Facebook: www.facebook.com/BMTUSALLC. BMT USA is the premier supplier of fully sanitary Clean Steam Generators utilized for the sterilization of kegs prior to refilling. BMT Clean Steam Generators are manufactured in the United States utilizing an all stainless steel construction. BMT also provides incubators and autoclaves for the QC lab. BMT, assuring your quality.
- 617 Bratney Companies**, 3400 109th Street, Des Moines, Iowa 50322 U.S.A.; +1.515.270.2417; Fax: +1.515.267.2067; Web: www.bratney.com; E-mail: info@bratney.com; Facebook: www.facebook.com/BratneyCompanies; Twitter: @BratneyCompany. Bratney Companies is known for providing world-class equipment, processes, and solutions. We bring innovation and value with manufacturers such as Cimbria, Concetti, and BoMill. These, in addition to our complete offering of high quality engineering, design, and construction, make us the company to consider for your next project.
- 209 Briggs of Burton, Inc.**, 400 Airpark Dr Ste 40, Rochester, NY 14624 U.S.A.; +1.585.426.2460; Fax: +1.585.426.0250; Web: www.briggsplc.co.uk; E-mail: sales@briggsusa.com. Briggs, with a history going back over 270 years, is one of the most experienced brewing and distilling process engineers anywhere. Developing world-class facilities in terms of efficiency and output is the norm for us. We welcome the opportunity to put this knowledge and experience to work for you.
- 413 BSG CraftBrewing**, 800 West First Avenue, Shakopee, MN 55379 U.S.A.; 1.800.374.2739; Web: www.bsgbrewing.com; E-mail: sales@bsgcraft.com; Facebook: www.facebook.com/BSGCraftbrewing; Twitter: @BSGCraftBrewing. Since 2004, we have earned the trust of our customers by delivering the finest brewing ingredients at competitive values, all backed by excellent customer service and a depth of industry experience. BSG CraftBrewing is committed to being your partner and shares your passion for creating outstanding beers.
- 201 Bühler Inc.**, 13105 12th Ave N, Plymouth, MN 55346 U.S.A.; +1.763.847.9900; Web: www.buhlergroup.com; E-mail: Minneapolis.buhler@buhlergroup.com. Bühler specializes in every stage of the grist production process: from malt and grain intake, grain storage, transport, cleaning and classification, through to preparation of grain. In close cooperation with our customers, we can provide solutions that can address a variety of needs.
- 115 BW Container Systems**, 1305 Lakeview Drive, Romeoville, IL 60446 U.S.A.; +1.630.759.6800; Web: www.bwcontainersystems.com. BW Container Systems is part of the Barry-Wehmiller Group, supplying the brewing industry for over 100 years. We specialize in advanced conveyance technologies for cans, bottles, and packages, including rinsers, combiners, laners, and accumulation systems. We provide conventional and robotic depalletizing, palletizing systems, lid-feeding systems, and pasteurizers and warmers.
- 400 Cargill Malt**, 15407 McGinty Road West MS135, Wayzata, MN 55391 U.S.A.; 1.800.669.6258; Web: www.cargillmalt.com; E-mail: CargillSpecialtyMalts@cargill.com. Our team of maltsters and brewers share your enthusiasm to create the most distinctive products. Our experience and dedication to the science and art of making great beer is exhibited in every product we offer. Call us to learn about how Cargill can be your partner in brewing great beer.
- 300 ChemTreat Inc.**, 5640 Cox Road, Glen Allen, VA 23060 U.S.A.; +1.804.935.2000; Web: www.chemtreat.com. ChemTreat is one of the world's largest providers of water treatment products and services. We develop customized programs with sustainable solutions to improve operating efficiencies, minimize expenditures, reduce carbon footprints, and improve energy and water management delivered through the most experienced sales and service team in the industry.
- 113 ClearCove Systems Inc.**, 7910 Rae Blvd, Victor, NY 14564 U.S.A.; +1.585.267.5004; Web: www.clearcovesystems.com; E-mail: jfox@clearcovesystems.com; Facebook: www.facebook.com/FlatlineWater; Twitter: @ClearCoveSys. ClearCove provides a revolutionary solution to wastewater treatment for the food and beverage industry. The ClearCove ClearCapture system provides a low cost, fully-automated, effective wastewater treatment solution that reduces or eliminates surcharges, reduces energy consumption, enables renewable energy generation, and provides water that can be reused in the manufacturing process.
- 611 Cloud-Sellers**, 4855 Morabito Place, San Luis Obispo, CA 93401-7500 U.S.A.; +1.805.549.8093; Fax: +1.805.549.0131; Web: www.cloudinc.com; E-mail: mkemp@cloudinc.com. Cloud-Sellers was founded in 1870 and designs and manufactures a complete quality line of Rotary Impingement Tank Cleaning machines for cleaning of all process and storage vessels.

- 512 CO2Meter, Inc.**, 131 Business Center Drive, Ormond Beach, FL 32174 U.S.A.; +1.386.872.7669; Web: www.co2meter.com; E-mail: info@co2meter.com; Facebook: www.facebook.com/co2meter; Twitter: @co2meter. CO2Meter, Inc., is the premier designer and manufacturer of gas detection and monitoring equipment for the brewing industry focusing on carbon dioxide and oxygen.
- 503 Commodity Specialists Company**, Ste 260, 10733 Sunset Office Drive, Suite 260, St. Louis, MO 63127 U.S.A.; +1.314.909.7447; Fax: +1.314.909.7866; Web: www.csc-world.com; E-mail: twilkinson@csc-world.com. A national marketer of processed feed by products and for over 35 years the largest in tonnage sales of wet brewer's grains in the United States serving large and small craft brewers. Experienced personnel nationwide who understand feed values to farmers and logistic needs of breweries, ensuring maximum returns.
- 506 Day & Zimmerman**, 125 The Parkway, Suite 400, Greenville, SC 29615 U.S.A.; +1.864.241.6886; Alt: +1.717.391.7998; Web: www.dayzim.com; E-mail: aaron.landolt@dayzim.com. Day & Zimmerman specializes in engineering and construction, staffing, and defense solutions for leading corporations and governments. With more than 150 worldwide locations; 23,000 employees; and \$2.5 billion in revenue, D&Z is ranked as one of the largest private companies in the United States by *Forbes*. We do what we say.®
- 307 DCI, Inc.**, 600 N 54th Ave, Saint Cloud, MN 56303 U.S.A.; +1.320.252.8200; Fax: +1.320.252.0866; Web: www.dciinc.com; E-mail: aclegatt@dciinc.com. From start-up microbreweries to large breweries, we design and create custom brewing and storage tanks and agitation. We believe that a quality beer originates from quality equipment. DCI, Inc. offers: fermenters, lagering tanks, bright beer, hot/ cold tanks, mash and lauter tuns, brew kettles, whirlpools, and storage tanks.
- 417 DSM Food Specialties**, 3502 N Olive Rd, South Bend, IN 46628 U.S.A.; +1.574.210.9979; Web: www.brewersclarex.com. DSM Food Specialties is a global supplier of food ingredients. We offer a range of brewing enzymes and support from our global team of brewmasters to ensure you gain maximum control over your production processes, improve your brewing efficiency, and deliver consistently clear, higher quality beer at a lower cost.
- 613 Ecolab, Inc.**, 370 Wabasha Street North, St. Paul, MN 55102 U.S.A.; +1.651.250.2233; Fax: +1.651.250.2260; Web: www.ecolab.com; E-mail: Pablo.segoviatorres@ecolab.com. As the leading global provider of sanitation, water management, wastewater programs, and pest elimination services to the brewery industry, the Ecolab team will provide expertise and solutions to help customers produce safer, high quality products, improve operational efficiency, and enhance environmental stewardship with water and energy reduction solutions.
- 306 EMG International, Inc.**, PO Box 1600, Media, PA 19063 U.S.A.; +1.484.444.0400; Fax: +1.484.444.0999; Web: www.emgint.com; E-mail: contact@emgint.com. EMG is an environmental engineering company with a focus on design, fabrication, installation, and operation of high-rate anaerobic digester systems. EMG's digester systems treat brewery wastewater, provide high organic removal efficiencies, generate renewable electricity, and recover waste heat. EMG has over 10 years of experience working with leading U.S. breweries.
- 109 ENERVEX Inc.**, 1685 Bluegrass Lakes Parkway, Alpharetta, GA 30004 U.S.A.; +1.770.587.3238; Fax: +1.770.587.4731; Web: www.enervex.com; E-mail: info@enervex.com. ENERVEX combines quality components, superior technology, and experienced personnel to deliver complete venting and heat recovery systems that are economical, sustainable and reliable. Our custom engineering and compact designs meet code requirements and exceed brewers' expectations. We don't build a one-size-fits-all draft system—we understand each project is unique.
- 202 Esau & Hueber GmbH**, Kapellenweg 10, Schrobenuhhausen, 86529 Germany; +49 0 82 52 89 85-25; Fax: +49 0 825 8985-85; Web: www.esau-hueber.de; E-mail: sebastian.kappler@esau-hueber.de. Esau & Hueber is now acting after acquisition of NERB as a global full-range supplier of brewhouses up to 250 bbl. and complete process technology for the cold block area. The formidable range includes specialist systems like VariioBoil wort boiling, TurboAir wort-aeration, carbonation, nitrogenation, FlexiProp yeast-management, and WinBrew controls.
- 416 Flottweg Separation Technology Inc.**, 10700 Toebben Drive, Independence, KY 41051-9418 U.S.A.; +1.859.448-2300; Fax: +1.859.448-2333; Web: www.flottweg.com; E-mail: sales@flottweg.net. Located in Independence, KY, and headquartered in Vilsbiburg, Germany, Flottweg specializes in the manufacturing of a wide range of separation equipment. This includes Sedicanters for beer recovery from spent yeast, High Speed Separators for Green beer clarification, Decanters for hot wort separation from trub, and Belt Presses for grain dewatering.

- 518 Flowmation Systems, Inc.**, 2069 Elm Road, Oakville, ON L6H 3K9 Canada; +1.905.849.1910; Web: www.flowmation.com; E-mail: info@flowmation.com. Better manage brewery operations with affordable IT solutions. Beginning at Molson Breweries and later growing to include others in Canada (Sleeman, Moosehead), current implementations in the U.S.A. includes one of the largest multisite operating brewery companies. Flowmation's fully integrated software suite revolutionizes the brewhouse operation with complimentary quality management.
- 504 Fulton Companies**, 972 Centerville Road, Pulaski, NY 13142 U.S.A.; +1.315.298.5121; Fax: +1.315.298.7905; Web: www.fulton.com; E-mail: mike.mclean@fulton.com. Fulton Boiler Works, Inc., was founded in 1949 with Lewis Palm inventing the vertical tubeless boiler. Fulton offers a range of boilers from 1.5HP up to 150HP. Stop by our booth for extensive information on the benefits of Fulton Boilers, boiler maintenance, steam system design, and good piping practices.
- 502 Furst-McNess Company**, 120 E. Clark Street, Freeport, IL 61032 U.S.A.; +1.815.232.9700, Alt: 1.800.435.5100, Web: www.mcness.com, E-mail: info@mcness.com. As one of North America's most trusted wet brewers grain marketing companies, Furst-McNess has its hand on the pulse of the industry. Through our long-standing relationships with key suppliers, we can offer virtually unlimited amounts of feed ingredients to customers in the U.S.A. and Canada
- 407 GEA Group**, 9165 Rumsey Road, Columbia, MD 21045 U.S.A.; +1.410.997.8700; Web: www.gea.com. GEA is a leading provider of equipment, systems, and services for brewery process technology. In addition to designing and realizing customized, turnkey plants, we provide and implement individual components, such as separators, valves, and CIP systems that enhance the performance of existing equipment, while keeping lifecycle costs to a minimum.
- 205 GKD-USA, Inc.**, 825 Chesapeake Drive, Cambridge, MD 21613-3424 U.S.A.; +1.410.221.0542; Fax: +1.410.221.0544; Web: www.gkdusa.com; E-mail: sales@gkdusa.com. Woven Structures for Industrial Applications. Metal wire mesh from GKD SOLIDWEAVE for precoat filtration systems. High-tensile mesh constructions made of PZ-Microdur, KPZ-Microdur, YMAX®, and Plain Dutch Weave form the basis for long, trouble-free operation of precoat filters because they were specifically designed for high mechanical demands of pressure vessel filtration.
- 204 Gusmer Enterprises Inc.**, 1165 Globe Avenue, Mountainside, NJ 07092-2903 U.S.A.; +1.908.301.1811; Fax: +1.908.301.1812; Web: www.gusmerenterprises.com; E-mail: sales@gusmerenterprises.com; Facebook: Gusmer Enterprises; Twitter: @gusmerbeer. For over 90 years, Gusmer Enterprises has taken a revolutionary approach to serving the brewer's vision. It's why Gusmer offers a full line of solutions for the brewing industry, including fermentation and processing aids, filtration media and equipment, analytical products and instrumentation, processing equipment, and analytical laboratory services.
- 304 Hamilton Company**, 4970 Energy Way, Reno, NV 89502 U.S.A.; 1.800.648.5950; Web: www.hamiltoncompany.com/Beverly; E-mail: sensors@hamiltoncompany.com. High DO can impact the taste and shelf life of product. Designed for both at-line and laboratory use, the Beverly Portable DO Monitor provides accurate measurement in a rugged design. With easy calibration, quick response time down to ppb levels, and simple maintenance, it's an ideal tool for DO monitoring.
- 301 Handtmann Armaturenfabrik GmbH & Co. KG**, Arthur-Handtmann-Str. 11, Biberach/Riss, 88400 Germany; +49.7351.342.4449; Web: www.bandtmann.de; E-mail: sales.fittings@handtmann.de; Facebook: www.facebook.com/HandtmannArmaturenfabrik. Handtmann Armaturenfabrik is one of the leading suppliers of fittings, valves, and process plants to the beverage industry, as well as the biotechnology and chemical-pharmaceutical industries. Our engineering provides knowhow from brewhouse to bottling. Innovative and Reliable—Made in Germany High Quality Components and Process Technology.
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- 107 Heuft USA Inc.**, 2820 Thatcher Rd, Downers Grove, IL 60515-4051 U.S.A.; +1.630.968.9011; Fax: +1.630.968.8767; Web: www.heuft.com; E-mail: laura.quid@heuft.com. Heuft USA is a technological leader in quality assurance for the food and beverage industry. The product range

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- 303 Hopsteiner**, 1 Washington Avenue, Yakima, WA 98903 and 655 Madison Avenue, New York, NY 10021 U.S.A.; 1.800.339.8410; Alt: +1.212.593.4238; Fax: +1.212.593.4238; Web: www.hopsteiner.com; E-mail: sales@hopsteiner.com; Facebook: www.facebook.com/hopsteiner; Twitter: @Hopsteiner. Hops. We have been breeding, growing, processing, and selling quality hops for 170 years. CO₂ extract as well. From the U.S.A., Germany, England, and Czech Republic, we offer just what the brewer needs to make award-winning beers. Visit us at booth 303. Hopsteiner Quality...The Proof Is In The Pour.
- 103 Hygiena**, 941 Avenida Acaso, Camarillo, CA 93012 U.S.A.; +1.805.388-8007; Web: www.hygiena.com; E-mail: info@hygiena.com; Twitter: @HygienaUSA. ASBC directory recognized worldwide for accuracy, ease of use, and affordability, Hygiena's ATP Sanitation Monitoring System is used extensively throughout food and beverage industries to validate sanitation protocols and determine whether equipment is truly clean. The EnSURE Monitoring System measures ATP from surface and liquid samples. Free trials are available!
- 603 Invisible Sentinel**, 3711 Market Street, Suite 910, Philadelphia, PA 19104 U.S.A.; +1.215.966.6118; Fax: +1.215.921.5091; Web: www.invisiblesentinel.com; E-mail: info@invisiblesentinel.com; Facebook: www.facebook.com/InvisibleSentinel; Twitter: @Invisible_Sntl. Invisible Sentinel, Inc., is a global molecular solutions company providing first-in-class microbial detection tools to advance quality processes at the brewery. The "game-changing" product, brewPAL, provides quantitative detection of *Pediococcus* and *Lactobacillus* in less than three hours from sample to result at any stage of the brewing process.
- 501 Kagetec Industrial Flooring**, 24631 Saint Benedict Road, Jordan, MN 55352 U.S.A.; +1.612.435.7640; Fax: +1.612.435-7643; Web: www.kagetecusa.com; E-mail: info@kagetecusa.com; Facebook: www.facebook.com/kagetec. Kagetec provides chemical resistant, hygienic, industrial flooring systems consisting of slip resistant ceramic tile and integrated stainless steel drains. We have more than 25 years of experience in the food and beverage industry. Let Kagetec help you with one of the most critical areas of your facility.
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- 505 Loeffler Chemical Corporation**, 200 Great Southwest Parkway, Atlanta, GA 30336 U.S.A.; +1.404.629.0999; Fax: +1.404.629.0690; Web: www.loefflerchemical.com; E-mail: info@loefflerchemical.com. Loeffler Chemical Corporation is the premier provider of sanitation chemicals and services to the brewing industry. In addition to a complete line of sanitation products, Loeffler offers enzymes, fining agents, stabilizers, as well as draft line cleaning equipment and chemicals. Featured will be a water-free, food-grade line lube.
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- 500 Mettler-Toledo Process Analytics Inc.**, Building 8, 900 Middlesex Turnpike, Bld #8, Billerica, MA 01821 U.S.A.; +1.781.301.8800; Web: http://us.mt.com/us/en/home/products/Process-Analytics.html?smartRedirectEvent=true. Mettler-Toledo Ingold is the leading producer of in-line process analytics worldwide. We offer solutions in pH, dissolved oxygen, gaseous oxygen, conductivity, and turbidity measurements.
- 313 Miura America Co., Ltd.**, 2200 Steven B Smith Blvd, Rockmart, GA 30153 U.S.A.; +1.678.685.0929; Fax: +1.678.685.0930; Web: www.miuraboiler.com; E-mail: us.steamsolutions@miuraz.com. Miura's "low water content water tube" design is the most versatile boiler available today, producing steam in just 5 minutes while maintaining an 85% fuel-to-steam efficiency. Miura provides many components for a complete boiler room solution including water treatment, boiler control system, water softener, and a water hardness detection system.

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- 509 optek Danulat Inc.**, Germantown Technology Park, N118W18748 Bunsen Drive, Germantown, WI 53022 U.S.A.; 1.888.837.4288; Web: www.optek.com; E-mail: brew@optek.com; Facebook: www.facebook.com/optek; Twitter: @optek. Inline photometers provide precise, real-time control for brewing optimization. Monitor color, haze, and yeast and solids concentration. Control fermentation, filtration, separation, yeast pitching, wort color and clarity, DE and PVPP dosing, and more. Achieve uninterrupted processing of your best possible product with reduced product loss, improved profitability, and greater efficiency.
- 514 Pall Corporation**, 25 Harbor Park Drive, Port Washington, NY 11050 U.S.A.; 1.866.905.7255; Fax: +1.516.625.3610; Web: www.pall.com/foodandbev; E-mail: foodandbeverage@pall.com. Pall Corporation is a global filtration, separation and purification leader. Pall Food and Beverage provides products and services to ensure product quality and maintain process reliability in beverage and food production. Our solutions assist in consumer protection, the reduction of operating costs, and waste minimization.
- 317 Palmer Canning Systems**, 3759 N. Ravenswood Ave Ste 233, Chicago, IL 60613 U.S.A.; +1.773.463.7714; Fax: +1.773.463.7740; Web: www.palmercanning.com; E-mail: info@palmercanning.com. We manufacture complete canning systems 40-300 CPM for beer. Our equipment includes auto de-pal, ionized or water rinsing of empty can, monobloc filler, and seamer. Single, 4-head, and 6-head seamers. Low oxygen pickup and good seam quality.
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- 609 Petainer Manufacturing USA Inc.**, 1500 North Michigan Ave, Suite 1950, Chicago, IL 60601 U.S.A.; +1.416.670.8897; Web: www.petainer.com; E-mail: andres.jensen@petainer.com; Twitter: @petainer. The petainerKeg™ offers a significant breakthrough in the sales and marketing of volume beer, wine, and other beverages. It opens up new channels and markets and provides a progressive change in environmental performance—as well as reducing costs and improving cash flow. Petainer Keg—A Game Changer!
- 206 PONNDORF Anlagenbau GmbH**, Leipziger Str. 51, Kassel, Hessen 34123, Germany; +49-561-5114-10; Fax: +49-561-5114-24; Web: www.ponndorf-gmbh.com; E-mail: s.ullah@ponndorf-gmbh.de. PONNDORF Anlagenbau GmbH is a family-owned worldwide operating company. We specialize in the engineering and manufacturing of wet spent grains systems. Our customized solutions for breweries include: pneumatic conveyors, buffers and silos, silo discharging devices, dewatering screw presses, and indirectly heated driers.
- 319 PQ Corporation**, PO Box 840, Valley Forge, PA 19482 U.S.A.; +1.610.651.4600; Fax: +1.610.251.5249; Web: www.pqcorp.com. PQ's BRITESORB® silica gels meet the needs of brewers the world over and provide selective chillproofing performance with excellent filtration characteristics. The gels remove only the proteins that cause chill-haze, not those that stabilize foam. PQ BRITESORB® beer stabilizers: the clear choice for world-class beer. See us at Booth 319.
- 604 Profamo Inc.**, 26329 Basswood Avenue, Rancho Palos Verdes, CA 90275 U.S.A.; +1.941.284.7990; Web: www.profamo.com; E-mail: info@profamo.com. Profamo—a manufacturer's representative specializing in QA/process and keg line solutions. Our partners include Sigrist for lab and in-line turbidity, Rotech Keg Monitor, Lambrechts keg lines, ISS Density measurement, Hamilton in-line yeast viability sensor, Advanced Instrument's CO₂ Purity analyzer, O₂ sensors, and BMT clean steam generators.
- 508 ProLeiT Corp.**, 100 S. Saunders Road, Suite 150, Lake Forest, IL 60045 U.S.A.; +1.469.464.5909; Fax: +1.469.464-2701; Web: www.proleit.com; E-mail: info@proleit.com; Facebook: www.facebook.com/ProLeiTGroup. ProLeiT is one of the leading suppliers for brewing process automation worldwide. The specific strength of its process control system brewmaxx lies in the recipe driven batch execution with brewing specific modules. Complete parameterization allows the brewer to fully control his production and get transparency about all processes.

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- 619 Providence Process Solutions**, P.O. Box 354748, Palm Coast, FL 32135-4748 U.S.A.; +1.262.770.1292; Web: www.prov-ps.com; E-mail: vern@prov-ps.com. Providence Process Solutions is a complete design/build craft brewery engineering company. Our solutions begin with detailed financials, then all process engineering and facility utility requirements definitions, then on-site project management. Our solutions support 20–200 BBL craft brewery brewhouse systems.
- 418 Rheonix Food & Beverage Testing**, 10 Brown Road, Ithaca, NY 14850 U.S.A.; +1.607.257.1242; Alt: +1.585.201.0764; Fax: +1.607.257.0979; Web: www.rheonix.com; E-mail: info@rheonix.com. Rheonix Food and Beverage Testing is announcing a subscription-based microbial testing service available to brewers. Brewers simply send samples overnight and PCR-based test results are returned electronically one day later. The first available test screens for lactic acid bacteria (*Lactobacillus* spp. and *Pediococcus* spp.) and valuable hop resistance information.
- 406 Sealed Air Corporation**, 100 Rogers Bridge Road, Duncan, SC 29334 U.S.A.; +1.864.433.2000; Fax: +1.864.433-2134; Web: www.sealedair.com; E-mail: cryovac.mkt@sealedair.com. Sealed Air Corporation creates a world that feels, tastes, and works better. Our portfolio of brands—Cryovac® brand food packaging solutions, Bubble Wrap® brand cushioning, and Diversey™ cleaning and hygiene solutions—ensures a safer and less wasteful food supply chain, protects valuable goods, and improves health through clean environments.
- 606 Separators Inc.**, 5707 W Minnesota Street, Indianapolis, IN 46241-3825 U.S.A.; 1.800.233.9022; Web: www.separatorsinc.com. Separators, Inc., is North America's leading independent centrifuge service provider specializing in the remanufacturing of Alfa Laval and Westfalia centrifuge equipment. Separators, Inc., offers a full complement of startup, maintenance, repair, and emergency services and stocks over 4,000 spare parts. Industries served: beer, wine, dairy, beverage, edible oils, and pharmaceutical.
- 309 Siebel Institute/Lallemand Brewing**, 900 N. North Branch Street, Suite 1N, Chicago, IL 60642 U.S.A.; +1.312.255.0705 104; Fax: +1.312.255-1312; Web: www.siebelinstitute.com; E-mail: klemcke@siebelinstitute.com. The Siebel Institute of Technology and World Brewing Academy offer more brewing-related courses than any other school including campus and web-based programs covering the full range of brewing-related subjects. We also offer a full range of brewing-related services. Lallemand Brewing offers products including high-performance dry yeast and nutrients.
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- 507 Therma-Stor LLC**, 4201 Lien Road, Madison, WI 53704 U.S.A.; 1.800.533-7533; Web: www.thermastor.com; E-mail: thermasales@thermastor.com. Therma-Stor manufactures glycol chillers and heat reclaim water heaters. Heat reclaim systems capture waste refrigeration heat to produce hot water. Therma-Stor's innovative chillers are designed for reliable, efficient cooling. The company has a strong history of heat transfer innovation, being recognized by the U.S. DOE for energy efficiency contributions.
- 607 Veolia Water Technologies**, 913 Industrial Park Drive, Vandalia, OH 45377 U.S.A.; +1.937.890.4075; Fax: +1.937.890.9925; Web: www.veoliawaterstna.com; E-mail: craig.jolley@veolia.com. The high demand of water in brewing makes it a significant cost and quality factor. Veolia Water Technologies understands these demands, helping small and large breweries with tailored, technically proven solutions for saving energy, reducing discharge costs, recovering water, and reducing the manufacturing impact on the environment.

- 207 Weber Scientific**, 2732 Kuser Road, Hamilton, NJ, 08691 U.S.A.; 1.800.328.8378; Web: www.weberscientific.com; E-mail: info@weberscientific.com. Weber Scientific is a leading manufacturer and distributor of laboratory supplies and equipment to the beverage and food processing industries. Since 1959 we have specialized in supplying the quality control needs for product testing and for overall processing and facility quality assurance.
- 415 Weyermann Specialty Malts**, Brennerstrasse 17-19, Bamberg, 96052 Germany; +49.951.93220.12; Fax: +49.951.93220.970; Web: www.weyermannmalt.com; E-mail: info@weyermann.de. Weyermann®, now in its fourth generation as a successful family business, has been bringing color and flavor to beer since 1879. Built on a tradition of quality, consistency, and service, Weyermann® offers more than 85 different malt varieties to brewers all around the world, in 135 countries, on all continents!
- 608 Wilbur-Ellis Company**, 1114 Washington Ave Ste. 201, Feed Division, Golden, CO 80401 U.S.A.; +1.303.993.6411; Fax: +1.303.997.4552; Web: www.wilburellis.com; E-mail: rtrinkler@wilburellis.com. Wilbur-Ellis Company is your distributor of brewery co-products. Our team takes a professional approach to marketing brewers' wet grains and provides solutions to liquid co-products as well. We've improved the "bottom line" for our partners across the country and look to grow with you and this wonderful brewing industry!
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- 401 Ziemann International GmbH**, Ludwigsburger Str. 86, Ludwigsburg, 71636 Germany; +49.7141.4080; Web: www.ziemann.com; E-mail: info@ziemann.com. From the brewhouse to the bright beer tank-cellar – Ziemann offers tailor-made solutions for small craft and large-scale breweries as well as the required process technology. Keep your flexibility with our expandable and innovative systems! Take advantage of our state-of-the-art pilot brewery and develop individual beer recipes!

1. Warm beer filling: An energy efficient concept

H. FISCHER (1), F. Scheer (1); (1) Krones Inc., Franklin, WI, U.S.A.

In times of rising energy costs and companies putting more efforts in sustainability, “warm beer filling” has shown significant advantages as an energy efficient solution. Especially when a flash pasteurizer is used to enhance the shelf life of the beer, large quantities of cooling energy are saved when the pasteurized beer doesn’t need to be cooled down again to freezing temperatures but instead is filled at warmer temperatures than those originally from the tanks. Energy efficient and microbiological safe flash pasteurization combined with hygienic upgrades at a state-of-the-art filler is cutting-edge technology. Set-up, design, and potential savings will be shown.

Henri Fischer is a brew master and an MBAA membership, chair of District Milwaukee, and member of District Mid-South. Henri has worked in Process Technology and Aseptic Technology, Krones, Inc., Franklin, WI (since 2013). Previously, Henri was team manager of the Process Technology 2 Division, Krones AG, Germany (until 2012) and worked in the Technology Department., Steinecker, Germany (until 2006). Henri completed brew master studies at TUM Weihenstephan and Doemens Academy, Germany, finishing in 2003. From 1993 to 1998, Henri apprenticed to become a brewer and maltster in a German brewery (Freiberger Brauhaus AG).

2. Considerations for brewery automation

K. MCENERY (1); (1) McEnery Automation, St. Louis, MO, U.S.A.

Incorporating automation systems into your brewery can yield a multitude of advantages, ranging from increased quality and repeatability, to increased throughput and productivity and reduction of waste and resource consumption. However, the selection and design of a brewery automation and control system may seem to be an overwhelming undertaking. For those who are not directly involved in the world of process automation, there are seemingly endless options and possibilities and an whole new world of terminology and buzzwords. Many brewers have the skills to develop the mechanical and process design of a brewery, as well as a basic understanding of electricity and controls, but may not have the experience to put it all together. Before one can begin the process of control system selection, it is important to answer the questions, “Why do I want to automate my system?” and “What do I want from my control system?” Process control automation can help you save money by minimizing labor and time consumption, increasing the quality and consistency of your product, reducing waste and scrap, and minimizing resource consumption and increasing sustainability. In

addition, an advanced automation solution can provide seamless information flow from plant floor instrumentation up to your MES system. This enables you to put real-time, actionable information into the hands of decision makers quickly, helping you to respond quickly and cost-effectively to production issues as well as market demands. Even after deciding that it is appropriate to incorporate a new control system, it is still difficult to decide how much automation is appropriate. Each facility is unique and so the control system design must fit the need. Control systems can range from very small semi-automated systems with minimal instrumentation, all the way to complete fully automation systems with extensive instrumentation, recipe management systems, reporting capabilities, and MES integration. What level of automation is right for you? Several key factors must be weighed when answering this question, including safety considerations, initial system cost versus total cost of ownership, current needs versus scalability and expandability, flexibility versus complexity, and long-term support and maintenance considerations. A careful analysis of these factors will help to guide you to the implementation of a system that will address your needs today and well into the future.

Kevin McEnery is a senior process control systems engineer with 25 years of experience in the brewing industry. He has provided consulting services, including strategy definition, requirements definition, system analysis, and design of numerous batch and process control systems across a wide variety of industries. He has led numerous process improvement projects in all areas of the brewing process, as well as packaging and utilities. Kevin holds an electrical engineering degree from the Missouri University of Science and Technology and is a registered professional engineer in the state of Missouri. Kevin is the owner and chief technology officer for McEnery Automation, a systems integration company that focuses on process control. He is proud to be a member of the MBAA St. Louis District.

3. Long-term system sustainability considerations for small brewing operations when transitioning from operator tended brewing to a semi or fully automated brewhouse

S. M. CARTER (1); (1) LT Software Solutions, Portsmouth, NH, U.S.A.

Considerations when transitioning from a hand brewing operation to a semi or fully automated brewhouse involve some very complicated decisions. Where you need to be in 5 or 10 years has a lot to do with some of the early decisions you need to make when you are starting down the automation path. Not making the right decision early on can severely cripple the future capacity of a brewing operation. The most important areas to consider are during this transition are functionality, expandability, maintainability,

traceability. Functionality: reviewing the attributes of the myriad of brewhouse automation systems available can be daunting. You should have a road map of where you want to be in 5 and 10 years before beginning this task. You will need to pick from a set of criteria that will help you to decide what is important to your operation. You should also limit your final vendor decision to three or four offerings. Features you may want to cover in your review include programming environment; features and options; flexibility of instillation of the wiring topology; lower level control features such as PID control and tuning, flexibility of alarm assignments, pre-engineered template functionality, recovery for a power outage, recipe and scheduling features, and batch administration; and quality control features such as batch-to-batch comparison, batch tracking, and long-term data archiving for later comparison. Expandability: the landscape you find yourself in today may look nothing like where you will need to be 5 to 10 years. What seem to be sound financial decisions today may prove to be limiting factors down the road. Maintainability: without decent documentation and automation symmetry throughout the brewing operation it may become very difficult to retain personnel who can maintain and grow your brewery automation system. Be careful not to shop different areas of the operation out to separate vendors and end up with a final product that looks and feels different in each separate area of the operation. Your maintenance personnel should be able to understand the theory behind the operation of the systems in the cellars if they have become familiar with the operations in the brewhouse. Traceability: you may have started out just wanting to make beer, but as you transition to a larger operation you will have to be able to track your raw materials. Beyond just being able to keep track of the raw material you have consumed, you will eventually want to be able to track a particular sack of malt or a delivery of hops into a specific brew and through fermentation and finally to a packaging run.

Stephen Carter is a 37 year veteran of the automation industry and has been involved in the development and upgrade of brewing automation systems for more than 20 years. In addition to brewing applications, Stephen has applied automated controls to hundreds of machinery and automation systems both nationally and internationally and has designed and implemented machinery and control systems across diverse industries, including semiconductor, food, beverage, brewing, packaging, plastics, marine, web, paper, transportation, and pharmaceutical systems.

4. Pretreatment of hop pellets before hop dosage into the brewing process

Y. YAMAGUCHI (1), M. Gastl (2), T. Becker (2), L. Narziss (2) (1) Suntory Beer Limited, Osaka, Japan; (2) Technical University of Munich, Freising, Germany

Hop is a very important raw material for beer that gives floral aroma and bitterness. Hop products can be divided into three groups: pressed hop cones, hop pellets, and hop extracts. Especially, hop pellets are widely used in the world because they have advantages in terms of storage costs, export costs, efficient extract yield, and separation during brewing process. Hop pellets are made by milling

of hop cones, which are then pelletized in a pelletizing machine with cylindrical holes. Generally hop pellets are added during the wort boiling process in order to diffuse sufficiently into the wort. However, that leads to reduction of hop aroma components in the wort and beer because of evaporation. On the other hand, adding hop pellets after the wort boiling process can cause a reduction of bitter components and aroma extracts included in the hop pellets due to weak effect of wort mixing. In this research, we investigated the difference in extraction of hop components of hop pellets mixed in hot brewing water before adding at the end of the wort boiling process. In the case of adding hop slurry into the whirlpool after treatment of hop pellets in the hot water, the concentration of hop aroma in the beer and flavor intensity of the beer were high. The quality of bitterness was good, so the quality of the final beer was also good. The particle size of break including hop were investigated during the rest period in the whirlpool. It was observed that the particle size was smaller than that of adding hop pellets added directly into the whirlpool.

Yutaka Yamaguchi graduated with a master's degree from the Department of Chemical Science and Engineering, Kobe University in 2005. After joining Suntory, he worked for 2 years in the position of second brew master at the Suntory Tonegawa brewery in Gumma Japan. He then worked in the Beer Development Department of Suntory Liquors Limited and attended the Technical University of Munich, Weihenstephan in Germany as an international student and studied there for 2 years. He currently works in the Development Department of Suntory Beer Limited.

5. Use of microscopic pressurized shockwaves generated by controlled cavitation as a non-shear method for increased extraction of alpha acids and oils from hops

S. GOMEZ (1); (1) Apotek Solutions, LLC, Plymouth, MI, U.S.A.

Low yield in alpha-acid extraction during beer processing continues to be an issue in the brewing industry. Increased boil times do not necessarily translate to an increase in yield, but do affect beer quality. Due to the sensitivity to shear of some beer compounds, standard food/beverage industry methods for mixing are not viable options. The use of microscopic shockwaves generated by induced cavitation has been explored as a non-shearing mixing method for increased alpha-acid extraction during the boil and for hop oil extraction during dry hopping. As the wort and hop mixture is circulated through the system, the hop particles are exposed to intense shockwaves that drive the wort deep into the hop particles. The research has shown potential alpha-acid yield above 90% and a reduction in dry hops of 50% without impacting the finished product characteristics. For bittering hops a system specifically designed for this trial circulated the liquid and hop pellet mixture during the boil. For aroma hops the system was adjusted for dry hopping to circulate the beer and hop pellet mixture in and out of the fermenter. For bitterness the samples were tested using the isooctane extraction method (IBUs); for aroma hops the samples were tested by a blind panel. During the trials, the concepts of wort saturation with iso-alpha-acids

and alpha-acid encapsulation were explored, as well as the required boil times for isomerization. A new formula for IBU calculations was developed based on wort saturation levels. Note: an abstract was submitted in 2013 but had to be withdrawn due to conflicting results that led to additional trials and new findings included in the updated version. The work was done at our facilities and at Griffin Claw BC, Witch's Hat BC, and River's Edge BC.

Santiago Gomez holds a mechanical electrical industrial engineering degree from Universidad Anahuac del Sur in Mexico City. Santiago has 19 years of experience in food and beverage processing related to blending, pasteurization, fermentation, packaging, heat exchange, liquid-liquid refrigeration, spray drying, CIP cleaning, process design, equipment integration, and commissioning. Santiago has been an MBAA member of District Michigan since 2012 and a recognized beer judge by the BJCP since 2006.

6. Hop growing and processing in the northeast United States

S. MILLER (1); (1) Cornell University, Ithaca, NY, U.S.A.

Hop production in the United States is currently going through some significant changes—when hasn't it? New York had more than 300 breweries in 1900 and 40,000 acres of hop production at its peak in 1890. We all know that changed. A hundred years of brewery consolidation is now moving into a rapid expansion of craft production and diversification. Every state is benefiting from consumer demand for quality, fresh, distinctive, local beers. These new investments in small and mid-sized breweries have opened the hop market to smaller scale hop production. The pie is getting bigger. What can eastern hop growers do to break into this market? There are potential added values for hops being produced in states like New York and Michigan that were once major production areas for hops. These include the recognition and selection of local agricultural products by both in-state and out-of-state tourists and consumers. Also, some expansion of production outside the Pacific Northwest could provide the ability to add to the currently available flavor profiles. Brewers too are looking for ingredients that distinguish their products. Terroir doesn't only effect grapes. The "modern" eastern hop industry began 15 years ago with craft brewers looking for wet hops. A few growers began producing for this market, and brewers for the most part were excited about what they bought, enough so that they began asking for dried whole-leaf hops and ultimately pellets. Along came craft expansion and a rapidly increasing demand for local hops. In recognition of the economic engine of the brewing and beverage industry, some states have reduced regulation and expanded the market opportunities for these industries. New York is one of the states where major changes have taken place, including a Farm Brewery Law that requires the use of increasing percentages of hops and agricultural inputs. This presentation will discuss what growers, processors, and brewers have done in the last 5 years to bring eastern hop production and processing to the quality standards that modern craft brewers expect. We are on our way, but not there yet.

Steve Miller is New York's first hops specialist. He holds a B.S. degree from SUNY ESF and a master's degree from Clemson University. He began his career at the New York Agricultural Experiment Station, working with diseases of vegetable crops, and worked as an educator with Cornell Cooperative Extension with horticulture and vegetable crop producers. In the last five years, Steve has worked exclusively with the hop and brewing industries to develop information that eastern growers need to produce a quality crop. He offers consultations with growers, newsletters, web resources, a hops scouting program, and farm visits, as well as field days and conferences for hop growers and brewers. He serves on the Governor's Task Force on Brewing and Hops and as an advisor to Morrisville College's Brewing Institute.

7. Overview of can transfers: General knowledge, best practices, and troubleshooting

M. BILSKI (1), C. Thompson (1); (1) Ecolab, Eagan, MN, U.S.A.

Consumers are driving beer consumption from aluminum cans and production volumes are increasing. In order to maximize throughput and reduce can reject rates, one must understand and effectively manage the can transfer area of the line. This presentation will discuss general can transfer knowledge, the different types of can transfers available on the market, the pros and cons of each, and their manufacturers. It will also outline best practices for lubricating and cleaning each type of can transfer, as well as general troubleshooting and some common issues that occur with can transfers.

Matt Bilski has 8 years of experience and in 2014 joined the Total Beverage group in the Food & Beverage division of Ecolab, Inc. as senior chemist. His responsibilities include the development and commercialization of new cleaning, sanitizing, and lubrication products for the brewery industry. He has been with Ecolab since 2007 and has contributed to numerous business segments within the corporation. Matt is a regular attendee at local MBAA meetings. He received his bachelor's degree in biology from Saint Mary's University of Minnesota and his master's degree in management of technology from the University of Minnesota. He has been granted one patent for his work.

8. Vapor space tunnel pasteurizer corrosion completely eliminated with the use of a "non-oxidizing" biocide to control pasteurizer bacteria

B. ORNAY (1), D. Duff (2); (1) Nalco – An Ecolab Company, Woodstock, GA, U.S.A.; (2) BW Container Systems, Romeoville, IL, U.S.A.

Thanks to utilization of the most recent technological innovations for reducing water usage in tunnel pasteurizers, total daily water consumption is now at record low levels. Minimal pasteurizer water turnover results in increased dosage rates of the conventional biocide treatment program consisting of chlorine/bromine, which is widely used to control bacteria. This increase in the feed of chlorine/bromine is a direct result of a significant increase in

organic load in low water consuming pasteurizers. This situation creates an environment consisting of elevated levels of haloamines, which condense and collect on the metal surfaces of the pasteurizer. Through the cycling of evaporation and condensation, elevated levels of chloride/bromide ions deposit on the surface. These highly corrosive ions penetrate the protective passivation layer of 304 stainless steel, not allowing it to repassivate. This leads to corrosion, which is not only unsightly but could diminish the integrity of the pasteurizer structure, thus reducing the life expectancy of a very expensive asset. The solution to this phenomenon, proven out recently at a regional U.S. brewery, is to move away from a conventional chlorine/bromine pasteurizer treatment program and switch to a “non-oxidizing” biocide treatment program. This presentation chronicles the issues observed while treating the pasteurizer with chlorine/bromine and the successful results after switching to the “non-oxidizing” biocide treatment program.

Brian Ornay is Nalco’s global beverage industry technical consultant, based out of Atlanta, GA. During his 14 year career at Nalco, he has been employed in field sales, marketing, and technical support. To complement his Nalco career, he worked for Anheuser-Busch InBev for 6 years in the Packaging Department of the Cartersville, GA, brewery. As part of Brian’s responsibilities during those 6 years, he was personally responsible for pasteurizer water and energy optimization projects. Brian holds a B.S. degree in chemical engineering from the University of Tennessee. Brian is a member of MBAA. Brian currently supports the Nalco sales force to ensure brewing best practices are being implemented and adhered to. As part of Brian’s role, he is the liaison between the Nalco sales force, local breweries and Nalco’s R&D Department. The focus of Brian’s role is water and energy reduction, ensuring product quality, and improving operational efficiency.

9. Palletized cans

S. BRENDECKE (1); (1) Ball Corporation, Broomfield, CO, U.S.A.

Packaging plays an important role in the quality of the product that the consumers experience, but is often only examined when a problem arises. This presentation will discuss some of the steps that a brewery should put into practice for receiving, storing, and depalletizing of cans and other packaging materials. Examples of chemicals that interact with packaging material and could produce off-flavors in finished products will be discussed. Best practices will be discussed to prevent damage to cans before filling and thus minimizing problems at the filler.

Scott Brendecke received his bachelor’s degree in chemistry from Adams State College, Colorado, in 1986, and a master’s degree in chemistry from Northern Arizona University in 1990. In 2009 he received an MBA from Jones International University. Scott worked at Los Alamos National laboratory, Rocky Flats and Rocky Mountain Arsenal from 1988 to 1997 doing environmental analysis. In 1997 he joined Ball Corporation. His work at Ball is focused on beverage and coating interactions. At Ball he

became an organoleptic analyst and has judged at events such as GABF, NABA, and WBC. He is the Packaging Subcommittee lead for the ASBC Technical Committee.

10. The science of packaging quality: The oxygen edition

L. TORRES (1); (1) Bell’s Brewery, Kalamazoo, MI, U.S.A.

Discover the science of the effects of oxidation through the packaging of beer. Learn to recognize oxidative characteristics in beer theoretically and through real-life samples. Discuss the difference between filler models and discover the different problems that can occur between systems. Finally, learn simple tools for auditing the filling process and reducing oxidation in package.

Lauren Torres began her career in the brewing industry shortly after graduating from Kalamazoo College with a B.A. degree in chemistry. Lauren began working in the laboratory of Bell’s Brewery as a lab technician. Over the years, many opportunities have presented themselves. Lauren is currently managing a division of the lab as quality team lead. Outside of the lab, Lauren has been fortunate enough to participate as a judge in various competitions, from home brews to professional brewers. Additionally, Lauren engages in various educational outlets. Lauren has assisted in teaching the Siebel Institute of Technology’s Quality Course and has presented at the American Society of Brewing Chemists Annual Meeting.

11. The importance of maintenance with respect to quality and sanitation

D. LOEFFLER (1); (1) Loeffler Chemical Corporation, Atlanta, GA, U.S.A.

Many breweries today are growing at a very rapid pace, some as much as several hundred percent per year. As breweries grow at these often difficult to sustain rates, scheduled and preventative maintenance are often dramatically reduced or even eliminated altogether in favor of keeping up with production and demand. However, the consequences from such a lack of maintenance can be severe and frequently lead to sanitation issues and equipment failures that affect the quality of the beer. This presentation will discuss which areas are frequently neglected, even under normal operating conditions, and how the lack of maintenance can affect the sanitary conditions in a brewery. We will look at practical examples of how the lack of maintenance may affect the various system parts and how these affected parts can quickly become quality hot spots for a brewery. This holds true more than ever in an environment where more and more yeast strains are handled within one brewery and cross-contamination is a real concern. Recommendations are given for scheduled service intervals for frequently missed wear-and-tear parts, as well as how preventative maintenance can save breweries money, time, and employee turnovers while maintaining its overall quality.

Dirk Loeffler is the technical director of Loeffler Chemical Corporation, a chemical company specializing in

sanitation products and chemical automation for breweries, with corporate offices in Atlanta, GA. In his position, Dirk continuously develops and implements new products, cleaning technologies, and automation systems. Dirk came to the United States from Germany in 1992 to lay the groundwork for the U.S. operations of Loeffler Germany, resulting in the incorporation of Loeffler Chemical Corporation in 1994. Born and raised in Cologne, Germany, Dirk graduated in Cologne with a degree in business administration. He then worked for Chemische Fabrik Kalk GmbH, a BASF subsidiary, before joining the Loeffler family business in 1989, where he worked in technical sales and research and development. Dirk lives in Atlanta, GA, with his wife Alexis and their twin boys Kai and Sebastian. Dirk has been an active member of MBAA since 1993, and he is also an active member of the Brewers Association, as well as the American Society of Brewing Chemists.

12. Brewhouse expansions and upgrades—How to avoid trouble and disinvestments

S. KAPPLER (1), H. Nerb (1); (1) Esau & Hueber GmbH, Schrobenhausen, Germany

Within the booming craft brewing market, many breweries run out of capacity, especially in the brewhouse. Increasing capacity is mostly achieved by replacing the existing brewhouse with a new one. To reduce investment costs many breweries settle for low priced and, therefore, low quality equipment; however, this strategy usually leads to very high life-cycle costs. In many cases, an investment in brewhouse expansion and/or upgrade is sufficient to break the bottleneck. Although this is often not even taken into consideration or not realized in a technically and technologically reasonable way. This presentation provides an overview of different strategies to increase the capacity of an existing brewhouse. Based on examples of successfully implemented brewhouse expansions and upgrades, the audience is taken through the requirements and possibilities. Examples of common cases of disengineering, which can be found in breweries, are also presented. Last, but not least, possible upgrades in automation, which help to increase capacity, are introduced.

Sebastian Kappler received a Dipl.-Ing. degree in brewing and beverage technology from Technische Universitaet Muenchen in 2008. He began his employment with the Augustiner-Wagner brewery in Munich as an apprentice to a brewer and maltster in 2000. After achieving the position of assistant, he started his studies in brewing science at the Technische Universitaet Muenchen. Since 2008 he has been working as a scientific employee at the Chair for Brewing and Beverage Technology in Weihenstephan. The topic for his doctoral thesis was the evaluation of the factors affecting the yield of isohumulones during preparation of wort. Since 2013 Sebastian has been working as a sales and design engineer at Esau & Hueber.

13. How craft brewers can move from hoses and flow panels to mix proof valves and valve manifolds for a more sustainable operation

R. FOLZ (1), J. Hauser (2); (1) Pentair, Venlo, Netherlands; (2) Pentair, Delavan, WI, U.S.A.

Transfer hose “snake pits” are commonplace in craft brewing cellars. Swing panels and hoses are widely used to route product and cleaning solutions through brewery piping systems and have the advantage of lower investment costs. However, operational costs are considerably more than those of an automated system because it is very dependent on the operator. It is also much more difficult to clean and to eliminate O₂ pick up in a swing bend system. Replacing hoses with valve manifolds can clean up cluttered cellars and improve safety, efficiency, product shelf life, and reduce overall operating expenses in the brewery. For the growing craft brewer who is making constant brand changes, dragging hoses from tank to tank, ensuring consistent product quality is difficult. While there is no “magic” number as to a size or time when a brewery should consider making the move to mix proof valves/manifolds, this technology needs to be on every growing brewery’s radar. Craft brewers need to ask themselves questions such as the following. Is there a place in the brewery where it makes sense, due to frequent changeovers, to install mix-proof valves? Is there a quality issue that has been pinpointed that mix-proof valves will alleviate? Have they reached a size where reducing operating costs and errors is top priority? Matrix piping systems were introduced to the North American brewing industry more than 40 years ago, but except for a few installations haven’t made their way into the craft brewing sector. This technology revolutionized the piping system in larger breweries improving the process over manual options: space requirements are reduced considerably; reduced O₂ pick up; reduced product losses; ease of installation with reduced costs; and faster changeovers. This valve system connects the process pipes from tank outlet to manifold and on to the destination. This greatly increases product recovery and considerably reduces product losses and contaminants. The bottom of the tank and valve cluster is enclosed in the tank skirt, which greatly reduces refrigeration costs. This saving, in combination with lower maintenance costs, reduces operating costs considerably. Product quality is maximized by the elimination of open lines between the vessels, which when mix-proof systems are not used are left standing in an unclean state for considerable times and, therefore, are a potential cause of contamination. Before and after examples will be presented to illustrate the benefits of valve manifolds to craft brewers.

Roland Folz is the director of technology and innovation for Pentair’s Food & Beverage Division. Since February 2014, Roland has been responsible for innovation, product design, solutions development, and global R&D function. Roland has 18 years of experience in the brewing and beverage industries. Prior to joining Pentair, he headed the VLB Department of Brewing & Beverage Science and Applications (BBSA), located in Berlin, Germany. With his team of experienced engineers at VLB-Berlin, Folz worked on sustainable developments for the beverage industry, future beverage streams, and fermentation and applied microbiological concepts and control mechanisms. Under his leadership, VLB became an internationally respected provider of mission-oriented research and solutions regarding technological topics, global consultancies, and international training courses. Roland started his career in the brewing industry with a technical apprenticeship as a brewer and maltster at the Beck’s Brewery, culminating with his doctorate degree with a thesis on the flavor stability of beer in PET

bottles. He has also served as the technical director for Germany-based Preussen Pils Brewery and plant manager for the Oettinger Group. Roland is the international director on the American Society of Brewing Chemists Board of Directors. He is an active member of the International Society of Beverage Technologists and MBAA. Roland holds a Ph.D. degree in engineering technology and a diploma for brewing technology from the Technical University of Berlin, Germany.

14. Minimize O₂ pickup from fermenter to bottle with portable and inline instrumentation

L. ERDODY (1), J. Tocio (2); (1) Florida Beer, Cape Canaveral, FL, U.S.A.; (2) Pentair, Delavan, WI, U.S.A.

The biggest enemy of beer that causes rapid decline in quality and taste is O₂. Together with the content of dissolved CO₂, O₂ plays a critical role in how the consumer enjoys beer during its complete shelf life. For growing craft brewers, advanced O₂ measuring technology allows them to pinpoint issues that could negatively impact product quality. The principle of measurement is based on the effect of dynamic luminescence quenching by molecular oxygen. This measurement principle provides long-term stability, high accuracy at low O₂ values, and quick response time. In combination with CO₂ measurement, this O₂ measurement enables breweries to control the two most important gases in a very efficient manner with the use of only one instrument. This presentation will present an overview and case study of a 50,000+ barrel craft brewer's initial experience with a portable O₂/CO₂ measurement instrument and the process improvements that were quickly made with the tool that led to better product quality. Comparison of portable grab sample measurement versus in-line process monitoring for O₂/CO₂ management in the brewery process will be made. Learning objectives: identify easy wins for improvements in O₂/CO₂ management; highlight areas where use of portable equipment is sufficient and areas where use of in-line instrumentation makes sense; and share best practices.

Luke Erdody has been the director of brewery operations at Florida Beer Company in Cape Canaveral, FL, since October 2013. Previously he was head brewer at Gordon Biersch (2009–2013). He has been brewing beer since 1999 and has worked in Australia with the Burleigh Brewing Company, where he was involved in advanced yeast management, lab work, and bottling in a production environment. Luke is a member of the Institute of Brewing & Distilling and MBAA. He holds a B.A. degree from the State University New York at New Paltz and has a diploma in brewing from the Institute of Brewing & Distilling.

15. Ten things you need to know about your pumps

T. RAUSCH (1), M. Cartee (1); (1) M.G. Newell Corp., Greensboro, NC, U.S.A.

Pressure, friction, and flow are three important characteristics of a pump system. Pressure is the driving force responsible for the movement of the fluid, expressed as pounds per square inch (psi). Friction is the force that slows fluid particles. Flow

rate is the amount of volume that is displaced per unit time, usually expressed as gallons per minute. Pumps are typically classified by the way they move fluids. For the brewing industry, we will only focus on centrifugal (or rotodynamic) pumps. This presentation will review: the basic parts of a centrifugal pump; how a centrifugal pump produces pressure; where it should be used; and how to read a pump curve.

Todd Rausch obtained his B.S. degree in food science from Purdue University and his M.S. degree in food science from North Carolina State University. After a brief internship with Master Foods in Hackettstown, NJ, Todd joined M.G. Newell Corporation in 2004 as an outside sales representative. He focuses his technical expertise on biopharma, wine, and beer processing.

16. Glycol chiller essentials: A comprehensive look at chiller components, critical design integrations, and opportunities for reducing ownership cost

R. M. STOCKINGER (1); (1) Arcadia Ales, Kalamazoo, MI, U.S.A.

Review chiller components: discuss critical chiller components and present the purpose and design within the system; present a basic understanding of refrigerant and the thermodynamics present in their system; showcase common chiller failures and techniques for self-diagnosis and repair; and chiller performance related to outside temperatures. Review glycol selection and maintenance: discuss common glycol types, glycol attributes, and proper selection for a brewery; define proper dilution rates and process temperatures; and discuss proper glycol maintenance. Critical design parameters for breweries: explore chiller plumbing design and options; calculations to determine proper chiller sizing (bigger is never better); importance of staging ability and cooling redundancy; and incorporating expansion requirements in the predesign stage. Opportunities for energy savings: staging ability and its inherent benefit to energy savings; use of freq drives, EC fans, and oversized condensers; and calculate potential savings and prove long-term benefits.

Ryan Stockinger is the engineering and maintenance manager for Arcadia Ales in Kalamazoo, MI. He is responsible for engineering aspects of the brewery, including brewery expansion, brewhouse and cellar process controls, production process controls and improvement, and facility maintenance. Ryan graduated with a mechanical engineering degree from Grand Valley State University in Grand Rapids, MI. Before entering the craft brewing industry, Ryan was a senior engineer for a prominent glycol chiller manufacturer and was responsible for refrigeration, plumbing, and electrical engineering design. After a 5 year tenure in the Engineering Department he was promoted to an application engineering position, leading the custom equipment market with a strong focus on the brewing and craft industry. Being continually immersed in the company of the craft industry fueled his passion for beer and the process behind it and allowed for a seamless transition into his current role at Arcadia.

17. Technological chances and challenges of a wide product diversification for brewing equipment

J. PREIß (1); (1) Kaspar Schulz Brauereimaschinenfabrik, Bamberg, Germany

For a very long time the biggest difference between most of our beers has been the individual design of bottles or crates. But times have changed. Nowadays everybody in the world recognizes that product diversification, especially in the United States, is reaching unbelievable dimensions. But not only in the United States—all over the world a lot of breweries are established every day, for example in Italy, Poland, South Africa, and South America. Most of the founders are young, highly motivated, extremely creative, and almost crazy (about beer). What does this mean for the suppliers of brewing equipment? Just selling a two vessel brewhouse and some CCTs is history. If you are reading tenders of current craft beer projects, topics like using alternative raw materials or historical equipment are even more important than brewhouse yields or occupation times. Due to this trend completely new machines or vessels are being developed or brought back to life. Small craft malting plants, hop- or spice-treating vessels, baudolet coolers, and coolships are just some examples. Additionally the functions or characteristic numbers of machines are changing. A few years ago a lautering tun had to lauter just 12 brews per day at a certain false bottom load. Today we have to process pine needles or fruit components in the tun. A CCT was designed for a fast and optimized fermentation and maturation. Nowadays we use it almost as an extraction vessel. This leads to completely different process and associated mechanism demands. Furthermore almost forgotten processes or machines are of more and more interest again. If the main criteria are not just time or money anymore, the use of a coolship probably made of copper, for example, might be interesting, even in combination with a baudolet cooler. This trend leads to an interesting challenge for suppliers of brewery equipment. Old drawings have to be studied and alternative materials or production processes have to be tested and verified. Who has been thinking about welding copper or the resistance of copper against modern chemicals during the last 20 years? Regarding the whole malting and brewing process this presentation will give you a diversified overview of interesting machines and systems from different suppliers on the market, which could help you to improve the originality and quality of your products. Starting at craft malting, focusing on modern alternative brewhouses and cellars, and finally ending at a further prospect for brewing processes in the future, this presentation will give you an interesting insight into what the global craft beer trend means for the work of the brewing machinery industry and what problems and challenges have to be solved.

Johannes Preiß's career in brewing began in Weihenstephan, Germany, where he studied at the Technische Universität München. Johannes graduated with a degree in brewing and beverage technology. He started working in 2008 at Kronen AG, Germany, as project manager in the Research & Development Department. The main focus of his work lay in brewhouse and cleaning technology, as well as energy optimization. His main topic areas were lautering technology and integration of solar heat into breweries. As

result of his work Johannes published several patents and scientific papers. Since the end of 2012 he has been working as technical director for Kaspar Schulz in Bamberg, Germany. In addition to his profession, Johannes is a talented musician. In 2009 he received a cultural award from the City of Nuremberg, Germany.

18. Behavior of hydrogen sulfide during late-stage fermentation using all malt wort

H. NAKAMURA (1), T. Maruhashi (1), Y. Hida (1); (1) Suntory Beer Limited, Osaka, Japan

Hydrogen sulfide (H_2S) gives beer an unpleasant off-flavor like that of rotten eggs, so it is important to keep the H_2S content in the final beer product well below the sensory threshold. H_2S behavior during fermentation has been investigated, and it is known that the behavior is related to yeast cell growth and the process of fermentation. It is released from yeast cells during the cell maturation period and assimilated during the budding period. The decrease in the H_2S content of beer during late-stage fermentation is attributed to the purging effect of carbon dioxide (CO_2) and assimilation by yeast. In 2013, we reported at the MBAA Annual Conference that H_2S content was decreased again in late-stage fermentation according to the balance between its production, its assimilation, and the CO_2 purging effect when the malt ratio of wort is low. In this study, we examined H_2S content during fermentation using all malt wort and observed another behavior in this case. H_2S content during fermentation increased at a certain time in late-stage fermentation. Since such phenomenon was not well known, we investigated the relationship between the H_2S content and the consumption of sugar during the fermentation process for further understanding of this phenomenon. As a result, sugar consumption by yeast almost stopped and glycogen content in yeast cells decreased at the same time in late-stage fermentation. So it was suggested that the end of sugar consumption by yeast leads to the increase of H_2S in late-stage fermentation.

Hiroshi Nakamura graduated with an M.S. degree from Kyoto University in 2008. After joining Suntory, he worked for 2 years in the Beer Development Department. He then went to Suntory (China) Holding Co., Limited, and worked there for 2 years. Hiroshi currently works in the Beer Development Department of Suntory Beer Limited.

19. Image-based cytometric analysis of fluorescent viability and vitality staining methods for *Saccharomyces cerevisiae*

L. L. CHAN (1), D. Driscoll (2), S. Saldi (1), D. Kuksin (1); (1) Nexcelom Bioscience, Lawrence, MA, U.S.A.; (2) Avery Brewing Company, Boulder, CO, U.S.A.

Saccharomyces cerevisiae has been an essential component in the production of beer for centuries. The viability and vitality of yeast during a standard brewing process is especially important for proper cell growth, consistent production of flavor, and optimal yield for fermentation. Viability refers to the ability of the yeast to live and continue dividing, while vitality refers to the metabolic

activity of the yeast. Yeast may be viable and dividing, while not vital and allowing for fermentation. The traditional method for yeast viability measurement depended mainly on manual counting of methylene blue-stained yeast cells in a hemacytometer. However, this method can be time-consuming and has user-dependent variations. In recent years, fluorescent viability and vitality stains have become widely used for flow and image-based cytometry methods. Specifically for image cytometry, it has been previously demonstrated for rapid yeast concentration and viability measurements. In this work, we demonstrate the capability of cellometer vision image cytometry for yeast viability and vitality measurement, validating the methods against methylene blue. Various fluorescent stains were employed for viability and vitality measurement, such as nucleic acid stains (PI, EB, 7-AAD, and DAPI), membrane potential, intracellular, and enzymatic stains (oxonol, MgANS, and CFDA-AM), and dual-fluorescent stains (AO/PI and CFDA-AM/PI). In addition, we performed a time-course study to compare viability and vitality of lager and ale yeast, in order to understand yeast physical and metabolic characteristics during a standard fermentation process.

Leo Chan currently serves as the technology R&D manager at Nexcelom Bioscience LLC, Lawrence, MA. His research involves the development of instrument and applications for the cellometer image cytometry system for detection and analysis of yeasts used in the brewing and biofuel industries. He is a member of MBAA. He received his B.S., M.S., and Ph.D. degrees in electrical and computer engineering from the University of Illinois at Urbana-Champaign (2000–2008).

20. Preventative measures for cross-contamination in breweries

N. MADER (1); (1) Fremont Brewing Company, Seattle, WA, U.S.A.

As more breweries continue to develop wild yeast and barrel aging programs, the risk for cross-contamination increases substantially. This project dissects common methods used to prevent cross-contamination by compiling information from a number of breweries and suppliers. Overall, 16 breweries that produce both clean (*S. cerevisiae* or *S. pastorianus*) and wild beers (*Brettanomyces* spp. or mixed cultures) participated in a survey. The survey first evaluated specific measures for equipment separation in the brewery, as well as changes to sterilization practices in regard to CIP procedures and chemical quantities. Next, differences in yeast handling methods for clean versus wild beers were examined, from propagation to pitching and/or inoculation. Among the breweries surveyed there were inconsistencies in cleaning and sanitation methods, especially treatment to barrels and foeders used for wild fermentations. From a quality control standpoint it is clear that specific carbonation, filtration, and packaging methods are advantageous for clean versus wild beers and need to be treated as critical control points for breweries to mitigate cross-contamination. Moreover, quality control measures taken before and after packaging, such as ATP swabbing, air monitoring, and pasteurization are discussed in more depth. The feedback provided by brewery-focused chemical and hygiene suppliers details

various sterilization techniques and misconceptions of killing beer spoilage (or enhancement) organisms like *Brettanomyces*. Results from the survey not only suggest methods of best practice to prevent cross-contamination, but also propose new technologies available to aid quality-driven breweries.

Nick Mader is a brewer/cellarman at Fremont Brewing Company, with previous industry experience at Crooked Stave Artisan Beer Project and Boulevard Brewing Company. He is currently an M.S. degree candidate in brewing and distilling at the International Centre for Brewing and Distilling through Heriot-Watt University. His research and interests include brewery sterilization practices, the integration of fermentation techniques from the wine and spirits industries, and bioflavoring through the use of secondary fermentations.

21. Influence of heat treatment for an optimal protein-particle distribution

R. Feilner (1), K. MÜLLER AUFFERMANN (1); (1) Kronen AG, Neutraubling, Germany

A main factor is the combination of yeast cell count and the height of pasteurization units. So the interaction of a centrifuge and a flash pasteurizer becomes an interesting plant constellation. Different numbers of pasteurization units, with different yeast cell counts, were analyzed. The results show an interesting effect on the haze and age stability of white beers. The additional heat influence through the flash pasteurizer after the fermentation, in combination with a shorter boiling time, will lead to an optimal protein-particle distribution. More free nitrogen will be available after the fermentation and could be transferred from a nanometer - to micrometer protein structure. The thermal impact by this process is much lower in comparison to traditional boiling time (e.g., 60 min). To eliminate the negative sensory heat impact on the yeast, it is very important to find the practicable combination of maximum yeast cell count and pasteurization units. More haze and age stability and a better taste are the positive results. A result overview to the particle distributions (gel electrophoresis), age stabilities (aging carbonyls fresh and aged beers), haze stabilities, thermal impact (electron spin resonance), and taste quality (sensory panel) will be part of this presentation.

Konrad Müller-Auffermann already had two years of international experience before he studied brewing and beverage technology at the Technical University of Munich (TUM). During his studies he worked for several major construction companies, partly in foreign countries. In 2009 Konrad was employed by the Research Center Weihenstephan for Brewing and Food Quality (TUM) as a consulting engineer specializing in international brewing, fermentation, and filling technologies. One year later he became head of the Research and Development and Hygienic Design Department at the institute. The focus of his ongoing Ph.D. thesis is continuous main fermentation methods and includes alternative plant and process designs. In 2015 Konrad became head of breweries product development of the Kronen AG.

22. Reduction of carbon footprint using a proline-specific endoprotease (PSEP) during beer production

S. VAN ZANDYCKE (1), F. van den Berg (2), W. Heijne (2); (1) DSM Food Specialties, South Bend, IN, U.S.A.; (2) DSM Food Specialties, Delft, Netherlands

Sustainability will be a key differentiator and value driver over the coming decades for the brewing industry, where efficient use of raw material and energy go hand in hand with taking environmental responsibility. Global brewers have announced their ambitious sustainability targets for the future; exogenous enzymes are flexible tools for meeting their increasing demands for sustainable and cost-effective beer production. However, to make the correct business decisions, the sustainability and economic advantages of enzyme technology should be made explicit and quantifiable on a case-by-case basis. A proline-specific endoprotease (PSEP) added during fermentation to stabilize beer by degrading haze-active proteins enables brewers to significantly lessen their carbon footprint by reducing energy costs due to the possibility of shortening and increasing the temperature of maturation. The latter is a unique feature of this particular enzyme, something that is not achievable with standard beer stabilizers such as silica gel and PVPP. In a life cycle analysis (LCA), all emissions released into the environment and resources consumed along the whole life cycle of beer are added up to produce an inventory list of substances. This inventory is translated with the help of an impact assessment methodology into environmental impacts. This study used two methods, Eco-indicator 99 and IPCC 2001, for calculating all the impacts and performing sensitivity analysis, respectively. The concept of LCA, methodologies, and results will be presented and discussed. Subsequently, a quantitative example will be given on how to obtain simultaneous financial and environmental benefits.

Sylvie Van Zandycke studied biochemical engineering and fermentation at the Institute Meurice (Brussels, Belgium), completing her degree in 1996. She then obtained her Ph.D. degree on Saccharomyces cerevisiae in 2000 from Oxford Brookes University in the United Kingdom. After that Sylvie was employed as project manager for the brewing consultancy firm SMART Brewing Services until 2004, when she left the United Kingdom for Montreal, Canada, and accepted a post with Lallemand. As project manager for their genetic identification laboratory she focused on yeast and bacteria used in alcoholic beverage production. In 2007 Sylvie became technical sales manager for Lallemand Brewing, looking after dry yeast and nutrition products on a global basis. At the end of 2011 she joined DSM Food Specialties as technical service manager for brewing enzymes in North America, and she is currently global key account manager for brewing enzymes.

23. The use of tannic acid in the brewing process as a stabilizing agent

J. FORMANEK (1); (1) Ajinomoto North America, Itasca, IL, U.S.A.

The use of clarifying and stabilizing agents during beer production is a common practice throughout the brewing industry in order to deliver a finished product with desirable stability. Many materials, both natural as well as synthetic, have been discovered to deliver a positive effect on beer clarity; however, other aspects of stability related more to the chemistry of the brew are not well addressed by these fining agents. The oxidation effects developed through the presence of iron ions, for example, allows a cascade reaction to occur with free-radical formation negatively impacting beer flavor stability. The use of certain forms of tannic acids can help with all areas of colloidal and flavor stability. Tannic acids have the ability to be easily added at multiple areas of the brewing process to deliver desirable finished product stabilization, allowing for enhanced shelf life and other key attributes.

Joe Formanek (director – new product development for Ajinomoto North America in Itasca, IL) has been a home brewer for nearly 30 years, with a few commercial brewing stints during that time. He has won numerous awards at local, regional, and national competitions, having twice been awarded the American Homebrewers' Association Ninkasi Award (2000 and 2006) for winningest brewer in the final round of judging, as well as having been honored as one of two home brewer winners of the 2011 Sam Adams Longshot American Homebrewing Competition with his Russian imperial stout, which was distributed nationally in the 2012 Longshot multipack.

24. Commercial enzymes in brewing

I. YANEZ (1); (1) DuPont Industrial Biosciences, Leiden, Netherlands

The brewing process uses a set of enzymes that naturally occurs in malt. Some of these enzymes are activated, many are used, and some are destroyed in the malting process. Various malts contain various levels of these enzymes, all leading to many of the different brew styles available today. Commercial enzyme producers have harvested much of this natural technology and packaged it for use by the brewer. These enzymes can be used to supplement the loss of enzymes in the malting process, as well as used to deal with specific issues created by crop damage, variability in the malting process, etc. In addition, these products can be used to stretch the limits of brewing and beer styles. Higher levels of low enzymatic materials like crystal malts, roasted malts, and cereal grains and adjuncts can be used to create a broad spectrum of beer styles and flavor opportunities. Higher alcohols and differing sugar spectrums are available with this technology. Beyond beer styles, these products can be used to help create process consistency and increase profitability with recovery of additional extracts. This paper reviews the various types of enzymes, their function, and potential uses, in a generic nonbranded fashion, to show the tools available to the brewing in this technology.

Iliana is a chemist, food scientist, and brewmaster. She works as global product manager for Brewing and Distilling Enzymes at DuPont. After completing her bachelor's degree in food chemistry at UNAM in Mexico, she moved to Europe. She first lived in Germany where became a brewmaster at the VLB. She then lived in France, Ireland, and Italy where she graduated summa cum laude and obtained three MSc. diplomas from the Paris Institute of Technology, the Dublin Institute of Technology, and the University of Naples Federico II. She is Mexican and lives close to Amsterdam in the Netherlands. Iliana is curious, innovative, and loves drinking beer. The combination generates great enthusiasm with customers in her global role at DuPont.

25. Early detection and risk-based analysis of *Lactobacillus* and *Pediococcus* contamination enables preventive quality and environmental monitoring programs at the brewery

K. M. KAHLE (1), Z. Miller (2), A. Bartles (2), J. J. Lindsey (1), M. K. Feeney (1), S. P. Terkhorh (1), N. A. Siciliano (1); (1) Invisible Sentinel, Inc., Philadelphia, PA, U.S.A.; (2) Victory Brewing Co., Downingtown, PA, U.S.A.

A major challenge in maintaining beer quality is early detection of spoilage microorganisms before they have the ability to produce unintended flavors and aromas. Spoilage organisms can be diverse and present different quality risks based on their potential to thrive in beer and in the brewery. Early detection coupled with risk-based analyses can provide invaluable information to quality-centric brewers. A novel molecular diagnostic assay, Veriflow brewPAL, was developed to provide accurate and sensitive detection of beer spoiling *Pediococcus* and *Lactobacillus* species in under 3 hr. Veriflow brewPAL is a DNA signature-capturing technology that specifically detects beer spoilers via hop resistance genes without the need for bacterial enrichment or DNA purification. This assay is versatile and can be employed to evaluate samples collected throughout the brewing process, from raw materials to finished product. Speed to results, specificity, and sensitivity are paramount for early detection in order to quickly provide actionable information and effectively preserve quality. Due to the unprecedented speed of the assay, brewPAL can shift the brewery spoilage monitoring paradigm from reactive to preventive. brewPAL has provided brewers with unique value by analyzing bright tank beer prepackaging and allowing them to implement environmental monitoring programs. Numerous factors can influence the ability of *Lactobacillus* and *Pediococcus* species to metabolize and affect the quality of beer, including levels of hop resistance factors and percent ABV, IBU, and pH of the beer. The effects of these factors on *Lactobacillus* and *Pediococcus* growth kinetics were evaluated to develop a model for beer spoilage risk assessment. A *Pediococcus* and *Lactobacillus* risk index (PAL score) was developed using quantified brewPAL results to assess the potential for bacterial outgrowth and spoilage. This scoring system can be used as a tool to help predict whether conditions within a particular beer are favorable for rapid bacterial growth and subsequent spoilage, thereby providing brewers with the ability to make early and informed decisions to maintain the quality of their products.

Kristen Kahle is the director of research at Invisible Sentinel, a global molecular solutions company that provides microbial diagnostic tools for multiple industries, including food safety and beverage quality. At Invisible Sentinel, Kristen leads the scientific team that developed brewPAL, a rapid molecular test for the detection of beer spoilage organisms, in partnership with Victory Brewing Company. Kristen specializes in the development of quantitative assays to identify spoilage organisms and has successfully commercialized new technologies for data analysis. She earned her M.S. degree in biotechnology from Pennsylvania State University and a Ph.D. degree in molecular pharmacology and structural biology at Thomas Jefferson University. Kristen has extensive experience investigating viral and microbial pathogens and resistance mechanisms and previously designed inhibitors to mitigate the effects of these biological agents. She has numerous publications in the field of microbiology and host-pathogen interactions.

26. Optimizing the utilization of brewhouse resources through enhanced data visualization: Connecting operations from start to finish

K. A. KUHR (1); (1) PerkinElmer, Hamden, CT, U.S.A.

In order to optimize resource utilization, it is essential to understand how current brewing procedures affect statistics such as beer loss, brewing material efficiency (BME), and hop utilization. With the growth of countless craft breweries in the past few years and the soaring popularity of highly hopped beers, controlling these costs while refining ingredient balance has become increasingly important. Effectively tracking beer loss, BME, and hop usage can save money, preserve raw materials, and provide a competitive advantage. Through the systematic collection of data pertaining to material quantities used, barrelage, and process time at each brewing stage, these numbers can be simultaneously analyzed alongside laboratory results to provide a big-picture perspective on subtle shifts in brewing operations and the resulting impact on beer quality. This exploration was carried out using TIBCO Spotfire and data obtained from a regional craft brewery. Chemical and microbiological data were linked by brew number in order to track laboratory results through each of the following stages: wort, fermentation, ruh, centrifuge, finishing tanks and final packages. Both aggregated mean and individual results for each brew were analyzed to track haze, pH, color, bitterness units, alcohol by weight/volume, apparent extract, real extract, original gravity, specific gravity, and real degree of fermentation, along with cocci, gram negative and positive rod, mold, and yeast counts. Rules were implemented to automatically visualize brews that need immediate attention and those whose laboratory results fall within the designated standard range. Through this visualization capability, brewhouse employees and managers can observe how quantities such as pounds of extract, pounds of hops, barrelage, laboratory results and even taste panel feedback synergize to change overall beer quality. This feedback can then be used to implement or revise procedures that reflect these findings and utilize the optimum quantity of malts, hops, and extract, among other brewing materials, that meet a desired goal.

Kathryn Kuhr obtained a B.S. degree in chemistry and forensic science from the University of New Haven in 2014 and is currently pursuing an M.S. degree in business analytics from Quinnipiac University. Since 2014, Kathryn has been working for PerkinElmer as an analytics application developer.

27. Novel approach of a universal milling system considering any brewing grains and each mashing-in strategy and mash filtration system

T. BECHER (1), W. Karstens (1), K. Wasmuht (1); (1) Ziemann International GmbH, Ludwigsburg, Germany

In the past, at least three milling systems have established themselves in the brewing industry. Steep-conditioning mills, as well as dry-roller mills, are applied if mash filtration is subsequently done by a lauter tun. In the course of lautering by mash filters the grist is prepared by means of hammer mills. However, each type reveals several disadvantages. Steep-conditioning mills cause high maintenance costs for riffles. Dry-roller mills result either in higher investment costs or lower throughput. Hammer mills have high electricity consumption, and the installed engine power is huge. In addition, all these systems are tailored to treat only one or two different brewing grains. If more grains are used, further machines are necessary. In contrast, the novel approach of a universal milling system is presented, describing in which way sophisticated milling technology has recently been transferred from the agricultural sector to the brewing industry. This system was initially developed in pilot operation and adapted to the needs of the brewing process and its different raw materials. All kinds of grain were tested regarding their usability. Respective grist compositions were investigated if they met required specifications. Subsequent mash filtration was done either by lauter tun or mash filters. The results of the pilot operation are presented in detail. Furthermore, industrial-scale applications in the brewing industry are introduced. Beneficial results are described in terms of throughput, maintenance, power consumption, quality, and yield of mash filtration. The innovative aspects of the new milling system are as follows: compensation for current disadvantages, exceeding previous performances, and unique characteristic through flexibility concerning both upstream material flow and downstream brewing processes.

Tobias Becher graduated as a diploma engineer of brewing science and beverage technology in 2001 at the Technical University of Munich in Freising-Weihenstephan (Germany). He apprenticed as brewer and maltster before and worked afterward as process engineer for beer filtration systems. Later he worked as a technical consultant, especially for environmental issues in the German brewing sector. Since 2005 he has been employed by Ziemann, the well-known supplier of brewery equipment, as an expert in process engineering and brewing technology. Today, he is head of research and development within the Process Technology Division at Ziemann International GmbH in Ludwigsburg (Germany).

28. Surface forces and their effect on lautering

J. E. ENGSTLE (1), P. Först (1); (1) Technische Universität München, Chair of Process Engineering of Disperse Systems, Freising, Germany

Filtration performance of fine grain suspensions highly depends on surface force effects. Those forces (mostly electrostatic and van der Waals forces) can lead to changes in the structure of filter cakes. A higher porosity and, therefore, a higher permeability can be achieved, as well as a shift in compression behavior. Consequently measurements of filter cake resistance as a function of pH value or zeta potential are widely used in the filtration industry. In brewing science this perspective is mostly unfamiliar. Since the upper layer of the spent grain cake consists mainly of proteins and is the limiting factor for lautering performance, it is very likely that this layer is influenced by surface effects. This offers great potential for further improvements in the lautering process. Measurements are carried out to show the influence of surface effects depending on pH value and temperature on fine spent grain cakes. A filter cell is used to detect filter cake resistance. It can be shown that a higher temperature results in better cake permeability and that the pH optimum is 4. This explains both why acidification of mash results in faster lautering times and that a higher temperature lautering is not only beneficial due to a lower wort viscosity but due to structural changes in the spent grain cake.

Jörg Engstle studied brewing and beverage technology in Weihenstephan. He graduated in 2012 with an engineering diploma. Since then he has been working as a doctoral candidate at the Chair of Process Engineering of Disperse Systems in Weihenstephan. His field of work covers the mash separation process, mostly via lauter tun. He also works on procedural characterization of different hop products to enable a faster matching of dry-hopping equipment to different hop styles, types, and products.

29. Scaling and logistics rethought: Multi-function mash-tun, kettle, and whirlpool

D. SCHROEDER (1); (1) Simatec Impiantibirra, St. Louis, MO, U.S.A.

One of the most daunting and consequential questions a brewery can ask is, “How big should my brewhouse be?” An oversized brewhouse will output stagnant product and, in turn, cause an inability to pivot, customize, and experiment with smaller batches. A too small brewhouse transforms your success into a burden—equipment wear and labor skyrocket, while the relatively young brewery must embark on the process of upgrading the brewery: permits, construction, fundraising, scaling, and starting over from square one. Simatec Impiantibirra has patented two designs that allow for a pragmatic solution to this question. First, a whirlpool paddle that converts a kettle into a brewhouse. This paddle is unique in itself for its simple yet elegant design and for reducing hot-side aeration of the wort by eliminating an auxiliary pump. It also opens up possibilities for scaling. Our second patent is held regarding the modular brewhouse: because the kettle is multifunctional as a whirlpool and a mash tun, we can exponentially expand

the brewery with the existing tanks. Simatec can add 1, 2, or 3 multifunction tanks to the existing tank and lauter tun, stagger brews very closely together, yet retain the footprint and control of a small brewhouse. This opens up possibilities for the scaling of small brewhouses not only from the perspective of the brewer, who will wish to create smaller custom batches but also have the option to brew high volumes of popular brews, but also from the financial side, where choosing an undersized brewhouse can open up massive financial obstacles as the brewery grows.

David Schroeder is a professional in the beverage industry with a decade of experience in brewhouse operations, management, sales, and strategy. At his first microbrewery job in Austin, TX, the brewery experienced a 170% volume increase and he learned firsthand the challenges of training staff, scaling equipment and processes, and quality control of liquid produced. Since that time, he has been a student of different sectors of the beverage industry supply chain—from the Maillard Reaction in coffee roasting, to reducing sediment level and increasing shelf life of cold-brewed coffee, to the performance of sensitive raw materials in aromatics. His work with Simatec stems from his interest in bringing new technologies and rethought operation processes that save time, money, and ultimately make better beer.

30. Safe boiler operations

D. BAUGHMAN (1); (1) Allied Boiler & Supply, Inc., Murfreesboro, TN, U.S.A.

The boiler is a piece of equipment that has the potential to inflict death, injury, and/or destruction. Most personnel who operate boilers have not had any training and have no idea that it actually has more destructive power than dynamite. This seminar will present safe boiler operations in a manner that is easily understood. Several parts of actual boilers will be used and passed around during the class for participants to handle and observe. The seminar is invaluable in what it can accomplish, and that is to save a life.

Dave Baughman is the president of Allied Boiler & Supply, Inc. His dad started the company after coming home from WWII. Dave took over the company in 1984 after the passing of his dad. He is a member of MBAA District Mid-South and has presented safe boiler operations previously at their district meeting. He is one of the instructors at Allied's boiler school in Murfreesboro, TN, bringing his expertise in safe boiler operations to personnel from around the world. He is a sitting member of the State of Tennessee Boiler Rules Board.

31. CO₂ safety monitoring in breweries

J. PRINGLE (1); (1) CO₂ Meter, Inc., Ormond Beach, FL, U.S.A.

No matter the size of the brewing operation CO₂ concentrations are always an issue. CO₂ is a silent killer and can render an employee unconscious within seconds. Recent deaths and incidents around the United States and abroad speak to the gas' deadly nature, as well as the lack

of uniform regulations that govern its storage or production. When you have a combination of a highly lethal gas and the lack of clear oversight you have increased incident rates. Three areas of every brewery are most susceptible to CO₂ safety issues: at the CO₂ bulk storage tank, at the brite tank, and in cold storage. How is your facility accounting for the CO₂ you use? Do you actually know the concentration of the gas and how it would affect you and your employees? Does your facility meet the code? Do you even know if there is a local code? Precise detection and monitoring of CO₂ is a necessity for the health and safety of your staff. CO₂ leaks and deadly incidents have increased dramatically in the last few years. From brewing incidents to incidents in brewpubs and restaurants the gas is taking its toll. Even simple processes like doing the "sniff test" to see if your purge was successful can be a dangerous operation. In addition to wanting to monitor for safety, recent changes in some states and local codes to existing codes and regulations have brewers scrambling to conform rather than be shut down. This is as much a change in brewers' mindsets about safety as it is an education about the true nature of the gas. Is or will your facility be required by code to have monitoring devices? This abstract discusses the science of the CO₂ gas itself: what is it, why does it act the way it does, and how do I know it's there? We will also discuss the necessities for measuring the gas, the variety of options in monitoring, and how brewers can best detect and monitor for the gas in their operations. In addition, we will discuss recent code changes in some locations and how these changes affect brewers and other business segments.

Josh Pringle is the director of marketing and sales for CO₂ Meter, Inc. CO₂ Meter designs and manufactures gas detection and monitoring devices for the brewing and other industries. After receiving his B.S. degree from James Madison University, Josh worked for Costco Wholesale in purchasing for 10 years, including 5 years in the beer and wine group. Josh now lives in Ormond Beach, FL, with his wife Kim and his children Emma and Evan.

33. Methods for characterization of different hop products for dry hopping

J. E. ENGSTLE (1), A. Scheidel (1), P. Först (1); (1) Technische Universität München, Chair of Process Engineering of Disperse Systems, Freising, Germany

There are a lot of different approaches for dry hopping. One possibility is adding hops directly into the kettle, special devices are offered by manufacturers, and some breweries even design their own special apparatuses (torpedo, etc.). During this process several problems occur. One major problem is beer loss. To flush out hop sediments from the kettle breweries accept waste of up to one-third of tank volume. Other problems are the sedimentation of hops in the kettle or the dispersion of hop particles in dissolving devices (hop gun, torpedo, etc.). To grant a better understanding of these phenomena and to determine differences in hop types and breeds a procedural characterization is important. For this project reliable methods are necessary. Methods have been developed to measure sedimentation behavior, swelling-behavior, filter cake resistance, and other characteristic properties.

Jörg Engstle studied brewing and beverage technology in Weihenstephan. He graduated in 2012 with an engineering diploma. Since then he has been working as a doctoral candidate at the Chair of Process Engineering of Disperse Systems in Weihenstephan. His field of work covers the mash separation process, mostly via lauter tun. He also works on procedural characterization of different hop products to enable a faster matching of dry-hopping equipment to different hop styles, types, and products.

34. The behavior of linalool during beer aging

A. GAHR (1), A. Forster (2); (1) Hopfenveredlung St. Johann GmbH & Co. KG, Train-St. Johann, Germany; (2) HVG Hopfenverwertungsgenossenschaft e.G., Wolnzach, Germany

For some time there have been observations that hop aroma in bottled beer is subject to sensory changes upon aging. Linalool is considered one of the major hop aroma contributors, and contradictory information on the aging behavior of linalool can be found in the literature. As linalool is a chiral substance it occurs in two enantiomers R- and S-linalool. Most laboratories measure the total linalool content only, but there is a big difference in the aroma contribution of R- and S-linalools due to their different flavor thresholds in beer. GC data from several trial series were collected and evaluated to find out how linalool and its enantiomers behave during beer aging at different temperatures in late- and dry-hopped beers. While the S-linalool content increases, R-linalool decreases and the R-linalool ratio that typically makes up about 90% of the total linalool in fresh beers decreases as well. This may be one of the reasons for the change in hop aroma while beer ages.

Andreas Gahr was trained on the job as a brewer and maltster at the Augustiner Brewery, Munich, Germany. He received a brew master degree from the Technical University Munich-Weihenstephan in 1994 and worked for another four years at the university for the Chair of Brewing Technology I. Since 1998 Andreas has been the head of the Research Brewery St. Johann, which belongs to the hop processing company of Hopfenveredlung St. Johann GmbH & Co. KG and deals with all kinds of hop-related brewing trials and product development, as well as technological and raw material trials for suppliers and the whole brewing industry. In 2010 he received, along with his co-authors, the MBAA Inge Russel Best Paper Award.

35. Formation of humulinones in hops and hop pellets and its implication for dry-hopped beers

J. P. MAYE (1); (1) Hopsteiner, New York, NY, U.S.A.

Humulinones are formed by the oxidation of alpha-acids. Their detection in hops, hop pellets, and dry-hopped beers is relatively new. Humulinone formation in leaf hops and continued formation days after pelleting can occur in the absence of air. High-HSI hops have higher concentrations of humulinones than low-HSI hops and concentrations as

high as 0.2–0.5%, wt/wt, are typically found in hops and hop pellets. Humulinones have been measured in dry-hopped beers at concentrations as high as 24 ppm, and their bitterness has been reported to be 65% that of iso-alpha-acids. Because humulinones readily dissolve in beer they can impact the bitterness profile of dry-hopped beers.

John Paul Maye is technical director at Hopsteiner. He has more than 20 years of experience in the hop industry. He received his Ph.D. degree in organic chemistry at Purdue University in 1994 and started working as a hop chemist in 1993. He has published several papers on hops and has received several patents on hops and their applications inside and outside the brewing industry.

36. Barley production: Factors in crop management, business, and risk assessment growers utilize in planting decisions

S. EDWARDS (1); (1) North Dakota Barley Council, West Fargo, ND, U.S.A.

The downward trend in U.S. barley production since the mid-1980s suggests that growers have shifted production systems to more profitable crops. Advancements in genetic technology in corn and soybeans have allowed these crops to migrate into new production areas in the northern plains. This presentation analyzes the trend in U.S. barley production and provides an in-depth discussion regarding the decision factors growers utilize in crop enterprise selection (both in terms of crop management factors and business decision factors). The comparative risks of producing malting barley, spring wheat, corn, and soybeans are quantified and explained to provide a comprehensive overview of the interactive risk dynamics considered by growers in crop enterprise selection. The impact on malting barley procurement programs is outlined. Future considerations for malting barley procurement are addressed.

Steve Edwardson has served as executive administrator of the North Dakota Barley Council since 2004. Steve and the NDBC Board of Directors work together to develop markets for barley, improve risk management for barley producers, and conduct education in malt barley contracting and supply chain management, crop enterprise selection, and market intelligence. Steve served for 12 years as vice president of research and development for Minn-Dak Growers Ltd., a North Dakota specialty crop company that contracted and processed mustard, buckwheat, confection sunflowers, and safflower. Steve also served as commercial manager for Kings Inc. (a former division of Associated British Foods) and as a farm management specialist for the North Dakota State University Extension Service. Steve holds B.S. and M.S. degrees in agricultural mechanization from the Department of Agricultural Engineering at North Dakota State University. Steve was raised on a small grain and sunflower farm near Carrington, ND. He is the 2010 recipient of the Distinguished Alumni Award from the College of Agriculture, Food Systems, and Natural Resources at North Dakota State University.

37. The influence of the combination of malt and yeast on beer characteristics

S. Hideshima (1), Y. Hida (1), T. Maruhashi (1), A. SHIMMURA (1); (1) Suntory Beer Limited, Osaka, Japan

These days customers in Japan desire various types of beer, so it is necessary to meet customer demands by developing brewing processes. Beer can obtain various characters depending on the kind of malt and yeast, mashing procedure, fermentation process, and so on used, but focusing only on the kind of malt and yeast used can provide a clue to what kind of malt is compatible with certain yeasts, and it is important to know them. In this study, we investigated the influence of combinations of several types of malts and yeasts (three top-fermenting yeasts and three bottom-fermenting yeasts) mainly on beer sensory evaluation and Maillard reaction compounds. Both top- and bottom-fermenting yeasts were evaluated because their performance differs. In order to compare the differences of each feature, the mashing procedure was the same with every sample and designed so all the colors, etc. of the final products would be the same. As a result, we have made sure that the combination of malt and yeast exert great influence on beer flavor quality. In the presentation, we will discuss the analytic values associated with the sensory profile.

Anna Shimmura graduated from Osaka University with a master's degree in chemical engineering in 2014. After joining Suntory, she worked for a year in the Beer Development Department of Suntory Beer Limited.

38. Specialty malt acidity

R. Hansen (1), J. GEURTS; (1) Briess Malt & Ingredients Co., Chilton, WI, U.S.A.

Mash pH is a factor that influences enzyme activity, yeast health, solubility of compounds, clarity, and the flavor of finished beer. Historically, in certain beer styles, the mash pH was sometimes manipulated by adjusting the grain bill with specialty malts of varying colors and acidities to achieve a desired target pH. This talk discusses the numerous factors affecting titratable acidity of specialty malts including: production method, resulting malt color, barley variety, malting location, and maltster. Our study evaluated the relative importance of these factors and their relationship to mash pH for a variety of samples with the aim of giving brewers a better quantitative feel for the effect specific malt types can have on mash pH. A strong relationship between mash pH and measured malt color was found. Barley variety, malting location, and malting company showed a smaller and more variable effect.

Jordon Geurtz has a B.S. degree in biology from the University of Wisconsin and worked for the USDA Cereal Crops Research Unit in small scale malting and malt analysis. He currently works for Briess Malting and Ingredients in Technical Services.

39. New wastewater treatment technology for breweries

J. Fox (1), A. WRIGHT (1); (1) ClearCove Systems, Rochester, NY, U.S.A.

One of the greatest challenges facing breweries today, both new and established, is the treatment and disposal of wastewater. Municipalities often impose surcharges on the organics a facility discharges into the sewer, which can place a significant financial burden on breweries. With aging infrastructures and municipalities' increased need for additional revenue it is likely these surcharges will continue and potentially increase. Conventional activated sludge treatment that has been utilized at breweries is expensive, consumes a great deal of energy, and requires a high degree of operations and maintenance. To address this challenge, ClearCove Systems has developed a game-changing patent-pending technology solution that removes the majority of organics from wastewater prior to it being discharged into the sewer or environment, significantly reducing or even eliminating surcharges. The ClearCove solution is a physical/chemical process that simply and reliably removes the majority of solids (TSS) and organics (BOD) from the wastewater, while also adjusting pH. The ClearCove solution can be combined with a membrane filtration unit to remove 100% of the BOD and produce reuse quality water to drive down brewery operation costs even further. This presentation will cover an introduction to the technology, as well as the performance results of a feasibility study performed at Saranac Brewery and an installation at Neighborhood Beer Company, a new start-up craft brewery in New Hampshire.

Alex Wright has worked for ClearCove Systems in a number of roles, including sales, marketing, and operations, since the company's inception in 2012. Alex currently supports the business development teams for both the food and beverage and municipal efforts of the company and is the project manager for the company's NYSERDA funded demonstration projects. Alex graduated in 2012 from Northeastern University with a degree in economics.

40. Financial and process design tools applied to brewery effluent treatment

J. JURADO (1); (1) Abita Brewing Company, Abita Springs, LA, U.S.A.

Increasingly, environmental concerns and pressure from within brewery leadership and from beer consumers have brought us to include environmental sustainability into our planning framework. Over the course of this presentation, we'll apply familiar and simple tools from differential equations, lifecycle analysis of engineering economics, and chemical process design for decisions on effluent generated across the brewery, focusing a derivation of maximum benefit, while returning this same effluent to a clean state suitable for return to the environment.

Jaime Jurado serves as director of brewing at Abita Brewing Company on the beautiful shores of Lake Pontchartrain. He was president of the Master Brewers Association of the Americas in 2005, prior to which he served as chair of

the MBAA Technical Quarterly Editorial Board. His B.S. degree is in chemical engineering, and his M.S. degree is in electrical engineering; he completed the requirements for full candidacy in a Ph.D. degree in engineering at Oxford University, but departed upon completion of 26 months and several publications, with a wholly unofficial M. Croquet (Hons.) from Magdalen College. An opportunity to commission a state-of-the-art brewery in Rajasthan was where he went next. He served a brewing apprenticeship at Patrizier-Brau AG breweries in Bavaria in 1983 and worked his way through the brewing hierarchy from project engineer at breweries in the United Kingdom and Ireland to master brewer at The Lion Brewery in Wilkes-Barre, PA. He also worked for Stroh Brewery Co. (Detroit, MI, headquarters) in corporate brewing. He next became director of brewing operations for 15 years at The Gambrinus Company breweries, then took an 18-month sabbatical to design, procure, and commission a new brewery in Pennsylvania, where he implemented novel technologies and approaches focused on resource conservation at every place that beer was touched in the \$5.5 million CapEx investment. Abita Brewing has a long history of resource optimization under its president, David Blossman.

41. High-rate anaerobic digester systems for brewery wastewater treatment and electricity generation:

System commissioning and start-up

M. H. FARHAN (1), Y. Farhan (1); (1) EMG International, LLC, Media, PA, U.S.A.

Craft brewers are passionate about making a positive impact on the brewing industry through innovation and creativity in developing new products for a diverse and growing consumer base. But, their commitment to making a positive impact isn't limited to the brewing industry. Most craft brewers are also dedicated to having a positive impact on their local communities and beyond with an emphasis on sustainable brewing methods and a commitment to minimizing their carbon footprint and overall impact on the environment. Despite significant improvements over the past 20 years in water consumption, wastewater treatment and disposal, remains a major issue affecting most breweries, with negative environmental impacts and considerable economic cost. As breweries have sought the best solutions for wastewater treatment, many have turned to digester systems, such as high-rate anaerobic digesters, for organics removal and energy generation. One of the leading systems in this category is anaerobic fluidized bed digester (AFBD) technology with electricity generation and waste heat recovery. This system offers breweries an innovative high-rate wastewater treatment system that can provide significant cost savings, revenue from renewable electricity generation, and have a positive environmental impact through reduction of the overall brewery carbon footprint. Following equipment fabrication and installation, digester system commissioning and start-up are critical tasks that require detailed attention and proper execution. This paper discusses commissioning and start-up of high-rate digester systems using an approach that keeps the start-up on schedule and supports efficient and successful long-term system operation. Digester system commissioning and shake-

down task work discussed in this paper address major and ancillary system pumps, flow equalization, solids removal, chemical and nutrient feed systems, instruments required for process monitoring and control, biogas collection and conditioning system, flare unit, gen-set unit, combined heat and power (CHP) recovery system, programmable logic controller (PLC) unit, supervisory control and data acquisition (SCADA) unit, and required plant utilities for digester system operation. The digester system start-up process discussed in this paper includes digester seeding, wastewater introduction, monitoring and controlling critical environmental conditions for the digestion process, increasing digester organic loading rate to design levels, and system performance trend analysis. This paper provides a detailed review of system commissioning and start-up work recently completed for a high-rate anaerobic digester system at the Bell's Brewery in Galesburg, MI, as a case study, including system start-up performance data leading to steady-state long-term operation under design conditions.

Manaf H. Farhan is the president and CEO of EMG International based in Media, PA. He holds a B.S. degree in civil engineering from the University of Notre Dame, a M.S. degree in environmental engineering from Columbia University, and M.S. and Ph.D. degrees in systems engineering from the University of Pennsylvania. He is a licensed professional engineer. His doctoral research focused on design and optimization of various anaerobic digester processes to maximize process efficiency and biogas production. He has authored several peer-reviewed articles on anaerobic digestion and has served as an adjunct professor in the Department of Electrical and Systems Engineering at the University of Pennsylvania. He has more than 20 years of experience providing a wide range of environmental engineering design and consulting services to private industry and governmental clients. His professional experience includes design and construction of digester systems for wastewater treatment and biogas and electricity generation for food and beverage facilities and for dairy farms; technical evaluation, process modifications, and operational support for various full-scale anaerobic digester installations; development and testing of bench- and pilot-scale wastewater treatment systems; pollution prevention and wastewater minimization audits; and biogas collection, clean-up, and utilization.

42. Observations on sustainability

L. SMITH (1); (1) Ecolab Food & Beverage, St. Paul, MN, U.S.A.

Most conference attendees won't need any convincing that sustainable business initiatives are important, because most of you have already seen the light. Take this piece as an encouraging cheer that you're on the right path, and that there's hope for the ones who criticize you for being responsible. I've worked in the food and beverage industry long enough to witness an amazing renaissance both personally and professionally, with regard to how things are done. When I started working here, I was a card-carrying member of the "I'm not a tree hugger" clan of non-environmentalists. When the tides began to turn,

and the winds shifted toward developing environmentally responsible ways to keep industrial sites pest-free, clean, and sanitary, I was one of the people in the back of the room complaining that the government was taking away all of the chemicals that worked. Change was difficult for me, and even though I had many friends who were successfully drafting their own sustainability stories, I lagged behind. I didn't believe it, and I wouldn't change my mind without compelling evidence. When I finally accepted the importance of adopting best practices with an eye on the future, it became obvious that making that difference meant a commitment to economic, environmental, safety, and social principles and making a difference by moving the needle in the right direction. The goals of environmental stewardship are to preserve natural systems, and, when possible, to improve soil, water, and air quality. We must all participate in these efforts and promote stewardship of natural resources and protect the environment.

Lee Smith works for Ecolab Food and Beverage as an account manager and has nearly two decades of experience in their industrial and service businesses. In his spare time he's also the director of a food pantry program that is a USDA Partner Agency, distributing commodity foods to those in need. Lee is always looking for creative ways to make things safer, more sustainable, better, faster, and cleaner. Look him up on LinkedIn and Connect!

43. Beer fermentative flavor visualization by principal component analysis

X. ZHAO (1), B. Sacher (1), S. Procopio (1), T. Becker (1); (1) Lehrstuhl für Brau- und Getränketechnologie, Freising, Germany

Glycerol and major fermentative flavors, which originate from yeast metabolism, exert the greatest impacts on the beer sensory profile. In the current investigation, we aimed to visualize the differences in fermentative flavors in various beers by principal component analysis (PCA). Furthermore, to identify the major variance of fermentative flavors within the beers 20 alcohol-free beers (AFB) produced from thermal dealcoholization, stop fermentation, and dialysis membrane and 17 of their alcoholic counterparts were kindly provided by 15 breweries in Germany. Glycerol, higher alcohols (HA), esters (ES), dimethyl sulfide (DMS), acetaldehyde, and vicinal diketones (VDK, including diacetyl and 2,3-pentanedione) were analyzed by photospectroscopy and gas chromatography. PCA was performed on the abovementioned flavors together with alcohol content, extract, pH, and viscosity. The first two principal components (PC1 and PC2), which accounted for 93% of overall flavor variances, were scattered for the 37 beers. The AFBs and the alcoholic beers clustered separately, while wheat beer and bottom-fermented beer showed no specific pattern. Nevertheless, glycerol appeared as an important attribute for AFBs produced from different production methods, whereas the thermal dealcoholization AFBs had the highest level in general. Surprisingly, HA, but not alcohol content, was identified as the major variance source, followed by ES, DMS, viscosity, glycerol, acetaldehyde, diacetyl, VDK, pH, and extract between AFBs and their counterparts. Our results further confirm that

one major problem encountered by AFBs is lack of fruity flavors. Furthermore, PCA was proved as a useful method for visualizing the flavor profile of beers.

Xiangdong Zhao is currently working at TU München on her doctoral degree, with a scholarship provided by the China Scholarship Council (CSC). The research interests of Xiangdong include the sensory contribution of glycerol to beers and the flavor characters of alcohol-free beers; the increase in fermentative glycerol yield by screening of strains; and the optimization of fermentation parameters aided by a high throughput screening (HTS) system. Xiangdong worked in the application of infrared spectroscopy on food for her master's degree at Zhejiang University.

44. Formation of dimethyl sulfide during beer storage via bisulfite reduction of dimethyl sulfoxide

M. BALDUS (1); (1) Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Brewing and Beverage Technology, Berlin, Germany

Dimethyl sulfide (DMS) is of considerable importance to beer owing to its unpleasant flavor and aroma impressions. Packaged beer still contains considerable amounts of the DMS-precursor dimethyl sulfoxide (DMSO), as well as numerous reducing substances like sulfite or thiols. In this study we are able to demonstrate that bisulfite reduces DMSO, resulting in rising DMS levels. At first kinetic investigations were conducted in sodium acetate/acetic acid buffer solutions containing 5% (vol/vol) ethanol with varying pH and concentration ratios of reactants. DMS and DMSO levels were analyzed by GC-PFPD; sulfite concentrations were determined using continuous flow analysis. In beer representative excess of sulfite in relation to the DMSO reduction follows pseudo first-order kinetics. The reaction favors low pH, which is assumed to be related to higher DMSO protonation and easier nucleophilic attack at bisulfite anion. The mechanism was further verified in beer by storage trials at 28°C. Significant DMS formation and concomitant DMSO decrease was observed, likewise especially when the decline of sulfite was minimized using educt spiking under inert atmosphere and crown corks containing oxygen scavengers. Moreover, the thiols L-glutathione and L-cysteine reduced DMSO, resulting in DMS formation as well, whereas in a range lower than bisulfite reduction. In conclusion a reaction mechanism of the sulfite-mediated DMSO reduction and its relevance for DMS formation in beer is highlighted and discussed.

Matthias Baldus works as a scientific assistant at the Technical University of Berlin at the Chair of Brewing Science led by Professor Frank-Juergen Methner. He apprenticed as a brewer and maltster at a middle-sized brewery in western Germany before studying biotechnology and brewing technology. During that time Matthias investigated grist fractionation methods to optimize the lautering process. Moreover, he evaluated thermal desorption processes to optimize volatilization of undesired aroma compounds. Matthias is currently working on his Ph.D. degree, which is focused on sulfuric substances in the brewing process, especially on DMS and its precursors. In addition, he is working on optimization techniques for the brewhouse process.

45. Using the Brix/TA ratio to determine sensory perception in sour beers

K. M. TAYLOR (1); (1) White Labs, San Diego, CA, U.S.A.

As sour beers become more popular, the most common trend is becoming the more sour the better. The most common practice to estimate the sourness of a beer is pH and sensory perception. Measuring sourness by titratable acidity (TA) is a better indicator in relation to sensory perception. Because of this, the use of TA testing of beer has become more popular. Measuring TA is very popular in wineries to understand the acidity of the beer and relates better to sensory perception than pH. Wineries also use the Brix/TA ratio to determine sensory attributes. Using the Brix/TA ratio in sour beers can help predict the level of sourness perceived by the customer. Using a trained sensory panel and many sessions of sour tastings in combination with the Brix/TA ratio we are able to correlate the ratio to the sour ratings. This correlation can then be used to estimate the perception of how sour a beer is.

Kara Taylor has been with White Labs since 2009. She became interested in fermentation science while home brewing during her days at Loyola Marymount University. She received a B.S. degree in biology in 2009 and began employment at White Labs in San Diego, CA, as a yeast laboratory technician. Since January 2014, she has functioned as the analytical laboratory manager. Kara is a member of MBAA and the American Society of Brewing Chemists.

46. Bringing modern science into flavor analysis

N. GARNEAU (1); (1) Flavor Lab, LLC, Denver, CO, U.S.A.

Members of the ASBC Sensory Subcommittee have produced an updated model for describing beer flavor that is scientifically aligned with the sensory research of the last three decades and accounts for new complexities in brewing science. The authors here validated, updated, and recategorized the flavor-active chemicals catalogued in the ASBC Beer and Hop Flavor Databases into a format consistent with the original Beer Flavor Wheel, with primary, secondary, tertiary, and quaternary levels that grow in complexity. Nevertheless, a two-dimensional model remains an insufficient format for making this information actionable; to address this problem, the information has been restructured to allow for the easy transmission of vital information like attribute origin, threshold level, and reference. For the first time, the entire picture can be accessed with the click of a button, giving the user the ability to utilize the information as a multidimensional training and troubleshooting tool. The app displays a computer-generated, graphic representation of the flavor wheel with links to the ASBC Beer and Hop Flavor Databases. By providing both graphic and text search functionality it allows users to dive deeper into beer flavor.

Nicole Garneau is a human geneticist in sensory science. Her research interests include determining the way a person's DNA affects their ability to taste, the interplay of the different senses in flavor perception, and the complex

interaction of food and beer pairings. Nicole serves on the Sensory Subcommittee of the American Society of Brewing Chemists, the Food and Beer Working Group, and the Advisory Board for the Fermentation Science Program at Colorado State University and cofounded the Flavor Lab, LLC. When she's not in the lab, or collaborating on sensory science in the beer industry, she's dropping science gems online as @yoppearlscigirl and at www.drnicolegarneau.com.

47. A low-cost, self-contained, and low-attention wastewater BOD5 reduction technology for breweries

S. J. BURY (1), J. Carlock (2), S. J. Gluck (2), J. Earnest (3), B. Wagner (3); (1) The Dow Chemical Company, Midland, MI, U.S.A.; (2) The Dow Chemical Company, Freeport, TX, U.S.A.; (3) Saint Arnold Brewing Company, Houston, TX, U.S.A.

Brewery wastewater discharge to publicly owned water treatment plants for BOD5 removal can be a significant primary cost for a brewery. The foreseeable trend is for these external treatment charges to increase coupled with stricter regulations and discharge limits that may force a brewery to curtail production or adopt an expensive in-house treatment. Indeed, production and sewer charge data compiled at many sites across the United States suggest that some areas with existing breweries have more costly fees than others. With the rapid growth of craft brewing, demand for simple systems to manage BOD5 discharge is growing and outpacing sewage treatment capacity. Therefore, to meet this growing need, a low-maintenance, easy-to-operate system for BOD5 removal is essential for economic and environmental sustainability. Recently we completed an intensive pilot study at Saint Arnold Brewing Company in Houston, TX, of such a wastewater treatment technology to quantify the BOD5 removal from the discharged wastewater. The unit consists of a holding tank, a pump for recycling from the tank, and an aboveground, passively aerated, attached growth biofilter. The skill set required to install and operate such a system exists within the maintenance staff of any craft brewer. The study consisted of 37 batches over 1,400 hr, including 3 detailed 24 hr studies collecting hourly BOD5 and TOC data. The unit was operated 24/7 in an unattended mode except for the batch changeovers and sampling. The feed stream was highly variable in organic content. We pulled each batch charge directly from the wastewater discharge line and did not employ equalization, as would occur in a permanent installation. Consequently the brewhouse operating schedule strongly influenced the wastewater pulled for each batch. In spite of the high variability, the system was extremely robust. Operating data and the configuration employed consistently achieved greater than 80% TOC and greater than 90% BOD5 removal. Batches that had lower removal were nitrogen limited. The detailed studies of the performance of the unit under a range of loadings from a low at 300 ppm BOD5 to a high at 5,200 ppm BOD5 demonstrated robust performance, even with uncontrolled pH, and dissolved oxygen demonstrating greater than 95% BOD5 removal. The results of this 2 month study indicate that this technology can be a low-cost solution for on-site treatment of brewery wastewater. We will present further analysis of the pilot data and examples of designs, capital, and operating expense estimates for different brewery sizes.

Scott J. Bury is a principal research scientist in the Process Optimization group of The Dow Chemical Company's Engineering Sciences organization within Core R&D. He received his B.S. degree in biology/biotechnology from WPI and his Ph.D. degree in chemical engineering from Rice University. His research interests include process simulation and optimization of biological and chemical processes, using both continuous and discrete event technology and eliminating failure modes when implementing new process technology. He is an expert in wastewater treatment.

48. Modification of existing digester systems at breweries to handle overloading and production growth

M. H. FARHAN (1), Y. Farhan (1); (1) EMG International, LLC, Media, PA, U.S.A.

An increasing number of breweries rely on anaerobic digester systems for wastewater treatment and reduction of sewer surcharge fees. Over the past 10 years, the craft brewing industry has experienced sustained growth rates, with some breweries increasing production multiple folds. This has caused a significant increase in wastewater generation rates and overloading of existing digester systems. This paper presents a systematic approach to evaluating digester system performance, identifying and correcting factors that result in inefficient digester operation, and optimizing existing digester system performance to handle overloading and production growth to the extent feasible. In addition, design and implementation of biogas handling, electricity generation and waste heat recovery systems, as well as design considerations for new anaerobic digester systems for brewery wastewater treatment will be discussed. More specifically, this paper addresses the following topics: a description of the anaerobic digestion process; established degradation pathways for digesting organic compounds produced by brewing operations; required environmental factors for optimizing the anaerobic digestion process; sampling and analytical methods to evaluate digester system performance; typical indicators of an overloaded, stressed, or unbalanced digestion process; engineering modifications for improving existing digester system performance and maximizing organic loading rate (OLR) capacity; general guidelines for design and implementation of biogas handling, electricity generation, and waste heat recovery systems; and design considerations for new anaerobic digester systems for brewery wastewater treatment, including system sizing and accounting for production growth, organic load capture, flow equalization, solids handling, and system monitoring and control. This presentation is based on related project work completed at three leading breweries in Pennsylvania, New York, and Michigan with operational anaerobic digester systems and electricity generation and waste heat recovery systems.

Manaf H. Farhan is the president and CEO of EMG International based in Media, PA. He holds a B.S. degree in civil engineering from the University of Notre Dame, a M.S. degree in environmental engineering from Columbia University, and M.S. and Ph.D. degrees in systems engineering from the University of Pennsylvania. He is a licensed professional engineer. His doctoral research

focused on design and optimization of various anaerobic digester processes to maximize process efficiency and biogas production. He has authored several peer-reviewed articles on anaerobic digestion and has served as an adjunct professor in the Department of Electrical and Systems Engineering at the University of Pennsylvania. He has more than 20 years of experience providing a wide range of environmental engineering design and consulting services to private industry and governmental clients. His professional experience includes design and construction of digester systems for wastewater treatment and biogas and electricity generation for food and beverage facilities and for dairy farms; technical evaluation, process modifications, and operational support for various full-scale anaerobic digester installations; development and testing of bench- and pilot-scale wastewater treatment systems; pollution prevention and wastewater minimization audits; and biogas collection, clean-up, and utilization.

49. Biogas energy applications that can reduce organic wastes and positively impact your brewery's sustainability goals

J. M. VAN VOORHIS (1); (1) Symbiont Science, Engineering and Construction, Inc., Milwaukee, WI, U.S.A.

This presentation will discuss biogas energy use applications and the positive sustainability impacts that can be achieved in association with utilizing brewery wastewater streams and other organic brewery wastes to produce "green" renewable energy via anaerobic digestion. Anaerobic digestion has been used for decades by wastewater treatment facilities and various industries to offset a portion of their energy use. Today, with increased energy costs and the desire to achieve higher sustainability thresholds, breweries and other industries are taking a second look at approaches to achieve these goals. Biogas can be used in a variety of ways to potentially create a high value use for a brewery operation. Biogas can be used for electricity generation, such as in the case of internal combustion (IC) engines, microturbines, or for boiler fuel in process heating or in combined heat and power (CHP) generation. However, there are other potential biogas energy applications, such as for powering fuel cells that produce electricity and waste heat that can be captured for secondary brewery thermal process uses. Biogas is also now being converted into renewable natural gas (RNG) for fueling truck fleets, and these users can achieve considerable savings over diesel fuel. Both fuel cells and RNG represent more recent applications that can be a potentially economically attractive option. This presentation will discuss these various biogas energy approaches, economic factors and system efficiencies, optimization aspects of using internally generated organic wastes for anaerobic digestion, and sustainability impacts that include the brewery's supply chain. In addition, other potential scenarios will be outlined that can be integrated to reduce overall water usage and/or water reuse that would have additional positive sustainability impacts. In summary, a brewery that put its waste to work can potentially help achieve substantial benefits from an economic standpoint, increase its energy independence, and help meet its overall sustainability goals.

Jeff Van Voorhis has more than 18 years of experience in wastewater treatment for the food and beverage industries. He has served as the project manager for a variety of large- and small-scale projects. He is experienced in all phases of wastewater treatment projects, from wastewater characterization and permitting through design, construction, and start-up. Jeff also incorporates renewable energy utilization into his projects whenever feasible. He received his B.S. degree in civil engineering (environmental emphasis) from Purdue University and his MBA from Marquette University.

50. Practical primary water treatment for breweries

M. HENK (1), W. Byrne (2); (1) U.S. Water Services, Inc., Saint Michael, MN, U.S.A.; (2) Company for Educational Advancement, Wayzata, MN, U.S.A.

Primary water quality has a direct impact on the brewing process and taste of the final product. There are a multitude of options available to provide consistent water quality for sustainable operations. Water treatment operations impact power and water consumption, chemistry/mineral content, and disinfection/disinfection by-products of the resulting primary water. This paper will discuss the technology behind the various treatment methods and their practical application. Best practices for water treatment operations to ensure sustainable operations will be covered along with advantages and disadvantages of the common treatment methods. Water treatment unit operations such as carbon filtration, reverse osmosis, softening, and ultraviolet light systems will be discussed. Disinfection technologies discussed will include ozone, chlorine dioxide, and hypochlorite.

Michael Henk has 15 years of experience in the engineering, design, commissioning, and ongoing maintenance and support of a wide range of water treatment equipment and programs. He obtained a B.S. degree in chemical engineering from the University of Pittsburgh. Michael is currently the strategic business leader for equipment service and automation at U.S. Water Services, Inc., where he develops service programs for water treatment applications and manages a team of technology developers to support field service operations. Michael is a member of the MBAA Sustainability Committee and is an avid home brewer.

51. Developing a screening system for the brewing ability of non-*Saccharomyces* yeasts

M. MICHEL (1), F. Jacob (1), M. Hutzler (1); (1) Research Center Weihenstephan for Brewing and Food quality, TU München, Freising, Germany

The brewing sector is ruled by *Saccharomyces* species. Besides spontaneous fermentation, there is very little use of non-*Saccharomyces* yeasts all around the beer industry. There are approximately 670,000 species of yeasts in different habitats, where of only 20 species are being used for industrial needs. The possibility of a lot of new aroma compounds produced by this huge variety of yeasts is unimaginable. To make use of this big field of unknown species, aromas, and maybe new aspects of taste

or functionalities for more mouthfeel or higher pressure-resistant yeasts, a screening system is being developed. The screening system includes preliminary biochemical tests to make sure the investigated yeasts can survive in beer wort and, of course, ferment it. This includes the carbohydrate fermentation of wort sugars, hop resistance, and ethanol resistance, as well as different combinations. It is continuous with the propagation ability and flocculation behavior, as well as different brewing trials with the observation of all important beer characteristics. It also includes precursor tests for phenolic off-flavors by sensory evaluations. The further goal is to improve the fermentation ability and special flavor forming of the curtain yeasts found to be feasible for brewing. A bioflavoring for new tastes in beer, as well as new beer types, are being looked for. First trials were done with 12 different *Torulaspora delbrueckii* and 12 different *Hanseniaspora uvarum* strains from various habitats like the wine and cheese industries, as well as spontaneous banana wine fermentations. These yeasts have already been used in the wine industry for more fruitiness in certain wines. There has been very little effort to produce beer. The tests and trials show large differences in just one species when it came to sugar fermentation and ethanol formation as well as flavors. The flavor varies from honey-like to pear- or apple-like fresh fruitiness. The brewing ability seems to be present. More yeast strains are being looked at from different spontaneous fermented beverages around the world as well as spoilage yeasts. The screening system is being updated constantly to improve the finding of new yeasts for the brewing industry.

*Maximilian Michel finished his studies in brewing and beverage technology with a Dipl.-Ing. degree from TU München in 2014. He wrote his diploma thesis on heat resistance of beer spoilage bacteria. He then started a Ph.D. program at the Research Center Weihenstephan for Brewing and Food Quality, TU München with the aim of developing a screening system for non-*Saccharomyces* yeasts for the beer industry. He also works as a counselor for breweries at the Research Center Weihenstephan.*

54. Recovering beer from yeast in a large craft brewery using a ceramic membrane cross-flow system with a novel membrane design

D. SCHLEEF (1), J. Grosser (2), R. Villas (3); (1) Pall Food and Beverage, Port Washington, NY, U.S.A.; (2) Stone Brewing Company, Escondido, CA, U.S.A.; (3) Pall Corporation, San Paulo, Brazil

Surplus yeast from the brewing process can contain a significant amount of beer that can be recovered and reintroduced into the brewing process. Depending on the brewing process and the dry matter of the harvested yeast, up to a 5% beer recovery or improvement of yield can be achieved. Ceramic membrane cross-flow systems have been used for more than 20 years to recover beer from yeast in the brewing process. These systems have been primarily utilized at breweries producing 1 million hL/year or more due to the relatively large system installation that was required to achieve an acceptable return on investment. Traditionally these systems were designed to recover beer from a mixture of yeast from multiple brands in a batch process, with

recovered beer being added back into lower value brands. Craft brewers, on the other hand, are faced with a wide variety of beer styles across many brands. Depending on the beer type the recovered beers from surplus yeast require the return directly back into the source tank rather than blending a “composite” beer downstream or upstream that can be used in all brands. A direct return is only possible with a system that operates in continuous mode. Thus, the harvested yeast is directly processed and the recovered beer returned to the original tank. Furthermore, craft brewers tend to create more excess yeast and, therefore, more recoverable beer, due to the brewery design and product mix of the brewery. To solve this challenge, a new membrane design with double the surface area of traditional membranes was evaluated at Stone Brewing Company for both economic viability and organoleptic quality of the filtrate. This was achieved by using a full-scale pilot skid designed and operated by Pall Corporation, with beer analysis performed by Stone Brewing Company. Implementing this new design proved that it is technically and economically viable to design a system for recovering beer from excess yeast in a continuous manner that can reduce the extract loss of a craft brewery by 5% or more.

David Schleef has worked for more than 20 years for both small and large breweries and as a supplier to the brewing industry. After earning a diplom braumeister degree (diploma master brewer) from the Technical University of Munich-Weihenstephan in 1997, he commissioned and ran several start-up craft breweries on the West Coast, as well as working for Miller Brewing Company as a quality engineer. Since 2005 he has worked in numerous roles in the Food and Beverage Division of Pall Corporation, including his current role as brewing business development manager for North America, developing filtration and lab solutions for the brewing industry. He currently lives with his family in Oregon City, OR, and enjoys the outdoors, as well as traveling the world.

55. Succeeding of fines in spent grain cakes—Truth or legend?

J. E. ENGSTLE (1), P. Först (1); (1) Technische Universität München, Chair of Process Engineering of Disperse Systems, Freising, Germany

Blocking behavior of spent grain cakes during lautering is a common problem in the brewing community. To prevent blocking, raking knives are used. The standard view is that fine particles are succeeding in the cake toward the false bottom and, thereby, block pores in the cake. This leads to a blocking behavior of the whole cake. But is this true? Recent work showed that there is no particulate movement relative to the cake at all. Therefore, we have to reconsider our picture of the lautering process. Data supporting the finding that there is no particulate movement is shown.

Jörg Engstle studied brewing and beverage technology in Weihenstephan. He graduated in 2012 with an engineering diploma. Since then he has been working as a doctoral candidate at the Chair of Process Engineering of Disperse Systems in Weihenstephan. His field of work covers the mash separation process, mostly via lauter tun. He also works

on procedural characterization of different hop products to enable a faster matching of dry-hopping equipment to different hop styles, types, and products.

56. Reduction of hot-side aeration by way of a whirlpool paddle in a kettle

D. SCHROEDER (1); (1) Simatec Impiantibirra, St. Louis, MO, U.S.A.

Hot-side aeration is one of the most difficult by-products to detect and reduce in the brewhouse. Simatec is working with a Ph.D. student at the University of Turin to effectively measure oxidation during brewing. Simatec has three patented technologies. One is the paddle placed in the kettle that, by way of an inverter motor, turns the kettle into a working whirlpool. The paddle first rotates clockwise, with in-line wings that rest on grooves at 45°, promoting a vigorous boil to help boil off dimethyl-sulfide. Once boil is complete, an inverter below the tank spins the paddle in the opposite direction, where the wings lay flat in set grooves at 0°. At this point, heavier particles have already fallen to the bottom, but slightly lighter particles remain in suspension. There is zero agitation during whirlpool. At the end of whirlpool, particles in suspension fall out to the trub bed. This system offers several advantages for the brewer: first, whirlpool is started instantaneously, without the time taken to introduce wort to another tank. Second, whirlpool is not created by use of an auxiliary pump that agitates and aerates the wort. Finally, this allows the kettle to become a multifunction tank, allowing the brewery to scale with additional tanks without scrapping the initial brewhouse or starting from scratch.

David Schroeder is a professional in the beverage industry with a decade of experience in brewhouse operations, management, sales, and strategy. At his first microbrewery job in Austin, TX, the brewery experienced a 170% volume increase and he learned firsthand the challenges of training staff, scaling equipment and processes, and quality control of liquid produced. Since that time, he has been a student of different sectors of the beverage industry supply chain—from the Maillard Reaction in coffee roasting, to reducing sediment level and increasing shelf life of cold-brewed coffee, to the performance of sensitive raw materials in aromatics. His work with Simatec stems from his interest in bringing new technologies and rethought operation processes that save time, money, and ultimately make better beer.

57. The importance of cleanliness—An overview of CIP and COP systems

T. Rausch (1), M. Cartee (1), A. SPROWL (1); (1) M.G. Newell Corp., Greensboro, NC, U.S.A.

Sanitary equipment design is defined as the engineered design of handling, processing, storage facilities, and equipment to create a sanitary processing environment in which to produce pure, uncontaminated, high-quality products consistently, reliably, and economically. The universal guideline that is most useful to the food and beverage industry in this regard is “Good Manufacturing Practices” (21 CFR, Part 110, Sec. 110.40). To meet this

cleaning standard or any other standard, clean-in-place (CIP) and clean-out-of-place (COP) systems are used. CIP is the process of cleaning equipment, vessels, fittings, and pipes without dismantling. The process circulates cleaning solutions and sanitizers through tanks and other equipment to eliminate built-up scale, bacteria, and other chemicals and residues. Each stage of the CIP cycle requires a specific length of time, temperature, flow, velocity, and concentration of detergent. The challenge is that to remove soils, CIP solutions must reach the surface and soil to have an effect. COP systems are used to clean equipment parts and components. They provide consistent, repeatable cleaning with reduced chemical and water usage, less labor, and faster cleaning than hand washing. COP is typically used for pump rotors, impellers, cases, hoses, tubing, fittings, gaskets, and any other handling equipment.

Aaron Sprowl graduated from the University of Kentucky in 2002 with a B.S. degree in mechanical engineering. After graduation, he worked for RWS Design & Controls as a controls engineer. He then took over the role of senior project engineer at Ralcorp Frozen Bakery. After Ralcorp, he worked for Dean Foods in their Athens, TN, facility and then in their Louisville, KY, facility, where he was a plant engineer and maintenance manager. In early 2015, he brought his 12 years of experience in food and beverages to M.G. Newell. He now works as a project engineer in their Louisville, KY, office.

58. Real-time PCR: A multipurpose tool to increase quality of craft beer

M. FANDKE (1);(1) BIOTECON Diagnostics GmbH, Potsdam, Germany

BIOTECON Diagnostics real-time PCR Kits specifically amplify and detect the smallest quantities of DNA of microorganisms that are important in (craft) breweries. The information gained can be used to increase the quality of craft beers, optimize sanitation procedures, and increase awareness and knowledge of the present microorganisms. Breweries can use the foodproof beer screening kit for the detection and identification of 30 different beer spoilers after only 48 hr of unspecific enrichment. Importantly, this kit detects and distinguishes not only relevant *Lactobacillus* and *Pediococcus* species that grow in beers with a typical alcohol and hop content, but also the obligatory anaerobic beer spoilers of the genera *Megasphaera* and *Pectinatus*. This test is easy to use with short hands-on time and can be used at all stages of production. Apart from bacterial beer spoilers, the presence of wild yeasts is a common problem in craft breweries, and microbiological analysis is time-consuming and error prone. On the level of DNA, the distinction of important wild yeasts can be made easily. For brewers of lambic beers, for example, the presence or absence of *Brettanomyces* (the anamorph of *Dekkera*) can be detected and even quantified using the foodproof *Dekkera* quantification kit, thus enabling brewers to monitor the amount of *Brettanomyces* during fermentation. The foodproof *Saccharomyces cerevisiae* var. *diastaticus* kit enables brewers to easily screen and identify this problematic wild yeast. Thus, most of your quality control microbiology can be carried out using the validated, specific, and highly sensitive BIOTECON Diagnostics products. The use of this open real-time PCR platform enables scientifically interested

brewers to additionally create their own assays, thus extending the possibilities of using real-time PCR for further applications.

Markus Fandke started working at BIOTECON Diagnostics in 1996 to prepare his diploma thesis, "Development of a Rapid Detection System for Megasphaera and Pectinatus." After graduating as a chemical engineer from the Niederrhein University of Applied Sciences he went on to work in the BIOTECON Diagnostics R&D Department, where he significantly contributed to the development of the foodproof® beer screening kit. As part of the marketing team, he has been strongly involved in the implementation of real-time PCR in brewery quality control labs worldwide for many years. In this function and his function as head of the BIOTECON Diagnostics service laboratory he has always been in touch with customers, especially brewers, to discuss their needs regarding relevant microbiological issues.

59. Beer monitor basic: A new, economical method for in-line alcohol measurement in the brewery

D. L. Gore (1), J. P. NORTHROP (1); (1) Anton Paar GmbH, Graz, Austria

The classic method of measuring beer extract and alcohol using density and sound velocity has been around for more than 20 years and is the recognized standard in breweries around the world for its high accuracy and reliability. As the global beer industry changes, however, new requirements and alternatives present themselves. Many craft breweries have reached the point where process instrumentation is vital to ensure product quality, improve process automation, and reduce costs. A classic beer monitor, however, often remains out of reach or is simply not yet needed, and an "entry level" system is more attractive. Other breweries may only need to measure alcohol and do not need other parameters or the highest accuracy. A simple, compact, and easy-to-install alternative is needed. This presentation will describe a new, low-cost alternative for measuring beer alcohol using only sound velocity and a stored average brand density and demonstrate how well it compares to existing laboratory methods. Although density is not actually measured, alcohol and original extract are still accurately determined and an optional CO₂ sensor can be added at any time but is not necessary. A six week comparison test of four different beer styles (filtered, unfiltered, and bottle conditioned) will further demonstrate the overall measurement stability, correlation to the lab reference, and influence of any batch-to-batch variations.

J. P. Northrop is a senior technical sales rep for Anton Paar's Process Instrumentation Division. He is responsible for sales and assists the technical support of all U.S. brewery clients. He has authored and co-authored multiple scientific papers, posters, and presentations covering a wide range of topics. He has a bachelor's degree in chemistry from the College of William and Mary, a master's degree in chemistry from the University of Delaware as well as an MBA from Temple University. J. P. is a board member of the American Chemical Society and an active member of the Master Brewers Association of the Americas.

60. Depletion of ions through freezing concentration for water desalination

K. RUDOLPH (1), P. Hahner (1), T. Kunz (1), F. J. Methner (1); (1) Technische Universität Berlin, Berlin, Germany

Of the total amount of water on earth, 97% occurs as salt water and just 3% as fresh water. Only 0.3% of fresh water is available as drinking water. Due to an increasing global industrial demand, water consumption is increasing steadily (70% of fresh water is used for food production). There are methods for seawater treatment, such as reverse osmosis and evaporation, however, these are very complex and expensive. Therefore, it is necessary to find alternative methods for seawater desalination. One possibility is the freezing concentration. If salt water is frozen, only the pure fresh water freezes. The salt is displaced, because it cannot be integrated in the ice crystal lattice. In order to yield water with high purity and drinking quality, it was important to avoid spontaneous crystallization during the freezing process, which occurs due to the supercooling of water. The disadvantage of spontaneous crystallization is that due to the rapidity of the freezing process the concentrated brine is incorporated in the lattice, and therefore, the ice purity decreases. Controlled crystallization was achieved through the application of seed ice. The purity of ice and, therefore, the depletion of salt could be increased up to 40–60% by controlled crystallization compared to spontaneous crystallization. It was observed that all ions were depleted to the same extent over the freeze concentration. This fact is of great interest for the beverage industry, especially for the brewing sector. It is possible to treat water and wastewater specifically by freeze concentration. For example, to increase the colloidal stability of the beer, the content of iron in the brewing water can be decreased in advance.

Kerstin Rudolph obtained her graduate engineering degree in food technology, with thematic priority on extraction of food ingredients and food microbiology, from Technische Universität Berlin in 2013. In her diploma thesis in the Department of Food Technology and Food Chemistry, Chair of Brewing Science, she investigated, in cooperation with Herbstreith & Fox KG, the effectiveness of pectin in the colloidal stabilization and fining of beer. Since 2013 she has been employed at the Chair of Brewing Science as a scientific assistant. In August 2014 she started working on the cooperative project Seawater Desalination through Freezing Concentration.

61. Colloidal stabilization by silica at different temperatures

K. A. BERG (1); (1) PQ Corporation, Conshohocken, PA, U.S.A.

The colloidal stabilizing activity of silica gel at elevated temperatures has not been clearly established. One earlier report said that one silica had no temperature sensitivity, whereas another was less active at 6.3°C when compared to activity at 0°C. An unstabilized American lager was treated anaerobically with a silica hydrogel (BRITESORB A100) and a silica xerogel (BRITESORB D300) at three temperatures and at a range of doses. Treated beer was

anaerobically diluted to final gravity and either measured for sensitive protein or forced (5 days at 60°C followed by 2 days at 0°C) and measured for total haze at 0°C. Dose/response data were fit by least squares method to the equation: Forced total haze, in ASBC FTU = $\text{Max_Haze} - (\text{Max_Haze} - \text{Min_Haze}) \times (\text{Dose}/(\text{Dose} + \text{Half_Dose}))$. Higher temperature increased the activity of the hydrogel but had no effect on the xerogel. Surprisingly, higher treatment temperature greatly increased the haze of unforced beer (3-fold higher at 8°C than at 0°C). The equations allow the prediction of the forced total haze at any dose or temperature. Because all the fits show a Min_Haze of 0 ASBC FTU (i.e., at infinite dose), one can also calculate the dose needed to maintain a chosen stability at any treatment temperature. Thus, the prediction that loss of colloidal stability at higher treatment temperature can be overridden by higher dose has been verified.

Ken Berg received a B.A. degree in biology (biochemistry concentration) from Cornell University in 1976, and a Ph.D. degree in biochemistry from Brandeis University in 1981. After a post-doctoral appointment at North Carolina State University, Ken designed protein purifications for Lee Scientific in St. Louis, MO. For the last 30 years he has aided PQ Corporation by supporting its silica gel plants and their food industry customers globally. His customer-support techniques include biochemistry, microbiology, optical microscopy, powder mechanics, and the chemistry of foods and silica. Ken lives near Philadelphia, PA, with his music teacher wife Shelley.

62. Pectin: A natural plant-derived alternative fining agent for the brewing process

T. KUNZ (1), K. Rudolph (1), H. Gierth (1), G. Dingel (1), F. J. Methner (1); (1) Technische Universität Berlin, Berlin, Germany

Fining agents are used to improve the filtration performance of clear and bright beers, wines, and juices, as well as to lower their production time. Conventional agents that are being used within the beverage industry like isinglass or gelatin are derived from animals. In the literature pectin is mentioned as a possible vegetarian alternative to the conventional fining agents. The aim of this study was to investigate the use of pectin as a fining agent in the brewing process and its applicability as a substitute for traditional fining agents like isinglass. Therefore, elementary filtration and settling tests with pectins of variable degree of esterification (DE) and amidation (DA) were carried out to get a better insight into the flocculation mechanism and the ideal conditions in different beer matrices. Beside the suitable pectin types the focus of the investigations was on the right practical application and dosage conditions. For this it was necessary to figure out the best conditions for the use of various pectin types depending on different beer matrices. The affinity of pectin depends strongly on the degree of esterification and amidation and the beer matrix. So for each given beer it is necessary to find the best acting pectin and its optimum concentration to achieve an efficient fining effect. Settling tests have shown that pectin can be an alternative agent for isinglass, but the density of the yielded

precipitation is rather fluffy and needs longer settling time. In the brewing process the application of pectin shortly before or after separation of the hose beer proved to be most effective. Additional large-scale trials indicated that the flow conditions in CCVs can disturb the sedimentation performance of the fluffy pectin floc. Against this background the use of a centrifuge after pectin application in the brewing process is suggested. By treating pectin this way, it was possible to shorten the filtration time up to 30–40%. Nevertheless a suboptimal pectin concentration can cause an insufficient fining effect or lead to filtration problems. After pectinase application, galacturonic acid residue was not detectable (IC) in the filtrated beer, which indicates that pectin is completely removed after filtration. With the right handling and dosage, pectin can be an effective and low-cost alternative to conventional fining agents for the brewing process.

After qualifying as a certified technician in preservation engineering (1991–1993), Thomas Kunz completed his basic studies in chemistry at the University of Applied Sciences, Isny (1994–1995) and his basic studies in food chemistry at Wuppertal University (1995–1998), before studying food technology at the University of Applied Sciences, Trier (1998–2002). After graduating, he worked as a chartered engineer in the area of ESR spectroscopy at the Institute of Bio Physics at Saarland University (2002–2004). Since 2005, he has been employed as a Ph.D. student and scientific assistant in the Department of Biotechnology, Chair of Brewing Sciences, Berlin Institute of Technology (Technische Universität Berlin). As head of the laboratory since 2009 his main research focus lies in analyzing the influences of brewing process stages, filter aids, stabilizing or fining agents, and specific beer ingredients on radical reaction mechanisms and the oxidative stability of beer or other beverages using ESR spectroscopy and GC-MS. Another part of his research is the influence of oxygen during brewing and oxygen permeation through a wide range of different packaging materials during storage.

63. Optimized beer filtration with the latest generation membrane filter

R. FOLZ (1), M. Mol (2); (1) Pentair, Venlo, Netherlands; (2) Pentair, Enschede, Netherlands

In most countries, traditional beer filtering with diatomaceous earth (DE) is seen as environmentally and socially irresponsible. Membrane filtration provides the answer. More than a decade ago, the first beer membrane filtration (BMF) ever was commissioned at Oettinger Brewery in Bayern, Germany. Since then, Pentair has put more than 80 systems into operation worldwide. Based on the experiences and in close relationship with customers, the newest generation of beer membrane filter called BMF +FLUX was developed. This presentation will give brewers information on how they can meet environmental demands while at the same time ensuring they have the flexibility to produce different beers for different tastes and reduce capital and operational expenditures in a competitive industry. BMF +FLUX takes the advantages of the original BMF into a new design, featuring a tripled membrane surface area per module, a simplified filtration process, a smaller

footprint, and a 20% longer run volume. This provides significant cost reductions and environmental gains: 20% lower operational expenses, lower water consumption, lower chemical consumption. The simpler process allows for the reuse of tanks and periphery from the existing filter line, which results in reduced capital expenditures. Technical and scientific background will be given for the improvements in beer filtration with membranes. Among others, the filtration surface per module was increased from 9.7 to 27 m², and a feed-and-bleed system is no longer applied. This means that there is no retentate (bleed) beer flowing back to the unfiltered beer tank. Besides the design of the module was changed significantly to a module with a separate insert with hollow fiber membranes in a stainless-steel housing. The membranes, which have proven performance, remain unchanged.

Roland Folz is the director of technology and innovation for Pentair's Food & Beverage Division. Since February 2014, Roland has been responsible for innovation, product design, solutions development, and global R&D function. Roland has 18 years of experience in the brewing and beverage industries. Prior to joining Pentair, he headed the VLB Department of Brewing & Beverage Science and Applications (BBSA), located in Berlin, Germany. With his team of experienced engineers at VLB-Berlin, Folz worked on sustainable developments for the beverage industry, future beverage streams, and fermentation and applied microbiological concepts and control mechanisms. Under his leadership, VLB became an internationally respected provider of mission-oriented research and solutions regarding technological topics, global consultancies, and international training courses. Roland started his career in the brewing industry with a technical apprenticeship as a brewer and maltster at the Beck's Brewery, culminating with his doctorate degree with a thesis on the flavor stability of beer in PET bottles. He has also served as the technical director for Germany-based Preussen Pils Brewery and plant manager for the Oettinger Group. Roland is the international director on the American Society of Brewing Chemists Board of Directors. He is an active member of the International Society of Beverage Technologists and MBAA. Roland holds a Ph.D. degree in engineering technology and a diploma for brewing technology from the Technical University of Berlin, Germany.

64. Increasing bitter substance yield by recycling hot trub and yeast washing solution

F. Pereira (1), T. KUNZ (1), M. Marinoff (1), F. J. Methner (1); (1) Technische Universität Berlin, Berlin, Germany

Bitter substance utilization during conventional beer production is considerably low. It is generally known that the major losses of BU occur during wort boiling and fermentation. Recent studies gave a deeper insight into the losses of bitterness during different process steps and the investigation of specific influencing factors like pH and iron content in model solutions. Furthermore, the pH influences on the precipitation of hop acids was investigated in wort, with and without yeast addition. The findings were applied to develop a new procedure to improve the bitter yield by recovery from hot break and yeast washing solution. The

results demonstrate that reversible, pH-dependent hop acid complexes, including iron ions, are mainly responsible for the loss of BU during wort boiling and fermentation. The bitter substances precipitate with the hot break due to complexation with iron ions and during the first days of fermentation due to the pH drop caused by yeast. The achieved knowledge about the reversibility of pH-dependent precipitation can be used to improve the bitter yield by recovering the hop acids from the hot break and yeast washing solution under specific alkaline conditions and high temperatures. The usually applied method of recirculating the hot break to the lautering process should be reconsidered, since the new method leads to a higher bitter yield and also separates the prooxidative acting iron ions, resulting in better oxidative beer stability. Also later or incremental dosage regimes could become more popular since nonutilized alpha-acids can be recovered.

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65. A laboratory-scale approach for the quantification of whirlpool hop utilization

R. DANSBY-SPARKS (1), B. Hollinger (2); (1) University of North Georgia, Dahlonega, GA, U.S.A.; (2) Terrapin Beer Co., Athens, GA, U.S.A.

The isomerization of alpha-acids is facilitated by boiling temperatures, producing intensely bitter iso-alpha-acids. Since hops are the most important factor in the overall bitterness, flavor, and aroma of beer, it is important to know what factors contribute to the concentration of alpha-acids and the extent to which they will be converted to iso-alpha-acids. Many brewers add hops during the whirlpool process, and for some styles of beer, copious amounts are added while the wort is still very hot. This results in increased hop contact times with heated wort. It is generally assumed that hop utilization from whirlpooling is near zero, but this is highly unlikely. To date, the only attempts to determine hop utilization from whirlpooling have used professional tasting panels rather than detection of alpha-, beta-, and iso-acids. The initial goal of this work is to use analytical

characterization techniques to quantify hop acid content in real-time during the whirlpool and determine how various factors contribute to hop utilization in the whirlpool. Experimentation of this kind on the commercial brewery scale would be economically impractical. Therefore, a scaled-down model was developed to carefully simulate whirlpool conditions on a laboratory scale. The preliminary results from the study of temperature, time, and wort content will be presented.

Royce Dansby-Sparks is an assistant professor of chemistry at the University of North Georgia. Royce received his Ph.D. degree in analytical chemistry in 2010 from the University of Tennessee, Knoxville, and has worked in both the private and public sectors. He is a home brewer and is a member of the North Georgia Mountain Mashers home-brewing group.

66. Performance analysis of T45 hop pellets usage in late kettle additions in comparison to T90 pellets

S. Shirley (1), J. Schier (2), T. Pitra (3), P. E. DAVIDSON (4); (1) Harpoon Brewery, Windsor, VT, U.S.A.; (2) Harpoon Brewery, Boston, MA, U.S.A.; (3) S.S. Steiner, Yakima, WA, U.S.A.; (4) S.S. Steiner, Pottsville, PA, U.S.A.

With the continuing trend of beers intensely hopped for aroma and flavor, breweries are frequently approaching or surpassing the capacity of their brewing vessels to separate trub from wort and incurring excessive wort losses. Where early, conventional bittering additions of T90 pellets can be replaced by the use of CO₂ extract, additions late in the boil, or following the end of the boil may not be ideally suited to the use of CO₂ extract. T45 pellets, also known as concentrated pellets, are pelletized in a manner identical to T90 pellets, but the powder is frozen and processed through a mechanical sieving process, resulting in less vegetative matter and higher concentration of soft resins (i.e. alpha-acids, beta-acids, total hop oils). By using T45 pellets in place of T90 pellets for late hop additions to the kettle of an India pale ale, a 1.5% yield increase per brew in wort cast to the fermenter was observed. Laboratory analysis for iso-alpha-acid in solution comparing beer brewed with T90 to beer brewed with T45 was conducted, as well as triangle testing for detection of differences in the beers. Combined with the increased wort yields and alpha-acids percent standardization, use of T45 pellets reduces annual pellet shipping costs, storage space requirements, polyphenols, and sewer effluent, thus lowering the cost per barrel and adding capacity to the brewery.

Phillip Davidson began his brewing career in 2007 with D.G. Yuengling & Son in his hometown of Pottsville, PA, working through cellaring operations and into the brewhouse. In 2009 he attended the MBAA Brewing and Malting Science Course. In 2011 Phillip became secretary of MBAA District Philadelphia. Phillip joined S.S. Steiner as a sale representative to craft breweries in 2012 and in 2013 received a diploma in brewing technology from the Siebel Institute. Phillip was elected vice president of MBAA District Philadelphia in 2014.

67. An overview of hop products for the production of wort and beer

P. E. DAVIDSON (1), M. Sutton (2), S. Cocuzza (3); (1) S.S. Steiner, Pottsville, PA, U.S.A.; (2) S.S. Steiner, Germantown, TN, U.S.A.; (3) S.H. Steiner, Mainburg, Germany

As the number of breweries and people employed as brewers continues to grow, in addition to operational challenges with increased hopping rates used to produce hop forward craft beers, there is a growing need for information regarding the portfolio of hop products available to the brewer. Where brewers may be familiar with general use of whole leaf hops and type 90 pellets, they may not necessarily be aware of the efficiency of these products. By extension, there are many other hop products available that can help the brewer improve quality, efficiency, and reduce cost. In this overview, the production, application, efficiency, and logistical considerations of various hop products are considered.

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68. Determining mash pH from malt measurement

A. J. DELANGE (1); (1) McLean, VA, U.S.A.

In the fall of 2013 we presented a method for mash pH prediction and control based on modeling of all mash components (water, malts, added salts, acids, bases) as sources or sinks of protons dependent on the difference between their intrinsic pH levels (DI mash pH for malts; sample pH for liquor) and mash pH. Equilibrium mash pH is the pH at which sourced protons exactly equal protons absorbed. Proton deficits or surfeits for bicarbonate (from water) and for added acids, bases, or salts are calculated from simple mathematical models, while for malts they are based on titration data modeled by a simple (3 term) Taylor series expansion. In this presentation we review the concept emphasizing the malt measurement procedure and model hoping maltsters will adopt them and include measured data in lot analysis reports.

A. J. deLange is a retired electrical engineer with experience in digital signal processing, RF, systems engineering, and estimation. He has also been a home brewer for more than 30 years. He consults for Mad Fox Brewing Company in Falls Church, VA.

69. Weight reduction of paper-based 6-can and 24-can packages

Y. AIDA (1); (1) Kirin Company, Limited, Yokohama, Japan

In Japan, paper-based packages are widely used for 6-can packs and 24-can boxes. From the viewpoint of environmental conservation, we have worked on reducing the weight of these two packages. At first, we focused on weight reducing paper area (consumption) of 6-can packs. At the same time, the new package had to be improved with regard to can holding to ensure customer handling. Therefore we added bottom locking hooks on the package. As a result, we can make the holding strength twice as strong and obtain an 8% weight reduction compared to the conventional 6-can pack. As for 24-can boxes, corrugated paper generally is used. Our company already succeeded in reducing paper weight by developing an octagonal shape, corner-cut carton, in 2004. On the other hand, when reducing paper weight, we faced problems such as appearance defects, especially in high-humidity conditions. By tucking the upper ridgeline of the box inside, we obtained a 14% weight reduction without damaging box appearance. In addition CO₂ emission will be reduced by 5,300 tons per year.

Yusuke Aida graduated from Tokyo University of Agriculture and Technology and obtained an M.S. degree in management of technology in 2010. Since then, Yusuke has started a business career at Kirin Brewery Company. Yusuke has worked in production management and package development.

70. Panel demographics: What makes a great panel?

S. LANGSTAFF (1); (1) FlavorActiV Ltd., Fairfield, CA, U.S.A.

Over the past 13 years FlavorActiV has run a proficiency program with more than 40,000 sensory participants worldwide. All this data has been captured through a variety of testing methods, then stored and analyzed by FlavorActiV for panel leaders to facilitate further training, identify strengths and weaknesses, advise new product development, and improve product quality. However it can also be used to answer these fundamental panel demographic questions: What is the perfect panel group size? How important is panel stability? Who makes the better tasters, men or women? Does gender affect ability to perceive certain flavors? Which countries/regions are better at identifying certain flavors? Analysis of data taken from 600 global panels and more than 15,000 panelists, which was gathered through regular blind tasting sessions using various test parameters, has provided the evidence to answer these questions. We will discuss these questions and our findings, providing a fascinating and unique insight into panel performance globally.

Sue Langstaff is the owner of Applied Sensory, LLC, which provides sensory consulting to the wine, beer, and olive oil industries. She has a master's degree in food science from the University of California at Davis, where she studied sensory science, enology, and brewing. Sue worked as a sensory scientist for Vinquiry, an analytical wine laboratory

in California, and was an instructor at Napa Valley College, where she taught *Sensory Evaluation of Wine, Analysis of Wines and Musts, Wines of the World, and Introduction to North Coast Wines*. Sue has judged wine, beer, and olive oil at numerous competitions. Formerly, she was chair of the Sensory Evaluation Committee for the California Enological Research Association and leader of the UC Davis Olive Oil Taste Panel. Her research in sensory science has been published in several technical journals, and she has written a chapter entitled “Sensory Quality Control in the Wine Industry” in D. Kilcast (ed.), *Sensory Analysis for Food and Beverage Control: A Practical Guide*. Sue is co-editor of the book *Olive Oil Sensory Science* (Wiley/Blackwell, 2014) and is the creator of “The Defects Wheel for Wine, Beer and Olive Oil.” Sue was profiled in the bestseller *Gulp: Adventures on the Alimentary Canal* (W. W. Norton and Co., 2013) by Mary Roach.

71. Flaw detection and identification through data science and machine learning

J. M. COHEN (1), Z. B. J. Bushman (1), Y. Zhou (1); (1) Analytical Flavor Systems, State College, PA, U.S.A.

A successful quality program in a brewery must be capable of detecting flaws, taints, contaminations, and batch-to-batch deviations. GC/MS is considered the gold standard of quality control in brewing but requires capital investment, human experts, and constant upkeep. Analytical Flavor Systems has developed a machine-learning and artificial intelligence-based system capable of detecting and predicting quality control problems using only 16 sensory attributes and 8 sensations from human sensory data, without the need for expensive instruments. The sensory data generated by individual panelists can be used to identify a flaw, taint, or contamination, in real time, even if the taster is unable to recognize the flaw themselves. The sensory data is used to build flaw-detecting machine-learning algorithms, by training the algorithm on human-generated sensory data representing several different styles of beer spiked with 20 different contaminants. The Gastrograph review mobile application was used to collect sensory data, and the data were then used to construct models. These models were then tested in a similar fashion. The models were shown to be able to detect and identify, with a high degree of accuracy, an array of flaws found in beers.

Jason M. Cohen is the founder, CEO, and lead data scientist of Analytical Flavor Systems (AFS). Before starting AFS, Jason was the founder and executive director of The Tea Institute at Penn State, which oversees more than 20 researchers in 5 fields of study in traditional Chinese, Japanese, and Korean teas. Jason did his research in sensory science and data mining, developing the Gastrograph system after more than 3 years of research. Jason is a professional coffee, tea, and beer taster, and when he's not trying new products, he enjoys rock climbing, ice climbing, and fencing.

72. Identification and prediction of flaw, taint, and contamination causes using machine learning and artificial intelligence on sensory data and biochemical and metabolic pathway tracing

Z. BUSHMAN (1), R. Ahn (1), J. M. Cohen (1), Y. Zhou (1); (1) Analytical Flavor Systems LLC., State College, PA, U.S.A.

Latent flaws and contaminations, undetectable by most sensory and chemical based quality control programs, pose a real and existential risk to breweries—how can you detect and fix the cause of a flaw that has not yet developed? In this research, we present a novel approach to predicting latent flaws and tracing their creation back to the root cause in the beer brewing process. Furthermore, we show that the process is robust enough to predict flaws that occur in beer after packaging and distribution, increasing the actionability of any quality control program. At Analytical Flavor Systems we use machine learning and artificial intelligence to build quality control and flavor profiling tools for the food and beverage industry. By applying our algorithms to human sensory data collected with the Gastrograph review mobile application, predictions can be made as to the likelihood of a flaw appearing and how to prevent, delay, or mitigate the flaw.

Zachary Bushman is a chemist at Analytical Flavor Systems (AFS) and an avid home brewer. He received his B.S. degree in chemistry from the University of Wisconsin–Platteville in 2013. He then attended graduate school at the Pennsylvania State University, pursuing an advanced degree in chemistry. Upon withdrawal from graduate school he began working at AFS in State College, PA. AFS is a company dedicated to flavor profiling and quality control in the craft beverage industry. He is now the head chemist at AFS and directs projects on flaw detection and hardware development.

73. Sustainable solution for packaging hall conveyer track lubrication

F. F. REIS (1); (1) Sealed Air, São Paulo, Brazil

Breweries continue to find ways to reduce water consumption per unit of beer produced. This focus on water reduction becomes even more important if a region or country experiences a shortage of water as happened recently in Brazil. One application area where water can be saved is in the packaging hall conveyer track lubrication, where typically fatty acid lubricants are highly diluted with water and sprayed on the conveyer to reduce friction. Working jointly with the Araraquara-SP, Heineken brewery, Sealed Air trialed their SUSTAIN conveyor track program on one of their packaging lines. This program brings together new lubricant chemistry, unique dosing application equipment (Lubemaster), and Sealed Air's technical know-how. The SUSTAIN program changes the game by revolutionizing conveyer lubrication by applying the lubricant as a highly concentrated solution compared to the existing highly dilute lubricant application. This requires a change in the application timing on the different areas of the line. This is achieved by using Sealed Air's Lubemaster. Using the SUSTAIN program, a 70% water savings was achieved and 10% in lubricant savings. Other additional

benefits brought by the unique chemistry of the SUSTAIN lubricant compared to fatty acid lubricants include: clean conveyers; no microbial growth and associated smell, little or low foam on the floor under the conveyers; improved safety from less slippery floors; lower BOD into the effluent; and aesthetically pleasing production environment. Based on these results the plant decided to let Sealed Air extend SUSTAIN to another line.

Flavio Furtado Reis graduated with a degree in biology and started industrial cleaning professionally with DiverseyLever Company in 1995. Flavio obtained a degree in brewing technology from SENAI in 2009 and, since then, has been working as an application specialist in cleaning and sanitation solutions for the brewery and beverage industries at Sealed Air.

74. Independence from utility expenses: Generate clean energy and water on-site

M. R. SILVER (1); (1) Cambrian Innovation, Boston, MA, U.S.A.

The American craft beer sector is growing at a breakneck pace. As beer production increases, so does the volume of water required and, consequently, the volume of wastewater produced. Meanwhile, population growth, aging infrastructure, and climate change are driving new water supply restrictions and stringent regulations for wastewater disposal. Matthew Silver, CEO of Cambrian Innovation, pioneer of biotechnology solutions for industrial businesses, can discuss how generating clean water and energy on-site can cut costs, increase production, and boost sustainability for breweries. Water scarcity across the country is pushing up prices for fresh water. Breweries are also hit with increasing wastewater treatment fees from local municipal treatment plants. Cambrian Innovation's advanced biotechnology can dramatically reduce both expenses. The company's flagship product, the EcoVolt, converts brewery wastewater into clean water and clean energy—turning a cost center into a profit center. For craft brewery Bear Republic Brewing Company, dependent on a centralized municipal system for freshwater and wastewater treatment, trapped their growth potential by limiting discharge volumes and capping the fresh water supply. With an EcoVolt onsite, Bear can both expand production and expect wastewater and energy savings of up to \$200,000 annually. For Lagunitas Brewing Company in Petaluma, CA, the local municipality refused to accept brewery wastewater. Lagunitas was forced to haul truckloads of high-strength wastewater to a larger, regional treatment facility more than 40 miles away. With an EcoVolt solution treating all its wastewater on-site, Lagunitas is targeting a record low water/beer ratio of 2.5. The treatment system will produce enough recycled water to cut the facility's water consumption in half, while producing enough energy from the wastewater to cover 20% of on-site energy demand. Outdated and over-worked municipal wastewater treatment and water distribution facilities present costly line items for breweries. Craft brewers can ensure independent resource security, lower costs, and increase production capacity with on-site wastewater treatment systems. Cambrian CEO Matthew Silver can discuss how modular, on-site systems that maximize the use of resources

and minimize waste, like EcoVolt, can empower breweries to gain resource security by transitioning from a centralized to a distributed utility model. Many see the transition away from centralized systems to a distributed network as costly, but creative financing techniques, like some developed by Cambrian Innovation, can help ease the way. Performance-based leasing options, in which third-party investors put down the up-front capital for a system, allow brewers to only pay for the utility services they receive. This model provides an opportunity for small businesses to invest in a distributed wastewater, energy, and water system at no up-front cost or ownership risk. Businesses pay monthly for clean water and energy generated by the system, transforming the EcoVolt solution into a personal micro-utility.

Matthew Silver is founder and CEO of Cambrian Innovation Inc. Matthew has led Cambrian from inception through successful commercial penetration, scaling and validating its bioelectric technology with partners ranging from NASA and the U.S. Department of Defense to Lagunitas and Bear Republic Brewing Companies. Matthew has more than 14 years of experience in technology, commercialization, innovation strategy, and engineering design. Under Matthew's leadership, Cambrian has raised two equity rounds, won 14 government grants, and earned selection as a 2014 Global Technology Pioneer by the World Economic Forum. Matthew holds three advanced degrees from MIT—a Ph.D. degree in engineering systems; an M.S. degree in aerospace engineering and technology; and an M.S. degree in technology and policy. Matthew has published in more than 15 academic publications and testified before the U.S. Senate on the government's role in early-stage innovation.

75. Developing a B.S. degree program in fermentation, an industrial chemistry approach

W. G. KILLIAN (1), M. A. Thomson (1); (1) Ferris State University, Big Rapids, MI, U.S.A.

A new B.S. degree program in industrial chemistry with a concentration in fermentation science will start in fall 2015 at Ferris State University. This program builds on a 60 year history of preparing chemical technicians at the associate degree level, while addressing trending changes in employment requirements and expectations. Development of degree and course requirements will be discussed in the context of addressing stakeholder concerns voiced by potential employers, campus administrators, future students, and their parents. There are two particular areas of concern and interest: 1) the legal issues encountered with alcohol production, analysis, and tasting at a state educational institution where most of the students are not yet 21 years old; and 2) incorporating enough flexibility in the degree requirements to allow adjustment to address future industry needs and changes.

William Killian is a senior at Ferris State University, where he is pursuing his bachelor's degree in chemistry, as well as an associate's degree in industrial chemical technology (ICT) and a minor in mathematics. His plans involve the attendance of graduate school following his expected graduation in December 2015. William is currently involved

in the development and implementation of curriculum necessary for the B.S. chemistry degree program at Ferris State University. The proposed curriculum will involve both a fermentation and an ICT focus, with strong emphasis placed on instrumental analytical techniques and methods. The goal of this new degree is to provide students with the skills necessary to perform and succeed in the evolving fermentation and chemical industries.

76. Isolating interesting wild *Saccharomyces* yeast strain for brewing applications

J. AKERBOOM (1); (1) Lost Rhino Brewing Company, Ashburn, VA, U.S.A.

Saccharomyces yeast is the workhorse of the modern brewing world. Most of the yeast used for brewing belongs to two species, *S. cerevisiae* and *S. pastorianus*, although with the advent of very cheap sequencing and computational methods, the true classification might prove more complicated. The brewing industry is currently going through a period of extreme expansion, crowding the marketplace and pushing breweries to continuously differentiate by using new hop varieties and novel hop utilization techniques and focusing on new fermentables. Here we report on easy and straightforward laboratory methods to expand on the available yeast portfolio with personal isolates, concentrating on ease of application, speed, and success rate. Using these straightforward and relatively cheap screening methods we were able to isolate several novel yeast strains we use routinely in the brewery.

Jasper Akerboom received his B.S. and M.S. degree in Molecular Sciences in 2002. He finished his Ph.D. with Willem de Vos and John van der Oost at Wageningen University in the Netherlands, where he studied carbohydrate metabolism in extremophiles. He joined the Howard Hughes Medical Institute in 2007 to work on biosensors for small molecule in vivo detection. He set up the Quality Assurance and Quality Control Lab at Lost Rhino Brewing Company in 2011 and decided to join them full-time in 2013. He started his own yeast company, Bright Yeast Labs LLC, selling hard-to-find yeast strains and authored more than 25 peer-reviewed articles.

77. Keg and valve safety

M. CARPENTER (1); (1) Franke Beverage Systems, Inc., LaVergne, TN, U.S.A.

This presentation on keg and valve safety and repair was created at the request of several customers who wanted to learn the correct way to handle kegs and avoid injuries to their employees

Mark Carpenter has been working in sales and operations for Franke Beverage Systems since 2009. As the leading keg supplier in North America and the only keg supplier with its own keg repair operation, Mark has had the opportunity to see and analyze virtually every imaginable form of keg failure. Mark and the technical team at Franke are frequently called upon by their customers and other trade organizations to evaluate keg failures and keg-related injuries or to promote keg safety.

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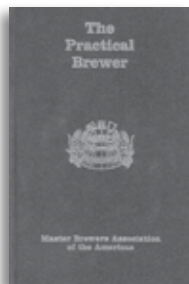
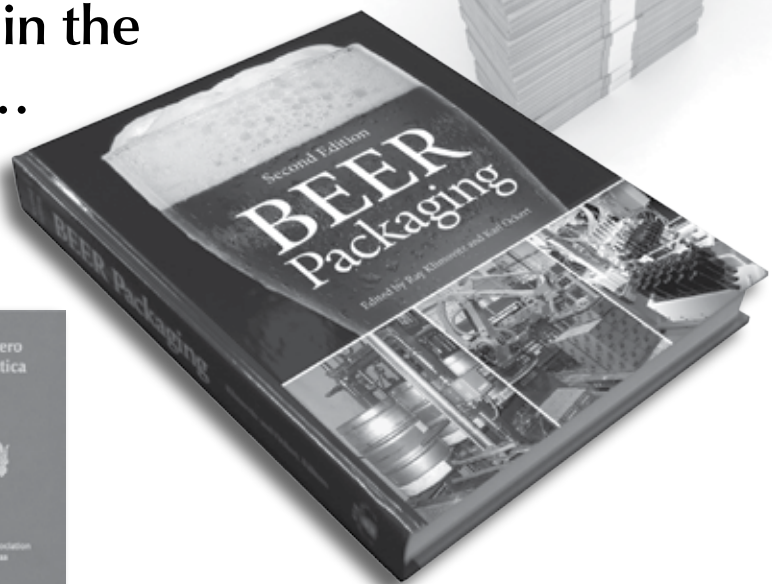
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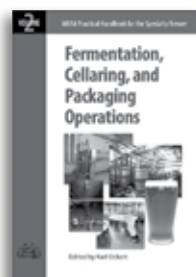
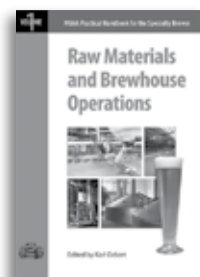
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