Master Brewers Association of the Americas

2013 Annual Conference

October 23–26, 2013 • Hilton Austin • Austin, Texas

PROGRAM BOOK

2013 Annual Conference

October 23–26
Hilton Austin • Austin Texas, U.S.A.

BIO-INNOVATION SUSTAINABLE ANSWERS UNCOMMON CONNECTIONS A BRIGHTER FUTURE

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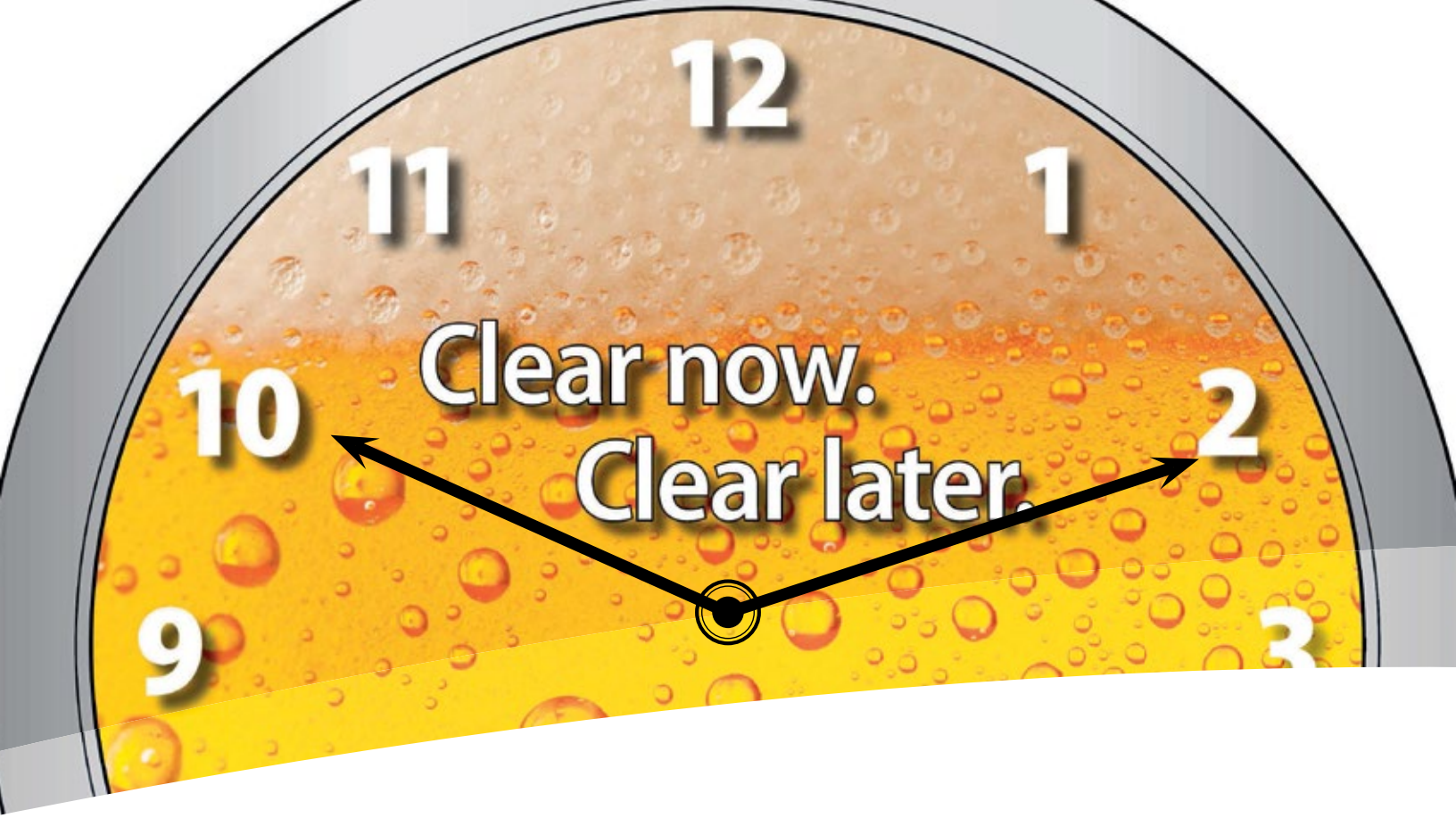

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For more information, please contact you local Ashland Specialty Ingredients representative or visit us at ashland.com/mbaa/polyclar.

Visit Ashland at MBAA in booth 515.

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WEDNESDAY, OCTOBER 23			
8:00 a.m. – 12:00 p.m.	Executive Committee Meeting • Room 619		
8:30 a.m. – 5:00 p.m.	**Preconference Short Course:** In-line Instrumentation Critical Process Measurement Points (CPMP)* • Room 416A *(4th Floor)*	**Preconference Short Course:** Basic and Advanced Cleaning in the Brewery* • Room 404 *(4th Floor)*	**Preconference Short Course:** Beer Steward Certificate Seminar* • Room 412 *(4th Floor)*
10:00 a.m. – 5:00 p.m.	Hill Country Brewery Tour* • Departs from 5th St. Entrance		
1:00 – 4:00 p.m.	Board of Governors Meeting • Room 615AB		
2:00 – 6:30 p.m.	North Austin Brewery Tour* • Departs from 5th St. Entrance	East and South Austin Brewery Tour* • Departs from 5th St. Entrance	
4:00 – 5:30 p.m.	District Officer Forum • Room 615AB		
7:00 – 9:30 p.m.	Opening Reception—Taste of Texas** • Salon FG/6th Floor Prefunction Area		

THURSDAY, OCTOBER 24			
8:15 – 9:45 a.m.	**Opening Session** • Salon FG		
10:00 – 11:45 a.m.	**Workshop:** Brewhouse Engineering • Room 615AB	**Workshop:** Gluten-free Beer* • Room 415AB *(4th Floor)*	**Brewing Fundamentals:** Brewing Water • Salon FG
11:45 a.m. – 2:00 p.m.	Lunch and Exhibits • Salon HJK	Posters • 6th Floor Prefunction Area	
2:00 – 3:45 p.m.	**Technical Session:** Brewhouse Operations • Room 616AB	**Workshop:** Beer Is Food—Food Safety for Today's Breweries • 415AB *(4th Floor)*	**Brewing Fundamentals:** Brewing Water • Salon FG
3:45 – 5:00 p.m.	Happy Hour with Exhibits and Posters • Salon HJK/6th Floor Prefunction Area		
5:15 – 8:30 p.m.	Plastic Kegs America Tour* • Departs from 5th St. Entrance		

FRIDAY, OCTOBER 25			
8:00 – 9:45 a.m.	**Technical Session:** Packaging • Salon FG	**Workshop:** Safety Throughout Your Brewery • Room 615AB	**Brewing Fundamentals:** Brewing Water • Salon AB *(4th Floor)*
10:00 – 11:45 a.m.	**Technical Session:** Sensory • Room 615AB	**Technical Session:** Food Safety/ Cleaning • Salon FG	**Workshop:** Wastewater: Everything You Need to Know, but Were Afraid to Ask• Salon AB *(4th Floor)*
11:45 a.m. – 2:00 p.m.	Lunch and Exhibits • Salon HJK	Posters • 6th Floor Prefunction Area	
2:00 – 3:15 p.m.	**Technical Session:** Sustainability • Room 615AB	**Technical Session:** Utilities Management • Salon AB *(4th Floor)*	**Technical Session:** World-class Management • Salon FG
3:15 – 4:30 p.m.	Happy Hour with Exhibits and Posters • Salon HJK/6th Floor Prefunction Area		
7:00 – 9:30 p.m.	President's Reception** • Salon ABC *(4th Floor)*		
9:00 – 11:00 p.m.	Afterglow Party • 6th Floor Prefunction Area		

SATURDAY, OCTOBER 26			
8:15 – 10:00 a.m.	**Technical Session:** Engineering • Room 615AB	**Technical Session:** Yeast and Fermentation I • Salon FG	**Workshop:** Establishing a Successful Sustainability Metric and Tracking Program • Room 415AB *(4th Floor)*
10:15 a.m. – 12:00 p.m.	**Technical Session:** Finishing and Stability • Room 615AB	**Technical Session:** Yeast and Fermentation II • Salon FG	**Workshop:** "Flavor Forward!"—Malt and Hops with Single-variety Brews* • Salon J
12:00 – 1:00 p.m.	Committee Meetings • Salon H		
1:00 – 2:45 p.m.	**Technical Session:** Hops • Salon FG	**Technical Session:** Malt and Grains • Room 615AB	**Workshop:** An Exploration of Beer Styles* • Room 415AB *(4th Floor)*
3:00 – 4:00 p.m.	**Closing Session** • Salon FG		

**Additional registration required.*
***Guests and Single Day attendees must purchase a ticket to attend.*

Conference space is located on the sixth floor unless noted.

Registration Desk
Registration will be in the 6th Floor Prefunction Area at the Hilton Austin. Registration will be open during the following times:

Wednesday, October 23	1:30 – 5:30 p.m.
Thursday, October 24	8:00 a.m. – 5:00 p.m.
Friday, October 25	8:30 a.m. – 4:30 p.m.
Saturday, October 26	8:30 a.m. – 3:00 p.m.

Silent Auction
Stop by the Registration Desk to participate in the MBAA Silent Auction. Proceeds go to the MBAA Foundation to help students interested in brewing. The Silent Auction will close at 4:45 p.m. on Friday, October 25.

Speaker Kiosk
The Speaker Kiosk will be available for speakers to review their presentations the day before their scheduled talk. The kiosk is located by the Registration Desk.

Bierstube
The Bierstube hospitality suite will be located in Room 616AB and open at the following times:

Wednesday, October 23	4:00 – 7:00 p.m.
	9:30 – 11:00 p.m.
Thursday, October 24	5:00 – 11:00 p.m.
Friday, October 25	4:30 – 7:00 p.m.
	9:30 – 11:00 p.m.

WiFi Lounge
Located on the 6th floor near Registration, attendees can stay in touch while at the Annual Conference by visiting the MBAA's WiFi Lounge. Sponsored by Novozymes North America, Inc.

Proceedings
Electronic proceedings are available for purchase for $49 during registration and at the conference. The proceedings will be available online following the meeting to all who purchased them.

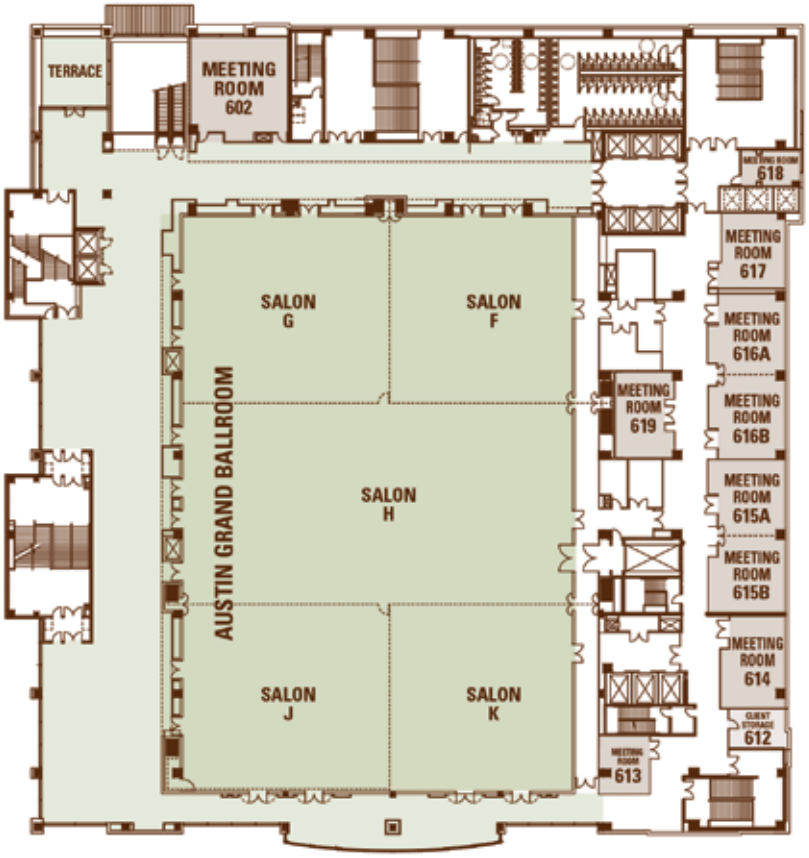
Photo Release
Photographs will be taken at the MBAA Annual Conference. By registering for the meeting, you agree to allow MBAA to use your photo in any publications, promotions, or websites for MBAA.

Emergency Procedures
The Hilton Austin is fully prepared to handle different types of situations to assist guests. The following is information on its emergency procedures:

The hotel internal emergency number is 44. The hotel has an emergency response team 24 hours a day. In the event of an emergency, calling the emergency number 44 will initiate the appropriate response.

Nearest emergency room:
Brackenridge Hospital
601 East 15th Street, Austin, TX 78701
(512) 324-7000
Approximately 0.8 miles from the hotel (5 min drive)

Hilton Austin



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Sierra Nevada Brewing Co.

Summit

Saranac

Trumer Pils

Widmer Brothers Brewing

Yuengling Since 1829 America's Oldest Brewery

Wednesday, October 23

8:00 a.m. – 12:00 p.m.	Executive Committee Meeting	Room 619
8:30 a.m. – 5:00 p.m.	Preconference Short Course: In-line Instrumentation Critical Process Measurement Points (CPMP)*	Room 416A *(4th Floor)*
8:30 a.m. – 5:00 p.m.	Preconference Short Course: Basic and Advanced Cleaning in the Brewery*	Room 404 *(4th Floor)*
8:30 a.m. – 5:00 p.m.	Preconference Short Course: Beer Steward Certificate Seminar*	Room 412 *(4th Floor)*
10:00 a.m. – 5:00 p.m.	Hill Country Brewery Tour*	Departs from 5th St. Entrance *(Next to Java Jive)*
1:00 – 4:00 p.m.	Board of Governors Meeting	Room 615AB
1:30 – 5:30 p.m.	Registration	6th Floor Prefunction Area
2:00 – 6:00 p.m.	Exhibit Set-up	Salon HJK
2:00 – 6:30 p.m.	North Austin Brewery Tour*	Departs from 5th St. Entrance *(Next to Java Jive)*
2:00 – 6:30 p.m.	East and South Austin Brewery Tour*	Departs from 5th St. Entrance *(Next to Java Jive)*
4:00 – 5:30 p.m.	District Officer Forum	Room 615AB
4:00 – 7:00 p.m.	Bierstube	Room 616AB
7:00 – 9:30 p.m.	Opening Reception —Taste of Texas**	Salon FG/6th Floor Prefunction Area
9:30 – 11:00 p.m.	Bierstube	Room 616AB

**Additional registration required.*
***Guests and Single Day attendees must purchase a ticket to attend.*

In-line Instrumentation Critical Process Measurement Points (CPMP)*

8:30 a.m. – 5:00 p.m. • Room 416A (4th Floor)
Course fee: $179
Presenters: James Ottolini, St. Louis Brewery, Inc.; Dean W. Schlueter, Equipment Pro, Inc.; Wayne Brinkman, Flow Emerson Process Management; Al Worley, optek-Danulat, Inc.; Heinrich Junker and Martin Lutz, ProLeiT AG; Rob Fraser and Fred Strachan, Sierra Nevada Brewing Co.
Moderator: Darren Goodlin, Anheuser-Busch InBev

This course will provide a general understanding of the traditional locations of in-line instrumentation and analyzers in the brewing process and the challenges each presents. When considering in-line instrumentation selection and location, each location has its own challenges, including environmental factors, process influences, hydraulic conditions, the need for sanitation, the need to periodically validate the in-line measurement, and of course measurement accuracy. Other considerations include the recurring cost, the skill set, the needed standard reference device, and the total cost of ownership (TCO). Various means of recordkeeping to monitor instrument measurement performance, as well as indications of a sensor nearing end of life, will also be discussed. There are trade-offs to having in-line measurements versus using a portable meter or grab sample, so being aware and knowing these exist is important, and total ownership must be considered when implementing any in-line solution.

Basic and Advanced Cleaning in the Brewery*

8:30 a.m. – 5:00 p.m. • Room 404 (4th Floor)
Course fee: $179
Presenters: Richard Rench, Sealed Air (Diversey); Joe Dirksen, EcoLab; Ed Ruble, Bell's Brewing Company; Dirk Loeffler, Loeffler Chemical

As cleanliness is an essential part of crafting great beers, it is crucial to have a solid understanding of the science and modern practices used to achieve the right conditions. This course will start with the fundamentals of the science behind cleaning and sterilization in the brewery. The presentations will go over the mechanics of actual cleaning and then finish with safety considerations when cleaning in breweries. Whether new to brewing or experienced, and whether involved in large operations or small, all attendees will take practical information back to their breweries and apply it to their day-to-day operations to further improve the quality of their beer.

Beer Steward Certificate Seminar*

8:30 a.m. – 5:00 p.m. • Room 412 (4th Floor)
Program fee: $275 advance/$300 onsite
Presenters: Rick Seemueller, Your Beer Ambassador, LLC; Bill White, Labatt Brewing Co.—Retired

From delivery to serving, learn how to properly handle, store, and present a variety of beers to maintain flavor and freshness. The MBAA Beer Steward Certificate Program will provide you with the necessary information to ensure you are bringing the freshest product to your customers. Participants in the program will also gain an appreciation of the craft by learning the history of beer as well as gaining an understanding of the diversity of beer styles and what makes them so different. In the end, participants will learn how to showcase beer styles using

food pairings and proper glassware, ultimately resulting in higher beer sales and increasingly satisfied customers.

Hill Country Brewery Tour*

10:00 a.m. – 5:00 p.m. • Departs from 5th St. Entrance (Next to Java Jive)
Tour fee: $69

Explore the Texas Hill Country as you travel to the historic town of Fredericksburg. First, stop at the Thirsty Planet Brewing Company, where you will tour their facilities and enjoy their hospitality in their lovely tasting room. Then, enjoy lunch at the Fredericksburg Brewing Company, the oldest existing brewpub in Texas. After lunch, take a leisurely stroll down historic Main Street. Next, you're off to Real Ale Brewing Company, where you can check out the brewery expansion or relax under the trees and enjoy the washer pitch. The final stop is Jester King Craft Brewery, an authentic farmhouse brewery that creates organic artisan ales. Your tour includes transportation to and from the Hilton Austin, lunch at the brewpub, and all tasting and tour fees at the breweries. Bring cash for souvenirs, including brewery swag!

North Austin Brewery Tour*

2:00 – 6:30 p.m. • Departs from 5th St. Entrance (Next to Java Jive)
Tour fee: $35

Explore the breweries on the north side of Austin. Visit Rogness Brewing, which creates beers from unique recipes featuring exotic ingredients, originally formulated by Forrest Rogness for his local homebrew shop, Austin Homebrew Supply. Then, enjoy Belgian-style ales at Adelbert's Brewery. Next, stop at Austin Beerworks, which won a silver medal at GABF for their Peacemaker American Pale Ale. Finally, grab a snack at Pinthouse Pizza Craft Brewpub and enjoy hop-forward, American-fusion style beers influenced by the Olde English traditions of complexity and drinkability. Sponsored in part by the Prospero Equipment Corporation.

East and South Austin Brewery Tour*

2:00 – 6:30 p.m. • Departs from 5th St. Entrance (Next to Java Jive)
Tour fee: $35

Take a journey to historic Austin breweries. Visit Live Oak Brewing, which produces European-style beers and is a World Beer Cup 2012 silver medal winner for their Primus Weizenbock. At Hops and Grain, you can try 2012 World Beer Cup Gold Medal winning Alt-eration Altbier or something experimental from the Greenhouse. Then, at Independence Brewing, sample Stash IPA or two-time Good Food Award winner Convict Hill Stout. The next stop will be (512) Brewing, where beers are built on old world English and Belgian styles using local, domestic, and organic ingredients. Finally, grab a snack while pleasing your palate with a refreshing handcrafted brew at Austin Beer Garden Brewing Co. Sponsored in part by the Prospero Equipment Corporation.

District Officer Forum

4:00 – 5:30 p.m. • Room 615AB

All district officers are invited to attend this forum. Learn about the priorities of MBAA, discuss the challenges your district is facing, and brainstorm with other district officers on what works and what doesn't. You will also be given a refresher on SharePoint to help you maintain your district website and stay in communication with your district.

Opening Reception—Taste of Texas**

7:00 – 9:30 p.m. • Salon FG/6th Floor Prefunction Area

Let Texas give you a heartfelt "Howdy!" at our Opening Reception! Get a taste of Texas fixin's with cheese and beer and meet with friends new and old, all while having a rip-roarin' good time. Stop by the photo booth for lasting proof that you were ridin' high in Texas!

Thursday, October 24

7:00 – 8:00 a.m.	Speaker Breakfast	Room 602
8:00 – 11:00 a.m.	Exhibit Set-up	Salon HJK
8:00 – 11:00 a.m.	Poster Set-up	6th Floor Prefunction Area
8:00 a.m. – 5:00 p.m.	Registration	6th Floor Prefunction Area
8:15 – 9:45 a.m.	Opening Session	Salon FG
9:00 a.m. – 3:30 p.m.	Silent Auction	6th Floor Prefunction Area
10:00 – 11:45 a.m.	Workshop: Brewhouse Engineering	Room 615AB
10:00 – 11:45 a.m.	Workshop: Gluten-free Beer*	Room 415AB *(4th Floor)*
10:00 – 11:45 a.m.	Brewing Fundamentals: Brewing Water • Water Sources Quality and Treatment. Debra Cerda, Besst, Inc. • Activated Carbon—Manufacture, Care, and Quality Monitoring. Roy Clackum, Cabot Corporation	Salon FG
11:45 a.m. – 2:00 p.m.	Lunch and Exhibits	Salon HJK
11:45 a.m. – 2:00 p.m.	Posters *(even-numbered poster authors present, 12:00–12:30 p.m.)*	6th Floor Prefunction Area
2:00 – 3:45 p.m.	Technical Session: Brewhouse Operations *Moderator: Mitch Steele, Stone Brewing Co.* 2:00 p.m. O-1. Using spectrophotometry to improve the brewing process of smaller craft breweries. RICK BLANKEMEIER 2:25 p.m. O-2. Some considerations on mash pH prediction. ANDREW DELANGE 2:50 p.m. O-3. The influence of decoction mashing procedure on beer characteristics. YUSUKE ISHIZUKA, Taichi Maruhashi, Yoshinori Hida, Kaneo Oka 3:15 p.m. O-4. Factors and new approaches for optimizing lautering operations. TRAVIS AUDET	Room 615AB
2:00 – 3:45 p.m.	Workshop: Beer Is Food—Food Safety for Today's Breweries	Room 415AB *(4th Floor)*
2:00 – 3:45 p.m.	Brewing Fundamentals: Brewing Water • Water Deaeration—Methods and Quality Considerations. John Kyle Dorton, Alfa Laval • Water Distribution and Storage—Design and Quality Considerations. Ashton Lewis, Paul Mueller Co.	Salon FG
3:45 – 5:00 p.m.	Happy Hour with Exhibits and Posters *(poster authors present)*	Salon HJK/6th Floor Prefunction Area
5:00 – 11:00 p.m.	Bierstube	Room 616AB
5:15 – 8:30 p.m.	Plastic Kegs America Tour*	Departs from 5th St. Entrance *(Next to Java Jive)*

**Additional registration required.*

Opening Session
8:15 – 9:45 a.m. • Salon FG

MBAA President Horace Cunningham will welcome you to Austin and kick off an exciting annual conference. This session will prepare you for a meeting full of learning with a program overview as well as honor the achievements and contributions of your colleagues with an award ceremony. The session will feature a presentation by Gary Luther, this year's MBAA Award of Merit recipient, about the merit of being a brewer.

Award of Merit Talk: The Merit—Being Called a Brewer
The beer brewer is one of the oldest known professions, going back to the time of the Sumerians. House breweries became industrial breweries. Along with this evolution came the definition of brewers and guilds in the 13th century. These brewers' guilds developed rules and regulations which defined the interests of the industry and the responsibilities of the brewer. These responsibilities included the guild-regimented order, education, and the support and maintenance of professional relationships. This talk discusses the brewer, based on these traditional responsibilities as well as personal experience.

Workshop: Brewhouse Engineering
10:00 – 11:45 a.m. • Room 615AB
Presenters: Brad Stevenson, Founders Brewing Co.; Michael Dillenburger, Dillenburger & Hertel GmbH; Alex Lenz, Krones AG; Joe Tippmann, TU Munchen–Weihenstephan
Moderator: Fred Scheer, Krones, Inc.

The removal of unwanted volatiles remains a major challenge in wort production. This workshop will describe the principles of rectification and distilling, discuss useful applications for the process of wort boiling, and facilitate a discussion of consumption figures in breweries and their significance in the

future. We will consider possibilities for setting benchmarks. Also, the implementation of energy savings and environmental responsibilities will be presented, using a case study in which Founders Brewing collaborated with Krones to install a vapor condenser unit in their brewhouse, along with the importance of having a perfect draught beer formula.

Workshop: Gluten-free Beer*

10:00 – 11:45 a.m. • Room 415AB (4th Floor)
Workshop fee: $5
Presenters: Sylvie Van Zandycke, DSM Food Specialties; Bob Hansen, Briess Malt & Ingredients Co.; Mary Rait, Craft Brew Alliance; Lindsay Guerdrum, New Belgium Brewing Co.
Moderator: Joe Casey, Craft Brew Alliance

In this workshop, a panel of brewing and allied industry professionals will discuss the various aspects associated with gluten-free beer and other alcoholic beverages. This workshop will be a chance to learn about the U.S. government's stance on gluten-free labeling, recent gluten test validations conducted by AACC International and ASBC, ways to produce barley-based gluten-free beers, gluten testing protocols, and various federal and state regulations pertaining to gluten-free beers, ciders, and spirits.

Brewing Fundamentals: Brewing Water—Water Sources through Dilution

10:00 – 11:45 a.m. • Salon FG
Presenters: Debra Cerda, Besst Inc.; Roy Clackum, Cabot Corporation

In the Brewing Fundamentals Seminar, the topic of brewing water will be tackled in-depth over three separate sessions. This first session will begin with the basics as Debra Cerda discusses quality and treatment of water sources. Roy Clackum will then present on activated carbon—manufacture, care, and quality monitoring.

Workshop: Beer Is Food—Food Safety for Today's Breweries

2:00 – 3:45 p.m. • Room 415AB (4th Floor)
Presenters: Rob Fraser, Sierra Nevada Brewing Co.; Jim Kuhr, Matt Brewing Co.
Moderator: Patrick Staggs, Crown Beverage Packaging

A panel of industry experts will answer questions regarding food safety, good brewing practices (GBP), and HACCP, as well as address culture barriers to implementation. Food safety is becoming an increasingly critical pillar for growing breweries, yet many of the principles, practices, and tools of food safety are not well understood. This panel represents breweries of various sizes, as well as key suppliers to the brewing industry. After a brief overview of these topics, there will be a roundtable collaboration session followed by a panel discussion that will construct the food safety road map needed for breweries of all sizes. Regardless of your level of food safety knowledge, this engaging workshop is sure to have tools and information you can put to use right away.

Brewing Fundamentals: Brewing Water—Water Sources through Dilution

2:00 – 3:45 p.m. • Salon FG
Presenters: John Kyle Dorton, Alfa Laval; Ashton Lewis, Paul Mueller Company

In the Brewing Fundamentals Seminar, the topic of brewing water will be tackled in-depth over three separate sessions. In this second session, John Kyle Doyle will expand upon the methods and quality-related details of water deaeration, and Ashton Lewis will discuss the design and quality considerations of water distribution and storage.

Plastic Kegs America Tour*

5:15 – 8:30 p.m. • Departs from 5th St. Entrance (Next to Java Jive)
Tour fee: $10

PKA is the world pioneer of reusable plastic kegs for beer, wine, cider, and soda that meet all requirements of standard metal kegs. Plastic kegs cost 50% less, are 60% lighter and quieter than steel, have zero flavor change, and have a 30% additional population life cycle. See how the kegs are made as PKA walks you through the manufacturing process. Texas craft brews and food will be provided.

Friday, October 25

7:00 – 8:00 a.m.	Speaker Breakfast	Room 602
8:00 – 9:45 a.m.	Technical Session: Packaging *Moderator: Tim Raymond, Krones, Inc.* 8:00 a.m. O-5. "One-way kegs": Helping brewers to increase sales volumes, while reducing environmental impact and production costs. ANDREW CARTER 8:25 a.m. O-6. A novel method for reduction of carbon dioxide consumption during can seaming process. YASUNORI TANAKA 8:50 a.m. O-7. Keg manufacturing standards. MARK CARPENTER 9:15 a.m. O-8. Prevention of premature failure of polypropylene mat top belts in tunnel pasteurizers. JACK BLAND	Salon FG
8:00 – 9:45 a.m.	Workshop: Safety Throughout Your Brewery	Room 615AB
8:00 – 9:45 a.m.	Brewing Fundamentals: Brewing Water • Water Chemistry—The Fundamentals. Rick Brundage, ChemTreat, Inc. • Brewing Water. John Palmer, Palmer Brewing Solutions, Inc.	Salon AB *(4th Floor)*
8:30 a.m. – 4:30 p.m.	Registration	6th Floor Prefunction Area
9:30 a.m. – 4:45 p.m.	Silent Auction	6th Floor Prefunction Area
10:00 – 11:45 a.m.	Technical Session: Sensory *Moderator: Fred Scheer, Krones, Inc.* 10:00 a.m. O-9. The effects of pH on beer haze, beer foam, and astringency perception. KARL SIEBERT 10:25 a.m. O-10. Investigation for improving metallic flavor in third-category beer. SHINICHIRO YAMAMURA 10:50 a.m. O-11. The perfect draught beer formula. JOHANNES TIPPMANN, Tobias Voss, Heiko Mann, Thomas Becker 11:15 a.m. O-12. Critical review of different sensory methods. MARTIN ZARNKOW	Room 615AB
10:00 – 11:45 a.m.	Technical Session: Food Safety/Cleaning *Moderator: Ken Berg, PQ Corporation* 10:00 a.m. O-13. Validation concepts for foam cleaning systems in the brewery. ROLAND FOLZ 10:25 a.m. O-14. Monitoring the cleaning and sterilization of kegs. CHRIS NIMPTSCH 10:50 a.m. O-15. The importance of supplier quality and its impact on brewing operations. BRAD RUSH 11:15 a.m. O-16. Yes, beer is good, but is it safe? A review of foodborne pathogen and toxic substance levels in beer. ALISON HAMM, Marisa Bunning	Salon FG
10:00 – 11:45 a.m.	Workshop: Wastewater: Everything You Need to Know, but Were Afraid to Ask	Salon AB *(4th Floor)*
11:45 a.m. – 2:00 p.m.	Lunch and Exhibits	Salon HJK
11:45 a.m. – 2:00 p.m.	Posters *(odd-numbered poster authors present, 12:00–12:30 p.m.)*	6th Floor Prefunction Area
2:00 – 3:15 p.m.	Technical Session: Sustainability *Moderator: Leo Chan, Nexcelom Bioscience LLC* 2:00 p.m. O-17. New materials for upgrading biogas to renewable natural gas. NEAL MEGONNELL, Shaun Wilson, Melissa Petruska, J. D. Carruthers, Edward Sturm, Aaron Primmer 2:25 p.m. O-18. Practical sustainability projects for breweries. MATT BAILEY 2:50 p.m. O-19. The algebra of sustainability: Technical metrics for the brewery. JAIME JURADO	Room 615AB

2:00 – 3:15 p.m.	Technical Session: World-class Management *Moderator: Tom Eplett, MillerCoors* 2:00 p.m. O-20. U.S. beer industry insights. LESTER JONES 2:25 p.m. O-21. The 20% solution for consistent beer quality. ALASTAIR PRINGLE 2:50 p.m. O-22. The use of Kaizens as a method for continuous improvement in a unionized 108 year old regional brewery: Framework and real results from The Lion Brewery, Wilkes-Barre, PA. LEO ORLANDI	Salon FG
2:00 – 3:15 p.m.	Technical Session: Utilities Management *Moderator: Matt Farber, University of the Sciences* 2:00 p.m. O-23. VeSave solution to reuse wastewater as technical water and save a significant amount of money. JENS KROGH 2:25 p.m. O-24. Breaking the barriers to collaborative waste-to-energy systems. JEFF VANVOORHIS 2:50 p.m. O-25. Case study—Executing a 210 kW combined heat and power project. MARK LINSBERG	Salon AB *(4th Floor)*
3:15 – 4:30 p.m.	Happy Hour with Exhibits and Posters *(poster authors present)*	Salon HJK/6th Floor Prefunction Area
4:30 – 5:00 p.m.	Poster Take-down	6th Floor Prefunction Area
4:30 – 7:00 p.m.	Exhibit Take-down	Salon HJK
4:30 – 7:00 p.m.	Bierstube	Room 616AB
7:00 – 9:30 p.m.	President's Reception**	Salon ABC *(4th Floor)*
9:00 – 11:00 p.m.	Afterglow Party	6th Floor Prefunction Area
9:30 – 11:00 p.m.	Bierstube	Room 616AB

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

Workshop: Safety Throughout Your Brewery

8:00 – 9:45 a.m. • Room 615AB
Presenters: Andrew Troccoli, Anfeald, LLC; Jeff Fanno, Stone Brewing Co.; Matt Stinchfield, Ploughshare Brewing Co.; Jason Tomsic, New Belgium Brewing Co.
Moderator: Jen Talley, Russian River Brewing Co.

Keeping employees safe is the primary responsibility of any brewery owner or manager. First comes safety, then comes great beer. This workshop will explore building a safe working culture, go over U.S. regulations, and examine existing technology. Whether you produce a thousand barrels or a million barrels, this workshop will help you build and maintain a safer work environment.

Brewing Fundamentals: Brewing Water—Water Sources Through Dilution

8:00 – 9:45 a.m. • Salon AB (4th Floor)
Presenters: Rick Brundage, ChemTreat, Inc.; John Palmer, Palmer Brewing Solutions, Inc.

In the Brewing Fundamentals Seminar, the topic of brewing water will be tackled in-depth over three separate sessions. This third session will complete the comprehensive exploration of brewing water as Rick Brundage and John Palmer tackle water chemistry and other considerations regarding handling water in the brewery.

Workshop: Wastewater: Everything You Need to Know, but Were Afraid to Ask

10:00 – 11:45 a.m. • Salon AB (4th Floor)
Presenters: Walker Modic, Bell's Brewery, Inc.; Dane Kriks, River Bend Laboratories; Adam Shy, Sierra Nevada Brewing Co.; Rick DeBar, Brewery Ommegang
Moderator: Evan Meffert, Bell's Brewery, Inc.

Whether legally mandated or fiscally prudent, the pretreatment and disposal of brewery wastewater has operational and pecuniary repercussions for brewers of any size. While treatment strategies are brewery specific, understanding treatment technologies, drivers of treatment strategy, and operational best practices is essential to successful design. This workshop will provide an introduction to those topics, case studies from brewery experts, and a forum for sharing experience, knowledge, and concerns regarding the pretreatment of brewery wastewater.

President's Reception**

7:00 – 9:30 p.m. • Salon ABC (4th Floor)

Unwind and connect with your colleagues at the President's Reception. Network and discuss what you've learned so far over appetizers and beer.

Afterglow Party

9:00 – 11:00 p.m. • 6th Floor Prefunction Area

Top off the night at the Afterglow Party, which has become an MBAA must-attend event. Irish coffee will be served. The Afterglow Party is sponsored by Malteurop North America, Inc.

Saturday, October 26

7:00 – 8:00 a.m.	Speaker Breakfast	Room 602
8:15 – 10:00 a.m.	Technical Session: Yeast and Fermentation I *Moderator: Jen Talley, Russian River Brewing Co.* 8:15 a.m. O-26. Yeast mitochondria—Their influence on brewer's yeast fermentation and medical research. GRAHAM STEWART 8:40 a.m. O-27. Maintaining batch consistency with subsequent knock out brews. ERIC BAUMANN 9:05 a.m. O-28. Genetics, ecology, and the diverse species *Saccharomyces cerevisiae*—Isolation of novel strains and lineages. ROB ARNOLD 9:30 a.m. O-29. Automated quantification of budding *Saccharomyces cerevisiae* using a novel image cytometry method. LEO CHAN, Daniel Laverty, Alexandria Kury, Dmitry Kuksin, Alnoor Pirani, Kevin Flanagan	Salon FG
8:15 – 10:00 a.m.	Technical Session: Engineering *Moderator: Tim Hawn, Dogfish Head Craft Brewery* 8:15 a.m. O-30. Pioneer wort boiling process with innovative internal calandria. TOBIAS BECHER, Klaus Wasmuht 8:40 a.m. O-31. From barley to the glass—Create your own beer. JOHANNES PREISS, Jörg Binkert, Johannes Lauer, Dietram Haertl 9:05 a.m. O-32. Engineering and design of brewery water deaeration systems. DAVE DUFF, Joshua Brickel 9:30 a.m. O-33. An economical brewery temperature control and monitoring system built using commercially available components. ADAM DEBOWER, Ken DeBower	Room 615AB
8:15 – 10:00 a.m.	Workshop: Establishing a Successful Sustainability Metric and Tracking Program	Room 415AB *(4th Floor)*
8:30 a.m. – 3:00 p.m.	Registration	6th Floor Prefunction Area
10:15 a.m. – 12:00 p.m.	Technical Session: Yeast and Fermentation II *Moderator: Johannes Tippman, TU Munchen* 10:15 a.m. O-34. The effect of platelet-activating factor on yeast attenuation. PHILLIP CALLIHAN, William Roudebush 10:40 a.m. O-35. Operating a secondary location for barrel-aged wild and sour beer production. CHAD YAKOBSON 11:05 a.m. O-36. Innovations in antimicrobial tubing eliminate bacteria and biofilm growth in closed draught systems and brewery environments. GREG KINNEY, Bill Coulson 11:30 a.m. O-37. Relationships between dry hopped beers and diacetyl formation. KARA TAYLOR	Salon FG
10:15 a.m. – 12:00 p.m.	Technical Session: Finishing and Stability *Moderator: Mary Pellettieri, MillerCoors* 10:15 a.m. O-38. Beer filtration—Present and future. FRED SCHEER, Michael Skroblin 10:40 a.m. O-39. New approach in beer clarification with the focus on precoat filtration. JOERG ZACHARIAS 11:05 a.m. O-40. Direct oxidation of amino acids—An unrevealed pathway leading to the formation of staling aldehydes in bottled beer? PHILIP WIETSTOCK, Thomas Kunz, Frank-Jürgen Methner 11:30 a.m. O-41. Are U.S. brewers ready for beer membrane filtration (BMF)? RIK SCHUURMAN	Room 615AB
10:15 a.m. – 12:00 p.m.	Workshop: "Flavor Forward!"—Malt and Hops with Single-variety Brews*	Salon J
12:00 p.m. – 1:00 p.m.	Committee Meetings	Salon H

1:00 – 2:45 p.m.	Technical Session: Hops *Moderator: Bob McKenzie, Third Street Brewhouse* 1:00 p.m. O-42. Factors influencing the losses of bitter substances and possibilities to increase the yield during brewing. FRANK-JÜRGEN METHNER, Thomas Kunz, Mario Marinoff 1:25 p.m. O-43. Evaluation of the brewing properties of the new German hop varieties. ANDREAS GAHR, Adrian Forster 1:50 p.m. O-44. The effect of kilning air temperature on hop essential oil content and aroma. THOMAS NIELSEN, Val Peacock, Scott Garden, Patrick Smith 2:15 p.m. O-45. Dry hopping perspectives and beer stability. THOMAS BECKER	Salon FG
1:00 – 2:45 p.m.	Technical Session: Malt and Grains *Moderator: Amy Germershausen, Malteurop North America* 1:00 p.m. O-46. Accelerated malting using elevated steeping and germination temperatures with a focus on malt quality and homogeneity. CHRISTIAN MUELLER, Frank-Jürgen Methner 1:25 p.m. O-47. Influence of special malt and coloring agents on the oxidative beer stability and aging components. THOMAS KUNZ, Till Stoffregen, Cecilia Cruz Palma, Chaochao Xu, Frank-Jürgen Methner 1:50 p.m. O-48. Analysis of wort sugars using fluorescent biosensors. JASPER AKERBOOM, Jonathan Marvin, Benjamin Basanta, Loren Looger, Matthew Hagerman 2:15 p.m. O-49. A new beer design tool—Use of Malt-Aroma-Wheel for the prediction of beer characteristics. JENS VOIGT, Andreas Richter, Thomas Kraus-Weyermann	Room 615AB
1:00 – 2:45 p.m.	Workshop: An Exploration of Beer Styles*	Room 415AB *(4th Floor)*
3:00 – 4:00 p.m.	Closing Session	Salon FG

**Additional registration required.*

Workshop: Establishing a Successful Sustainability Metric and Tracking Program

8:15 – 10:00 a.m. • Room 415AB (4th Floor)
Presenter: Cheri Chastain, Sierra Nevada Brewing Co.

This workshop will explore the sustainability-specific metrics that are suitable for a brewery. Learn from Sierra Nevada Brewing Co. Sustainability Coordinator, Cheri Chastain, what to track, where to find the data you need, and what to do with it once you've started tracking. Cheri will share what tracking metrics Sierra Nevada has in place and how they have helped drive efficiency improvements. Metrics to be covered include electricity, water, recycling, and natural gas consumption. A simple Excel spreadsheet and attention to your monthly utility use/cost is all you need to get started!

Workshop: "Flavor Forward!"—Malt and Hops with Single-variety Brews*

10:15 a.m. – 12:00 p.m. • Salon J
Workshop fee: $5
Presenters: Tim Kostelecky, John I. Haas, Inc.; Pat Hayes, Oregon State University; Tom Nielsen, Sierra Nevada Brewing Co.; Jens Voigt, Trier University of Applied Sciences
Moderator: Matt Brynildson, Firestone Walker Brewing Co.

We will explore the sensory impact of several varieties of hops and barleys, each individually brewed with multiple kilning cycles. Taste samples of the single variety brews and the malt and hops behind them, and learn about the latest science behind malt and hop flavor profiling and sensory analysis.

Committee Meetings

12:00 – 1:00 p.m. • Salon H

MBAA Committees will be meeting over lunch to discuss their past results and to help plan for the future. Boxed lunches and beer will be provided.

Committees Meeting:
Brewery Excellence Recognition Award Ad Hoc, Brewpedia Editorial Ad Hoc, District Best Practices Ad Hoc Task Force, Editorial and Publications Committee, Education Committee, Food Safety Ad Hoc, Foundation and Scholarship Subcommittee, Heritage Committee, Membership Committee, and Technical Committee

Workshop: An Exploration of Beer Styles*

1:00 – 2:45 p.m. • Room 415AB (4th Floor)
Workshop fee: $5
Presenters: Mitch Steele, Stone Brewing Co.; Will Kemper, Chuckanut Brewery; Andy Tveekrem, Market Garden Brewery; Chad Yakobson, Crooked Stave Artisan Beer
Moderator: Andy Tveekrem, Market Garden Brewery

Join our panel of industry experts as we explore the history, evolution, and modern interpretation of selected beer styles.

With the proliferation of beer types being made today, this workshop will reveal how the past has influenced the present and what future trends may arise. Sampling, along with a lively discussion, will make for a truly interactive workshop.

Closing Session

3:00 – 4:00 p.m. • Salon FG

The closing session will be a great finish to the conference with a keynote presentation. Stay to find out the recipients of this year's Best Oral and Poster Awards and to meet MBAA's new officers during the officer installation. Charlie Papazian, President of the Brewers Association, will deliver a keynote to put a cap on an excellent program!

Keynote Talk: A Nation of Brewers—My Point of View
Charlie Papazian

MBAA is excited to feature a keynote presentation from Charlie Papazian, founder of the American Homebrewers Association and president of the Brewers Association, as he speaks about where the industry has been, currently is, and might be going from here. Charlie is a prominent figure in the brewing industry, lecturing worldwide at professional and hobbyist events and authoring five bestselling books on homebrewing. He is also known for his work with the World Beer Cup, the Great American Beer Festival, Brewers Publications, CraftBeer.com, and the magazines *Zymurgy* and *The New Brewer*.

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Winners will be notified by April 1 and recognized at the 2014 Brewing Summit, June 5-7, in Chicago, Illinois.

Ad#2-2013

Oral Presentation

O-1
Using spectrophotometry to improve the brewing process of smaller craft breweries

Presenter: Rick Blankemeier, Stone Brewing Company, Escondido, CA

With more and more craft breweries opening, the quality and consistency of their beers comes into question. Establishing baseline specifications using simple analytical equipment is essential for maintaining brand and style consistency—even for small craft breweries with limited monetary resources. Establishing baseline specifications for core beer brands is important to carry quality and consistency throughout the growth of brewing capacity. The UV-Vis spectrophotometer is an essential tool to determine empirical specifications of beer and wort. The objective of this presentation is to introduce smaller craft breweries to the UV-Vis spectrophotometer, the cost of running assays, and the cost benefit of utilizing this essential piece of analytical equipment. In addition, this presentation will cover the specifics of bitterness, color, free amino nitrogen, vicinal diketones, oxidative precursors, beta-glucans, and polyphenol assays and using those tests to help optimize the brewing process and diagnose issues. Included are studies that smaller craft breweries can use to determine the return on investment of purchasing and utilizing a UV-Vis spectrophotometer in their daily brewing process.

Rick Blankemeier left the world of natural gas process engineering for the realm of craft beer and hasn't looked back. Rick helped establish the standard operating procedures for QA and QC at Stone, as well as for the barrel and small-batch program. Rick has given presentations and seminars on quality assurance and spectrophotometry at Southern California MBAA technical meetings and the 2013 Craft Brewers Conference. Rick holds bachelor's and master's degrees in chemical engineering from the University of Colorado at Boulder. He currently works as the quality assurance analyst at Stone Brewing Co., specializing in small-batch and barrel-aged beer.

O-2
Some considerations on mash pH prediction

Presenter: A. J. deLange, Mad Fox Brewing Company, Falls Church, VA

Clearly it would be advantageous if brewers could enter parameters describing their malts and water, the amounts of each, and the amounts of any salt, acid, or base additions into a spreadsheet or "app" and have it return a reliable mash pH prediction. This represents the holy grail for home brewers but would clearly be of value to craft and larger commercial brewers as well. In this presentation we offer a proton deficit/surfeit model in which the predicted pH is the pH at which the total of individual mash component proton deficits equals the total proton surfeit. We explore methods for determining (modeling) the proton surfeit/deficit for each relevant mash component. Among these are a Henderson-Hasselbalch–based model for carbonate and phosphate and, for malts, a simple (three term) Taylor series representation of their titration curves about the distilled water mash pH. Some experimental data are given. While the models for many of the mash components may be sufficiently robust, this is not true for all of them. For example, calcium carbonate and lime additions do not deliver the alkalinity that stoichiometry predicts. A theoretical explanation as to why this may be so is presented. Larger difficulties may lie in obtaining data that accurately reflect the actual acidity or alkalinity of malts encountered in the brewhouse on a particular day. These are discussed, with emphasis on the laborious and time-consuming nature of properly done malt titrations. Variations between lab and brewhouse handling, between malt batches, and the fact that thermodynamic equilibrium is never reached in the mash tun are noted. We conclude that while accurate mash pH prediction may be feasible it may, depending on required accuracy, not be practical.

A. J. deLange is a retired electrical engineer with more than 40 years of experience in signal processing, RF engineering, estimation, and analysis. He is also a home brewer with more than 25 years of experience who has particularly enjoyed applying the disciplines of his professional life to his hobby. He has a keen interest in brewing water chemistry and beer color analysis and has published and lectured on those subjects in the United States and abroad. He is a member of MBAA and ASBC. He has undergraduate and graduate degrees in electrical engineering from Cornell University and was employed by Zeta Associates in Fairfax, VA. He consults for Mad Fox Brewing Company in Falls Church, VA.

O-3
The influence of decoction mashing procedure on beer characteristics

Presenter: Yusuke Ishizuka, Suntory Liquors Limited, Osaka, Japan
Coauthors: Taichi Maruhashi, Yoshinori Hida, and Kaneo Oka, Suntory Liquors Limited, Osaka, Japan

Nitrogen compounds in mash contribute not only to beer taste and foam quality, but also affect the brewing process, provide the nitrogen source for yeast fermentation, and can affect beer filterability. Therefore, the control of protein modification during malting and mashing is very important, and we must consider optimizing the mashing procedures depending on malt quality, and vice versa. It has become popular to use malts with relatively high protein modification because they are both easy to use and economical. However, this may cause low fullness or an unpleasant aftertaste if the mashing method is not carefully considered. At the MBAA Annual Conference in 2010, we reported that decoction beer had better fullness and bitter quality than infusion beer when relatively low protein modified malt was used. At WBC 2012, we reported that the components of nitrogen compounds present in mash could also be controlled by the decoction mashing procedure (mashing-in temperature, rest temperature, or rate of temperature increase) and that, based on these results, it appears that high molecular weight nitrogen compounds are a good indicator of bitter quality and foam cling. As mentioned above, decoction mashing procedure influences beer characteristics when

relatively low protein modified malt is used. Furthermore, the mashing procedure used after decoction may also change the degradation of nitrogen compounds and affect Maillard reaction products at the mash and wort boiling stage. In this study, we investigate the influences of mashing temperature, before and after the addition of decoction mash to residual mash, and discuss the effects of mashing procedure on beer characteristics, focusing on nitrogen compounds and Maillard reaction products that result from enzyme reactions during the mashing process.

Yusuke Ishizuka graduated with a master's degree in environmental studies from the University of Tokyo in 2011. After joining Suntory, he worked for two years in the Beer Development Department of Suntory Liquors Limited.

O-4
Factors and new approaches for optimizing lautering operations

Presenter: Travis Audet, AB InBev, St. Louis, MO

Use of lauter tuns for wort separation is an essential step in the recovery of extract converted in the mashing process. The factors affecting lautering are vast, and often only a few fundamental factors are considered. The presentation will first examine pre-lauter tun factors that can have a significant effect on extract efficiency. The presentation will then outline factors involved in the actual lautering process that affect extract efficiency. Finally, a review of innovative approaches to the operation of lauter tubs and resulting improvements in performance will be considered. For all parts of the presentation examples from Anheuser-Busch InBev lauter tun installations will be used.

Travis Audet has been brewing professionally since 1994 and has been a proud member of MBAA since 1997. He has worked in brew pubs, craft breweries, brewing research and development, and regional breweries in both Canada and the United States. Currently, Travis is a brewing specialist for Anheuser-Busch InBev (AB-I) based in St. Louis, MO. In his current role, he serves breweries in the AB-I North American zone, assisting in process improvement and optimization in all areas of brewing from raw materials to bright beer tanks. Travis has a degree in natural resources from the University of Maine, holds an Institute of Brewing and Distilling Diploma Brewer Certification, and is a current candidate for the Master Brewer Certification. In service to MBAA, Travis has held multiple voluntary roles, including district officer positions, Membership Committee chair, Board of Governors representative, and, currently, Education Committee chair.

O-5
"One-way kegs": Helping brewers to increase sales volumes, while reducing environmental impact and production costs

Presenter: Andrew D. Carter, Petainer Manufacturing USA Inc., Chicago, IL

A case study showing how a U.S. craft brewer brewing a German "alt" style draft beer is able to send product 3,000 miles for consumers to enjoy at 60 London (England) pubs. "One-way kegs" have allowed this customer to distribute a premium draft beer as a commercially viable global product. In addition to opening up new and distant markets, these kegs have also allowed this brewer to tackle important environmental challenges. The case study will illustrate benefits throughout the supply chain: saving fuel during transport, saving water stress, saving effluent charges, and saving energy. The commercial advantages are also illustrated. These include less capitol spent on packaging machinery, less equipment to maintain, and a smaller equipment footprint. Product quality and safety throughout the product cycle are discussed. This paper looks at the whole commercial and environmental impact. A lot of businesses claim to take environmental challenges seriously. One-way kegs can allow a brewing business to demonstrate use of a keg system that puts that into practice.

Andy Carter joined APV in 1984 and began a career as a supplier to the beer and beverage industries. Working up from manufacturing, through production control, service, and then sales, the rationalization of APV's kegging business in 1991 led to Andy being promoted to the position of sales and service manager with responsibility for sales of APV's keg-racking products around the world. Invensys acquired APV in 1997. Restructuring resulted in Andy's appointment as sales manager (brewing) for APV UK at Crawley. In this role he was responsible for all brewery process sales within the Unite Kingdom and for keg-racking products globally. The following year Andy was appointed as general manager of the keg division. In 2004, he joined KHS, where he was responsible for sales of packaging plants to the U.K. brewing and beverage industries. In 2011 Andy joined Petainer as a regional sales director, responsible for the U.K. and North American markets. The specialist PET engineering and technology business is pursuing business growth in new and existing markets with development of the unique Petainer keg and other large container systems. Andy has 29 years of experience in packaging projects for the beverage industry. A member of IBD, he has lectured, trained, and published extensively in Europe, the United States, and Asia Pacific regions.

O-6
A novel method for reduction of carbon dioxide consumption during can seaming process

Presenter: Yasunori Tanaka, Kirin Brewery Company, Limited, Yokohama, Japan

While tackling individual environmental issues such as reducing CO_2 emissions, Kirin has been constantly reminded that maintaining environmental sustainability, along the Kirin Group's value chain, has much to do with the continuity of society and of our business. Canned beer products were introduced into Japanese market in the 1970s. The can share has increased year by year, and these days it reaches around 70–80% of the market. As for Kirin Brewery production, 70% of the products are canned beer, and more than half of the CO_2 consumption in the whole brewery is used for can production. We have developed technologies such as CO_2 usage efficiency improvements in the can-filling process, but a further effort has been demanded to achieve the CO_2 reduction target the Kirin Group is aiming for. Therefore we decided our next target area will be the seaming process. To prevent

product oxidation, a huge volume of CO_2 is purged to exclude O_2 from the headspace of the liquid after beer filling and just before seaming, and this process has been controlled basically only through the CO_2 flow rate. We successfully reduced CO_2 usage by heating it in the supply line according to the combined gas law. As gas density is decreased by heating, the mass (weight) of CO_2 could be reduced in the same gas flow volume as CO_2 itself. CO_2 temperature was controlled below the heat resistance of any parts of the supply line, thus we could construct this system only through the installment of a heating device. We also observed that headspace O_2 became lower under high-temperature CO_2 purging conditions. It is thought that headspace O_2 also heated, and it seemed to be effective in reducing O_2 density. None of the other concerns, such as odor, packaging duration, and seaming performance, were observed. This new method was able to reduce approximately 20% O_2 usage in the can seaming process without any changes in beer quality and packaging performance.

After graduation from Ukiha technical high school in Fukuoka, Japan, Yasunori Tanaka joined Kirin Brewery and worked in the packaging area of the Fukuoka brewery from 1994 through 2009. He has developed his expertise especially in canning operations, including quality control, quality assurance, and efficient production. He was involved in the Fukuoka brewery renovation project in 2006. He moved to the Technical Development Department in 2009 and has been working on can material weight reduction and CO_2 reduction in can fillers and seamers.

O-7
Keg manufacturing standards

Presenter: Mark S. Carpenter, Franke Beverage Systems, LaVergne, TN

Keg manufacturing standards in the United States (no documented standard), the United Kingdom (BFBi standard), and Germany (DIN standard) are discussed. This paper was written in response to dozens of inquiries regarding the internal pressure tolerance of stainless-steel kegs following the Red Hook incident. It explains what happens when a stainless-steel keg ruptures (including multiple photos), the safety features unique to the standard North American keg, and testing methods.

Mark Carpenter began working for Franke Beverage Systems in 2009. One of his first tasks at Franke was to develop keg service and repair capabilities, which allowed him to observe every conceivable keg failure mode and their respective results. In addition, as a part of Franke's Global Network Keg Services (GNKS), Mark regularly meets with other GNKS members from the United Kingdom, Germany, Czech Republic, and Poland to discuss keg repair techniques, failure modes, handling methods, and logistics.

O-8
Prevention of premature failure of polypropylene mat top belts in tunnel pasteurizers

Presenter: Jack L. Bland, ChemTreat, Glen Allen, VA

Polypropylene has been the material of choice for mat top conveyor belts in tunnel pasteurizers in recent years; however, premature catastrophic failure has cost the industry more than $50 million in belt replacement costs alone over the past five years, not to mention lost production associated with downtime for belt replacement. These mat top conveyor belts, which are designed for 7–10 years of useful service life have experienced failure in as few as 3 years of in-service operation. This paper details the root cause analyses of a variety of premature belt failures and offers recommendations for maximizing the service life of polypropylene belts in tunnel pasteurizers in future operations.

Jack Bland has more than 35 years of experience in water treatment programs associated with more than 30 individual U.S. and Caribbean breweries. He has been an active MBAA member since 1980 and has published six MBAA technical papers and posters, two of which were granted the Outstanding Paper Award in packaging. Jack has also taught the Pasteurizer Treatment section for many years at the annual MBAA packaging course in Madison, WI. Jack retired from Chemtreat in 2012 and is a retained consultant to the company, focusing primarily on water treatment programs associated with the brewing industry. Jack is also current president of the Cooling Technology Institute, a global industry association headquartered in Houston, TX. Jack is proud to be a member of MBAA Districts Mid Atlantic and Caribbean.

O-9
The effects of pH on beer haze, beer foam, and astringency perception

Presenter: Karl J. Siebert, Cornell University, Geneva, NY

Beer haze and foam and astringency perception are all strongly influenced by pH. Beer haze formation is mainly due to interactions between barley hordein, a protein rich in proline, and polyphenols. Haze-active polyphenols bridge the protein molecules together, resulting in complexes; these can grow to become suspended insoluble particles, at which point they scatter light and result in turbidity. Astringency perception is also mainly due to precipitation of proline-rich proteins (normally present in saliva and providing lubrication of oral surfaces) by polyphenols. Proteins generally have the least solubility in water near their isoelectric points, where the net charge on the protein is 0. Beer haze formation is greatest slightly above pH 4 and is much weaker at both higher and lower pHs. However, the isoelectric point of barley hordein is considerably higher than 4. The greatest precipitation of salivary proline-rich proteins by polyphenols also occurs slightly above pH 4, and these proteins also have fairly high isoelectric points. So, it appears that the pH at which the strongest protein-polyphenol interaction occurs has something fundamental to do with the nature of the interaction between proline-rich proteins and polyphenols, rather than protein precipitation per se. Beer foam is well known to involve one or more barley albumen proteins forming complexes with iso-alpha-acids. Studies with both beer and a model system showed greater foam formation with higher pH within the beer range. The foam protein–iso-alpha-acid interaction mechanism appears not to be due to ionic bonding, and in fact, the net charge on the beer albumens associated with foam decreases with increasing pH. Both the haze and foam interactions appear to result not from ionic bonding but from hydrogen or hydrophobic bonding or a combination of the two.

Karl Siebert received a Ph.D. degree in biochemistry from Penn State in 1970. He then joined the Stroh Brewery Company in Detroit, MI, where he spent 18 years and held positions from research associate to director of research. In 1990, Karl joined Cornell University as professor of biochemistry in the Department of Food Science and Technology. He served five years as department chair and now is involved in research, teaching, and extension. Karl is active as a consultant in beverage technology and chemometrics. He twice received MBAA Outstanding Paper Awards for papers he presented, and he and his colleague, Penny Lynn, received the ASBC Eric Kneen Memorial Award (for the best paper published in the Journal of the American Society of Brewing Chemists in the prior year) three times. Karl was named an honorary professor of the Moscow (Russia) State Academy of Food Processing in 1996, and in 1999 he received the ASBC Award of Distinction. He received the MBAA Award of Merit in 2011. He is currently a member of the ASBC Journal Editorial Board. Karl's research interests involve foam and haze in beverages, perception of astringency and other flavors, application of chemometric methods in food science, and assessment of microbiological risk.

O-10
Investigation for improving metallic flavor in third-category beer

Presenter: Shinichiro Yamamura, Suntory Liquors Limited, Ohra-gun, Gunma, Japan

"Metallic flavor" is a metal-like flavor that gives the impression of rusty iron or of a can. This flavor is easy to detect in beers with a light taste, such as third-category beers, and it is a factor that negatively impacts beer quality. Third-category beers have been rapidly expanding in the Japanese beer market, and the ratio of sales is about 35%. Therefore, it is an urgent task for us to improve metallic flavor. Based on a previous study, it was known that the substances causing metallic flavor are 1,5-octadien-3-ol and its oxide 1,5-octadien-3-one, which are oxides from an unsaturated fatty acid derived from raw materials. Our attempts to reduce metallic flavor could not proceed, however, because we did not know how the substances are generated. We analyzed a product that was judged as having a strong metallic flavor in our sensory evaluation. It was confirmed that this product had a high iron concentration in the beer. Based on this fact, we performed an iron addition experiment to elucidate the mechanism generating the metallic flavor. From this, we developed the hypothesis that it is necessary to reduce the unsaturated fatty acid and iron concentrations in the beer to improve metallic flavor. We tried to reduce wort turbidity during the lautering process to decrease the unsaturated fatty acid, because it had already been reported that there is a correlation between wort turbidity and the concentration of the unsaturated fatty acid (Kühbeck et al., J. Inst. Brew. 112:222-231, 2006). We also tried to reduce the amount of kieselguhr to decrease the iron concentration, because kieselguhr includes some iron. As a result, we were able to reduce the substances causing the metallic flavor and to improve the sensory evaluation score dramatically. We also carried out a sensory evaluation after eating various foods and consuming beers with high and low iron concentrations. When there were high concentrations of iron, a metallic flavor could be detected in reaction to the unsaturated fatty acid derived from the food. From this result, we could prove our metallic flavor hypothesis.

Shinichiro Yamamura is an assistant brewmaster in the Suntory Tonegawa brewery. The main subject of his work is development of brewing technology. He majored in molecular biotechnology at Hiroshima University, and he was engaged in elucidation of molecular mechanisms of mouse olfactory. He joined Suntory Ltd. in 2010. He is now engaged in improving beer quality and development of brewing technology.

O-11
The perfect draught beer formula

Presenter: Johannes Tippmann, Technische Universität München – Lehrstuhl für Brau- und Getränketechnologie, Freising, Germany
Coauthors: Tobias Voss, Heiko Mann, and Thomas Becker, Technische Universität München – Lehrstuhl für Brau- und Getränketechnologie, Freising, Germany

The issue of draft beer is a very hot topic that is based on a lot of knowledge from trial and error and experience. For this reason, in recent years a series of studies was conducted in Weihenstephan, based on which has gradually arisen the formula for a perfect draft beer from a hygienic point of view. In the course of these investigations, various aspects of how to both build and maintain a dispensing system were examined, with hygienic handling always in the foreground. In the studies, which will be presented in this paper, physical and sensory parameters of draughted beer were examined more deeply. The first part of the presentation shows investigations on the selection of the correct beer tap. If this component is incorrectly selected, there will be heavy foaming and high CO_2 losses, whereby the property of the beer is significantly altered. A series of trials was conducted to characterize the flow behavior of different beers at different flow rates with different temperatures in a variety of different beer glasses. The foaming was analyzed and evaluated scientifically. The second part of the presentation deals with the use of mixed gas (blends of CO_2 and N_2). Here, the focus of the investigation was mainly on sensory properties, but also on factors such as foam creation, stability, and consistency. After the implementation of a new analysis method, the CO_2 and N_2 contents in the tapped beers were analyzed. In addition, studies were performed to investigate the solving behavior of pre-assembled mixed gases.

Johannes Tippmann graduated from university in 2004 as a diploma engineer for brewing sciences and beverage technology. In 2005 he started his Ph.D. thesis with Prof. Sommer at the Lehrstuhl für Verfahrenstechnik disperser Systeme, TU München, on solid handling in the brewhouse. In 2012 he changed his affiliation and is now working as a group leader for the "brewhouse processing and dispense systems" work group at the Lehrstuhl für Brau- und Getränketechnologie, TU München. Since 2000 he has worked as a student research assistant in dispensing systems and collected lots of experiences in this subject area. Since 2006, he has been responsible for research issues in dispense systems. He is also a member of the "dispensing systems" technical committees of the government association for food and catering industry (BGN) and of the DIN German Institute for Standardization.

O-12
Critical review of different sensory methods

Presenter: Martin Zarnkow, Technische Universität München, Freising, Germany

This project covers the following areas: sensory analysis of beer and statistical evaluation of sensory test results. The aim was to develop a model that is appropriate to compare different sensory methodologies. The model is based on a modified ranking method. Within this work, three panels performed three difference tests. The stimuli in each test consisted of pale lager with different amounts of diacetyl. First the panel judges had to check the homogeneity for sensory materials. This test combines a ranking test according to ISO 8587:2006 with an intensity measurement. Afterward the panels carried out triangle tests according to ISO 4120:2004 and paired comparison tests according to ISO 5495:2007. It could be shown that a paired comparison test is more sensitive than a triangle test. The ranking test seemed to be the most difficult test in the case of finding differences between samples. Initial weights and distributions of samples can be computed with the model, and the boundary of two different samples can be defined. In these, judges should be able to discriminate them. The model can also be used to control a sample production for sensory analysis. The function of the model was proofed and validated. It can be used for each sample material. In addition an assumption was made to describe the difficulty of difference tests. In this way a comparison of tests is possible.

*Martin Zarnkow apprenticed as a brewer and maltster from 1989 to 1991 at a small brewery in Frankonia. Martin graduated with a Dipl.-Ing. (FH) degree, with brewing technology option, in 1996 from TU München Weihenstephan. Martin then worked as a brewmaster for one year in a medium-sized brewery in Germany. Since 1997 he has been the head of the research group for beer and beverage technologies at the Lehrstuhl für Brau- und Getränketechnologie (institute for beer and beverage technology) at TU München in Weihenstephan. In 2010 his finished his external Ph.D. research at the University College of Cork, Ireland, on the subject "Proso Millet (*Panicum miliaceum *L.): A Sustainable Raw Material for the Malting and Brewing Process."*

O-13
Validation concepts for foam cleaning systems in the brewery

Presenter: Roland Folz, Versuchs- und Lehranstalt für Brauerei in Berlin (VLB), Berlin, Germany

Long-term studies to investigate the performance and effectiveness of foam cleaning and disinfection in brewing and packaging operations by VLB together with the industry has led to a further control point definition to create a microbiological firewall on-line in the process. Trials performed in pilot scale as well as in industrial applications led to two developments to better classify, control, and document results during foam application. CIP and COP procedures are compared, especially in the crucial process of outer filler cleaning. Foam classes are defined that build the background for an apparative set-up, which releases an optical signal to classify the foam based on cluster analysis before being applied. Further developments alternate the foam chemistry itself to combine the goal of cleaning directly with an indicator that visually validates the effect regarding organic residues based on a permanganate reaction by a color change. During these developments, existing retention test media were compared and led to a new standard staining method in order to describe the sensitivity of the methods. Through the synergy of the new validation developments the author will create a holistic view of the application of foam cleaning in the brewing industry in order to enhance quality transformation goals by on-line validation results.

In his executive function as head of the VLB Department of Brewing & Beverage Science and Applications (BBSA), Roland Folz is involved in driving forward the process of VLB's internationalization. VLB is a German independent research institute and service provider for the brewing and beverage industries. Roland has built up his brewing career from scratch, starting with his technical apprenticeship as a brewer and maltster at the Beck's brewery up to his doctorate degree with a thesis on flavor stability and PET topics. In between he has been technical director for the Preussen Pils brewery and plant manager for the Oettinger Group. Under Roland's leadership the BBSA at VLB-Berlin has become an international provider of mission-orientated research and solutions regarding technological topics, global consultancies, and international training courses. With his team of experienced engineers, Roland is working on sustainable developments for the brewing industry, future brewing streams, and fermentation and applied microbiological concepts and control mechanisms. Roland is active on the Board of Examiners of IBD (Institute of Brewing and Distilling) and is heading the Working Group for Inline Measurement Techniques of MEBAK (Middle European Brewing Analysis Committee). Furthermore, he is a member of ISBT (International Society of Beverage Technologists), MBAA, and ASBC.

O-14
Monitoring the cleaning and sterilization of kegs

Presenter: Chris Nimptsch, Profamo Inc., Rancho Palos Verdes, CA

The cleaning and sterilization of kegs is a critical component of any brewery's microbiological QA and program. However, automated keg lines are black boxes for most brewers, and pulling microsamples is a long and complicated process with many opportunities for false results. As such, it is very important to be able to monitor the keg line's cleaning and sterilization efficiency with a simple and accurate monitor. Electronic test kegs afford the user a way of monitoring these processes. Data collected from an electronic test keg on various keg lines will be analyzed. Solutions to common problems will be discussed, as will best practices. A focus will be placed on the importance of high-pressure saturated steam to ensure sterilization of kegs.

Chris Nimptsch, president of Profamo Inc., has been a member of both MBAA and ASBC since 1994. He made presentations on keg line operations at the 2008 World Brewing Congress and the 2013 Craft Brewers Conference. Chris has a B.S. degree from McGill University in Montreal, Canada; a law degree from the University of Ottawa in Ottawa, Canada; and is a graduate of the Siebel Institute of Technology. After practicing law for seven long, boring years, Chris finally came to his

senses and started working in the brewing industry (his true love) when he joined the family business in 1994. Profamo Inc., has been a supplier of QA and process control equipment to the brewing industry since 1976 and now represents 12 manufacturers from all over the world.

O-15
The importance of supplier quality and its impact on brewing operations

Presenter: Brad A. Rush, The Samuel Adams Brewing Company, Cincinnati, OH

In today's business environment, supplier quality is a basic requirement needed to deliver a superior product to your consumers. The business models designed around price of materials, on-time delivery, and lack of defects won't get you very far in today's food production environments. With the recent passing of the Food Safety Modernization Act (FSMA), today's business focus needs to be around food safety and the pre-requisite programs required to be a world-class supplier in the food and beverage industries. This presentation will provide information on the basics of assessing a supplier for overall risk to the business through risk assessment and auditing. The result of the risk assessment will help to determine the higher risk suppliers to your business and at what frequency the customer may want to review or audit suppliers for risks or gaps in their business. An audit of your supplier should not be limited to food safety, as it will also need to focus on how the supplier manages consumer complaints, communication with employees, managing change, and the effectiveness of training, to name a few. More and more of the supplier audits today look at all aspects of the supplier's ability to be a consistent source of the highest quality materials that the brewery can use to deliver a quality product to the end consumer. The audit of a supplier today covers many areas of the business, and it must paint a clear picture as to what challenges and opportunities a supplier may have that can potentially impact the customer in any way. The focus of supplier quality for the Boston Beer Company has always been a top priority, but as we grow, we are seeing that it is a critical piece in the business model that our founder has built this business on.

Brad Rush, manager of supplier quality, joined The Samuel Adams Brewing Company in 2007. Brad holds a B.S. degree in environmental analysis from Carroll College in Waukesha, WI, and certificate in quality engineering from the Milwaukee School of Engineering; six sigma green belt certification from Lakeshore Technical College; and a diploma in advanced management and leadership from The University of Wisconsin–Madison, School of Business. Brad also has studied with the American Brewers Guild and Institute of Brewing. Brad joined the Boston Beer Company as the quality manager for the Cincinnati brewery and managed the packaging and analytical quality groups. In his current role he is in charge of the supplier quality program for Boston Beer and supports co-manufacture operations throughout North America. His previous experience includes a strong background in brewing, research, and operations at Jacob Leinenkugel Brewing Company and Miller Brewing Company, as well as hands-on quality analysis with an emphasis in sensory evaluation and quality.

O-16
Yes, beer is good, but is it safe? A review of foodborne pathogen and toxic substance levels in beer

Presenter: Alison K. Hamm, Colorado State University Department of Food Science, Fort Collins, CO
Coauthor: Marisa Bunning, Colorado State University Department of Food Science, Fort Collins, CO

Beer is a widely consumed food product, and brewers should be aware of emerging safety issues concerning foodborne microorganisms and toxic substances. Historically, beer consumption was encouraged in areas where drinking water was contaminated with pathogens. The malting and brewing process includes several "hurdles" for pathogens or potentially dangerous chemicals they must survive. The ethanol content, low pH, lack of nutrients, hop acids and anti-microbial properties, and high CO_2 and low O_2 levels in finished beer serve as obstacles for potentially dangerous microbes and chemicals. However, questionable levels of toxic substances such as aflatoxins, nitrosamines, pesticides, and heavy metals have been found in beers, especially those brewed in developing countries. Even low amounts of toxins may pose a threat due to chronic exposure. Current research evidence indicates beer is a safe beverage when consumed in moderate amounts. Foodborne pathogens cannot survive in beer at appreciable amounts, and potentially toxic chemicals do not generally occur at harmful levels. As a take-home message, the most dangerous element in beer produced in the United States is ethanol. The potential benefits of beer consumption with food contaminated with a pathogen will also be discussed.

Ali Hamm has been an MBAA Rocky Mountain District member since 2007 and has attended the MBAA Brewing and Malting Science course in Madison, WI. For the past seven years Ali has worked in several areas of the hops industry, including research, consulting, and sales. She has given several presentations at local brewing conferences and workshops, including the local MBAA district. Ali obtained a bachelor's degree in molecular and cell biology from UC Berkeley and then moved on to Colorado State University for a master's degree in horticulture. She is currently in the food sciences doctorate program at Colorado State University and is helping to develop a new fermentation microbiology course.

O-17
New materials for upgrading biogas to renewable natural gas

Presenter: Neal E. Megonnell, ATMI, Danbury, CT
Coauthors: Shaun M. Wilson, Melissa A. Petruska, J. D. Carruthers, and Edward A. Sturm, ATMI, Danbury, CT; Aaron Primmer, MV LLC, Golden, CO

Typical commercial brewing processes consume vast amounts of water for the production of beer and spirits. As regulations around disposal and treatment of wastewater become more stringent and energy costs continue to rise, there is a need for small and large breweries alike to examine the entire lifecycle of the raw materials used in their manufacturing processes. One area that has the potential to both reduce strain on municipal water treatment plants and provide an additional revenue stream for breweries is the anaerobic digestion of process wastewater and surplus yeast to produce biogas. The composition of this biogas is primarily methane (CH_4) and carbon dioxide

(CO_2), with other components present depending upon the specific source. In order to utilize biogas as a replacement for natural gas, it typically must be upgraded to 0–3% CO_2 with specific restrictions and requirements dependent upon utility company guidelines and local regulations. To this end, ATMI has developed BrightBlack carbon, a molecular sieve material based on polyvinylidene chloride (PVDC), which has the ability to selectively capture CO_2 from a biogas stream with minimal sacrifice to overall CH_4 production. ATMI and MV LLC have field tested a mobile pilot-scale vacuum swing adsorption (VSA) system at a commercial beverage manufacturer and two municipal wastewater treatment plants in the United States. The product gas produced during these field trials was found to meet pipeline and/or vehicle fuel purity requirements for CO_2, while maintaining CH_4 product yields of ≥85%. The results of this field testing and the BrightBlack adsorbent characteristics will be discussed.

Neal Megonnell is director of platform marketing for ATMI. He holds a bachelor's degree in chemistry from the University of Pittsburgh and a master's degree in chemical engineering and colloids, polymers, and surfaces from Carnegie Mellon University. He has over 20 years of experience in the activated carbon industry, has published many articles in various trade journals and industry publications, and holds two patents related to activated carbon. He is currently a member of the ASTM D-28 Activated Carbon Committee, as well as the American Water Works Association B604 Activated Carbon Committee. He can be reached by telephone at +1.203.241.4511 or e-mail at nmegonnell@atmi.com.

O-18
Practical sustainability projects for breweries

Presenter: Matt Bailey, Odell Brewing Co., Fort Collins, CO

Brewers feel close to the environment and are aware of the impact brewing beer has on the environment. Often, for small and large breweries, finding sustainability projects that have a significant environmental impact on operations are difficult to put into action. Common hurdles include capital, time, experience, and resources. This presentation will cover projects from Odell Brewing that can be implemented with little capital and time. The discussion will provide theory, plans, hurdles, and results of projects. Odell Brewing will cover its "closed-loop" bottle line vacuum pump and "zero-landfill" projects. The closed-loop vacuum pump project converted an open-loop vacuum pump to a closed-loop pump that reuses water many times, only needing to top off water to compensate for slight evaporation. A common problem with the closed-loop system is the temperature of reused water. Cooling of reused water is accomplished using an incoming city water and heat exchanger that is then used for two additional purposes after cooling. Implementation of the vacuum pump project reduced water in the brewery 14%, equivalent to 1,321,000 gal saved in 2012. Also covered will be efforts to overcome hurdles, habits, and implementation of a zero-landfill program at a brewery.

Matt Bailey is the maintenance, engineering manager, and sustainability coordinator at Odell Brewing. He oversees all things regarding maintaining and installing new production equipment, facility upkeep, and grounds at Odell Brewing. He attended Old Dominion University in Norfolk, VA, and Colorado State University in Fort Collins, CO, to acquire a B.S. degree in electrical engineering. While in college, he picked up home brewing as a hobby, which helped fuel his passion for beer, before joining the brewery workforce. Prior to joining Odell Brewing in 2010, he worked at Anheuser-Busch in Fort Collins, working in several different areas, including instrumentation, packaging process improvement, and maintenance reliability, and as a project engineer.

O-19
The algebra of sustainability: Technical metrics for the brewery

Presenter: Jaime Jurado, Susquehanna Brewing Co., Pittston, PA

An infrequently tested proposition from economics is that competitive pressure will force breweries to be efficient. Key ratios and sustainable development indicators (SDI) help focus an approach to sustainability into real and quantifiable action. An attempt to create an aggregate measure of various aspects of sustainability suggests a profile of indices that provide a technical perspective that is global, like world-class manufacturing, but with transparent numerical quantification. By excluding social factors, often a key part of sustainability considerations (i.e., community involvement), the role of the brewer in candidly calculating and presenting SDIs is made easier and clear. Key ratios such as MJ/hL, g of CO_2/L, or hL of water/hL of finished beer help the brewery understand basic primary resource drivers of the enterprise and, if metered sufficiently, of the underlying unit operations within the enterprise. A family of key ratios comprise a new aggregate SDI, which is framed on simple math that demystifies the novel metric, and in which specific sustainable developments at breweries can be seen to influence the SDI. The desired result is that competitive pressure in reducing SDI will motivate breweries to commit to more-sustainable investments in their production operations. Independent craft breweries have supported this development work with travel grants for the presenter to obtain order-of-magnitude scaling data.

Jaime Jurado served as MBAA President in 2005 following service as the editorial board chair of the Technical Quarterly. *With an undergraduate chemical engineering degree, Jaime's brewing career commenced formally after he completed a brewing apprenticeship in the Bavarian breweries of Patrizier-Bräu AG in 1983. Jaime spent 1984 and 1985 working as a project engineer in the London brewery of Truman, Hanbury & Buxton and at the Smithwick brewery in Ireland. He was hired as an assistant brewmaster at The Lion Brewery in Wilkes-Barre (the company which would fund his M.S. degree in electrical engineering). Jaime advanced to the role of master brewer at the brewery and then moved on to a management opportunity at Courage Brewing Ltd. After two years, he reduced his employment to part-time to study and perform research in the Department of Engineering Science at Oxford University, where his research resulted in several publications. He was recruited by Stroh for a new brewery in Rajasthan, India, and other projects. He departed Stroh to become the director of brewing operations at The Gambrinus Company breweries, where he stayed for nearly 15 years. He completed an 18 month "working sabbatical" to design, procure, and commission a new small regional brewery using novel technologies aligned with sustainable explorations across the*

enterprise. He also provided engineering support for the Dingle Distillery in Ireland. Jaime currently is doing engineering consulting work and planning for a new adventure.

O-20
U.S. beer industry insights

Presenter: Lester Jones, Beer Institute, Washington, DC

The U.S. beer industry is in the midst of significant demographic and economic changes. The combined impacts of the 2008 recession and the coming-of-age of the millennial generation have clearly left their mark on the U.S. beer business. Despite these setbacks, the beer industry has adapted to a new marketplace and set a new course. The Beer Institute and its predecessor organization, the USBA, have been tracking the beer industry since the 1940s and have gathered detailed data and insights that help explain where we have been and where we may go from here.

Lester Jones serves as chief economist and senior director of research services for the Beer Institute. In this capacity, he serves as the primary researcher and economist on issues affecting brewers and importers of more than 90% of the beer consumed in the United States. He is responsible for the biennial "Beer Serves America" study showing the total contribution of the beer industry to America's economy through the impact of jobs, wages, and taxes, from the national level to individual state legislative districts. He is also a regular presenter at industry events around the country and comments on industry trends in consumption, taxation, and economic policy. Lester joined the Beer Institute in 2004 and brings 20 years of business and economic research experience to the beer industry's national trade association. Prior to joining the Beer Institute, Lester was with Arbitron, Inc., an international media and marketing research firm. At Arbitron, he managed consumer research studies. Prior to Arbitron, he was assistant director of the Regional Economics Studies Institute at Towson State University. Lester received his M.S. degree in economics from the University of Delaware, where he specialized in regional economics and forecasting. He obtained his B.A. degree in economics from the University of Maryland Baltimore County.

O-21
The 20% solution for consistent beer quality

Presenter: Alastair T. Pringle, Pringle-Scott LLC, St. Louis, MO

Producing a beer with consistent sensory and analytical attributes is an important aspect of quality. For a new brewery this can be a daunting task as there are a seemingly endless number of items in the literature to measure and control. The Pareto principle states that 80% of the effects come from 20% of the causes. Therefore, to make efficient use of their resources brewers should identify and control those vital few (20%) causes that result in the majority of the inconsistency. One approach is to view the brewing process as a series of inputs, processes, and outputs. Through this approach product consistency can be achieved by controlling the inputs and a few key factors in each of the brewery processes. Control of the primary inputs to the overall process can be achieved by accepting shipments based on certificates of analysis, sensory analysis, and periodically auditing critical parameters. In the case of individual brewery processes (brewhouse, fermentation, conditioning, and finishing), each can be controlled by identifying and controlling a few factors that have a major effect on the important attributes of finished beer. Because each process is separate, but interdependent, it is critical to measure the outputs from individual processes. Fermentability, free amino nitrogen, and bitterness are examples of wort parameters that could be measured, as well as gravity, since these parameters affect the performance of the next process (fermentation) and the finished beer. The outputs of the entire process are the analytical and sensory attributes of the packaged beer, where the ultimate test of consistency is their trueness-to-type.

Alastair Pringle earned undergraduate and graduate degrees in microbiology. He joined Anheuser-Busch in 1984 following five years of postdoctoral research. At Anheuser-Busch Alastair held a number of technical management positions, including director of brewing research, where his responsibilities included all aspects of the brewing process. He is currently the principal consultant at Pringle-Scott LLC, a science-based consulting company that works with craft breweries on process control and quality. In addition, Alastair teaches microbiology at Maryville University in St. Louis, MO, and is a member of the IBD Board of Examiners.

O-22
The use of Kaizens as a method for continuous improvement in a unionized 108 year old regional brewery: Framework and real results from The Lion Brewery, Wilkes-Barre, PA

Presenter: Leo Orlandi, The Lion Brewery Inc., Wilkes Barre, PA

Kaizen process improvement and problem abatement strategy that is in place in one of the most traditional unionized breweries around is discussed. The Lion Brewery will share its story of the successful implementation of Kaizen lean manufacturing principles.

Leo Orlandini is currently the master brewer and director of operations at The Lion Brewery, where he has 25 years of brewing management experience. The Lion Brewery is a 108 year old regional brewery located in Wilkes-Barre, PA. Leo received his B.S. degree in biology from Wilkes College in 1983 and began his career with The Lion in 1988 as a quality assurance technician. He was promoted to quality assurance manager in 1990. He attended the Siebel Institute of Technology in 1991 and received his diploma in brewing sciences. In 1999, Leo was named the inaugural Mid-Size Brewmaster of the Year at the Great American Beer Festival.

O-23
VeSave solution to reuse wastewater as technical water and save a significant amount of money

Presenter: Jens S. Krogh, DWE A/S, Vejle, Denmark

Water/wastewater utilization with VeSave solutions concept is discussed. Saving of water by using wastewater as technical water. Wastewater without any vira, bacteria, or suspended solids to be used as technical water in various areas of the

brewery to optimize potable water usage consumption, as well as reduce utility costs. Test case done on a 4 million hL brewery that saved US$3 million per year with a capital expenditure investment of US$1.5 million, giving a simple pay back on investment in 6–8 months. Based on optimization of water balance in a brewery, it was identified where to use recovered clean wastewater as technical water and, thereby, save the cost for usage of water, as well as the cost for treatment and discharge of wastewater.

J. S. Krogh is CEO and founder of companies specializing in energy saving and value engineering.

O-24
Breaking the barriers to collaborative waste-to-energy systems

Presenter: Jeff C. VanVoorhis, Symbiont Science, Engineering and Construction, Inc., Milwaukee, WI

The number of breweries in the United States is at the highest level since prohibition ended in 1933. Craft brewing is the fastest growing market segment of the U.S. alcoholic beverage industry, according to data gathered by the Brewers Association. Annually, breweries in the United States spend over $200 million on energy. Total energy expenditures for malt beverages account for 56% of expenditures. Energy consumption is equal to 3–8% of the production costs of beer, making energy efficiency improvement an important way to reduce costs, especially in times of high energy price volatility. Uncertain energy prices in today's marketplace negatively affect predictable earnings, a concern for companies in the beer industry. For public and private companies alike, increasing energy prices are driving up costs and decreasing their value added. Successful, cost-effective investment into energy efficiency technologies such as waste-to-energy meets the challenge of maintaining the output of a high-quality product. Energy efficiency is an important component of a company's environmental strategy, as well. End-of-pipe solutions can be expensive and inefficient, while energy efficiency can often be an inexpensive opportunity to reduce pollutant emissions. Energy efficiency can be an effective strategy to work toward the "triple bottom line" that focuses on the social, economic, and environmental aspects of a business. Waste-to-energy is a cost-effective way to reduce energy consumption within a short payback period and accrue other benefits, such as reducing carbon dioxide emissions, reducing waste, and saving water. Creating energy from waste materials of the brewing process is important for breweries that are concerned with changing regulations. Today and in the future it will become very difficult for the brewing industry to dispose of its waste materials. Due to new regulations and higher standards for waste treatment, producers are being forced to find new methods of cost-neutral discharge of their biological waste that also meet regulatory requirements. This presentation will examine energy efficiency opportunities available to breweries using waste-to-energy technologies and financing to implement projects that result in an aggressive payback. We will explore anaerobic wastewater treatment, an alternative method for treating industrial wastewater that converts organic compounds in the wastewater into a renewable biogas that can be used to create energy on site. We will also explore several breweries that are using this technology and the positive return on investment. If return on investment is the primary barrier to realizing all the benefits of waste-to-energy projects, then one must consider the financial benefit of tax credits associated with energy recovery, as such credits will have a significant impact on project payback. We will explore financial aspects of these projects, including cumulative incentives, grants, loans, tax credits, and private equity. Mezzanine and traditional financing, other loan programs, negotiated incentives, and tax credit programs will also be discussed.

Jeff VanVoorhis has been a member of MBAA for more than five years and has contributed to the organization as a presenter on various brewing technology topics. Jeff is a senior project manager at Symbiont, who, since 1995, has specialized in industrial wastewater treatment, waste minimization, and renewable energy. Jeff holds a bachelor's degree in civil engineering from Purdue University and an MBA from Marquette University. Jeff has served as a project manager on numerous industrial wastewater projects that have total construction costs exceeding $100 million. During the past year, Jeff has been integrally involved in the design of wastewater energy production and recovery for two regional waste-to-energy designs in the state of Wisconsin, which produce 2 and 3.2 MW of green electric energy. He also has served as lead design engineer on comprehensive studies for energy use at digestion facilities for numerous industrial wastewater plants.

O-25
Case study—Executing a 210 kW combined heat and power project

Presenter: Mark A. Linsberg, Enerfab, Cincinnati, OH

Combined heat and power (CHP) is an efficient and clean approach to generating electricity and useful thermal energy from a single source of fuel. CHP has been in use in the Unites States for more than 100 years and currently represents approximately 8% of all generating capacity or 82,000 MW, located at over 3,600 industrial and commercial facilities. Centralized electric power generation in the United States typically converts 34–35% of the fuel consumed into electricity, with the remainder of the energy lost in the form of waste heat. Installing a CHP system that uses thermal energy and electricity can result in 60–85% of the fuel energy being utilized. Breweries are great potential candidates for implementing CHP because electricity, steam, and hot water are all requirements of the brewing and packaging processes. Although there are several U.S. breweries that have installed CHP systems, the majority have not. We believe there is great opportunity for additional U.S. breweries to cost effectively implement CHP projects. Successful execution of a CHP project requires financial, legal, engineering, construction, and environmental expertise. The case study presented describes the process of developing a 210 kW CHP project from concept though start-up. The steps described in the study are applicable to most CHP projects no matter the size.

Mark Linsberg is the director of alternative energy at Enerfab, where he has worked for three years. Mark has 30 years of experience in the energy industry. Prior to joining Enerfab, he worked for Dayton Power and Light, East Kentucky Power Cooperative, and Dravo in a variety of engineering and management positions. Mark is a licensed professional

engineer in Ohio and received his undergraduate degree in construction engineering from Purdue University.

O-26
Yeast mitochondria—Their influence on brewer's yeast fermentation and medical research

Presenter: Graham G. Stewart, GGStewart Associates, Cardiff, U.K.

Brewer's yeast strains (both lager and ale cultures) belong to a commercially significant grouping of yeast species that are used for the production of food, alcoholic beverages, and drugs for medicinal purposes. In addition, this yeast group is an invaluable model eukaryote because it is a single cell that can be genetically manipulated and cultured in the laboratory. The fact that it possesses a cell structure similar to plants and animals, including humans, that includes cell walls, a nucleus, vacuole(s), membranes, and mitochondria is also very important. In *Saccharomyces cerevisiae* and related species (including brewer's yeast strains) the most frequent spontaneous mutation is to the specific DNA contained in its mitochondria (mtDNA). This mutation is termed respiratory deficiency (RD) or petite because of the small size of the resulting colonies compared with the respiratory sufficient variant. The phenotypic effects of the RD mutation in a brewer's yeast culture are profound, and examples, particularly during wort fermentation, will be discussed. In addition, fundamental research on yeast mtDNA has assisted our knowledge of human mitochondrial function and disease. There is a group of diseases caused by dysfunctional mtDNA often as a result of mutation of mtDNA. These diseases include type one diabetes, deafness, hereditary optic neuropathy, and epilepsy, to name just a few. Mitochondrial research with yeast has provided considerable information and assisted medical research on many of the diseases listed above. Indeed, current research removing the mtDNA from the ovaries of a diseased patient and replacing it with unmutated mtDNA from a donor to produce healthy zygotes is a novel technique with significant potential. Importantly, in the context of this presentation, without mitochondrial research on brewer's yeast and its close relatives, these medical developments would have been inhibited, impeded, and protracted.

Graham Stewart, emeritus professor in brewing and distilling at Heriot-Watt University, Edinburgh, Scotland, was director and professor of the International Centre for Brewing and Distilling, Heriot-Watt University, from 1994 to 2007. He received his BS. (Honors) degree in microbiology and biochemistry from the University of Wales, Cardiff, and Ph.D. and D.S. degrees from Bath University. He was a lecturer in biochemistry in the School of Pharmacy at Portsmouth College of Technology (now Portsmouth University) from 1967 to 1969. From 1969 to 1994 he held a number of technical positions with Labatt's in Canada and from 1986 to 1994 was its brewing technical director. He was president of the Institute of Brewing (now the Institute of Brewing and Distilling) in 1999 and 2000. He is also a member of MBAA and ASBC. He holds fellowships in IBD, the Institute of Biology, and the American Academy of Microbiology. He has more than 300 publications (books, patents, review papers, articles, and peer-reviewed papers) to his name. Upon retiring he established a consulting company, GGStewart Associates, with an office in Cardiff, Wales. He was awarded the IBD Horace Brown Medal in 2008, the ASBC Award of Excellence in 2008, the MBAA Presidential Award in 1983 and 1998, the MBAA Award of Distinction in 2009, and the Society of Industrial Microbiology Charles Thom Award in 1988.

O-27
Maintaining batch consistency with subsequent knock out brews

Presenter: Eric C. Baumann, Oskar Blues Brewery, Brevard, NC

As breweries grow and expand, there comes a time when it no longer takes one brew to fill a fermenter, but several to fill one larger vessel. Knocking out multiple batches in the same fermenter quickly becomes standard practice. However, with multiple knock outs and extending total fill times, there are several factors that come into play to achieve the same flavor profile and product as is seen with single-fill batches. Batch consistency can be maintained by analyzing data collected from baselines established in each series of subsequent brews. If the appropriate baselines are not established or managed correctly, a finite fermentation curve and flavor profile is hard to achieve. This presentation will show process changes, analysis, and improvements made throughout the subsequent knock-out brewing process that equate to desired beer quality.

Eric C. Baumann is currently director of fermentation and quality control for Oskar Blues Brewery in Brevard, NC. He has been with Oskar Blues for more than four years. Within hi first few years at Oskar Blues, as cellar manager, Eric saw the growth of 70,000 bbl. He worked closely with brewhouse, lab, and plant managers to execute and achieve process improvements, plant expansions, and product quality control steps. In October 2012, Eric moved to Brevard, with a team of four others, to build and oversee the production of Oskar Blues newest brewery, which has an initial capacity of 50,000 bbl/year. He has previously worked at Uinta Brewing Co., Salt Lake City, UT, and Grand Teton Brewing, Victor, ID. Eric received his B.S. degree from the University of Utah in anthropology, with a minor in history. Eric started, as many do, home brewing on the side while pursuing a career in archaeology. Growing tired of archaeology and wanting to pursue a career in brewing, Eric got his foot in the door washing kegs at Grand Teton Brewing. Since then, he has been a part of several successful breweries and teams that have shaped his overall brewing background and passion to continue to push craft brewing further.

O-28
Genetics, ecology, and the diverse species *Saccharomyces cerevisiae*—Isolation of novel strains and lineages

Presenter: Rob J. Arnold, F&R Distilling Co., Fort Worth, TX

The budding yeast *Saccharomyces cerevisiae* has been associated with human activity for several millennia due to its use in a variety of processes, including the fermentation of alcoholic beverages. The species has also been intensively studied in the laboratory, being used as a model organism for genetics and molecular biology. It was the first eukaryote genome to be sequenced, and its 12 Mb genome is better annotated than any other eukaryotic organisms. The intensive research that surrounds *S. cerevisiae* has revealed surprising

data that could prove groundbreaking with regard to the production of alcoholic beverages. In 2011, there were five known lineages of *S. cerevisiae*: wine/European, North American, Malaysian, West African, and sake. In the Western world, most industrial yeasts (brewing, winemaking, etc.) come from the wine/European lineage (Warringer et al., *PlOS Genet.,* 2011). Data from the Warringer et. al. study revealed that each lineage possesses population-specific traits that are unique to one lineage. Traits (or phenotypes) result from the expression of an organism's genes, and genes control the expression of proteins that facilitate the catabolism of wort components into ethanol and aroma compounds. Therefore, it can be argued that population-specific traits among lineages could result in either the production of novel aroma compounds or the production of already known aroma compounds at strikingly different concentrations than are normally observed. In 2012, a Chinese expedition revealed eight new lineages of *S. cerevisiae* that were unknown to science: CHN I–CHN VIII. Interestingly, CHN I was revealed to be ancestral to all known lineages, making China the proposed origin of the species. If the argument that lineages contain population-specific traits is true, the discovery of eight new lineages could produce a wealth of novel aromas to be incorporated into alcoholic beverages. Furthermore, when one considers that the Western world has only utilized one lineage industrially, there are at least 11 lineages that could be explored for beverage production. Indeed, at least some of the lineages other than wine/European are suitable for beverage alcohol fermentation, with the sake and West African lineages being used for the production of sake and African being used for wines and beer, respectively. In 2011, Firestone & Robertson's Head Distiller Rob Arnold isolated 11 *S. cerevisiae* strains from a Texas pecan nut. One of these isolates, nicknamed Brazos, is the strain used at the distillery today. Although there is a North American lineage, all the strains within this lineage are unable to metabolize maltose. Arnold's strain is very effective at maltose fermentation, leading him to believe that the strain could fit into an unknown or mosaic lineage. This oral presentation will cover topics on *S. cerevisiae* lineages, the potential of lineage diversity with regard to unique flavors in fermented beverages, and the data surrounding the Brazos strain pertaining to lineage and novel aroma compound production.

A native of Kentucky with a grandfather and multiple uncles who worked in the bourbon industry, Rob Arnold grew up surrounded by the distilling world. After graduating from the University of Tennessee with a bachelor's degree in microbiology, he enrolled in a Ph.D program in biochemistry at UT Southwestern Medical Center at Dallas, where he studied microbial fermentation and analytical chemistry. Two years into the Ph.D. program, he was contemplating leaving the medical research field to open a distillery. While in the early fundraising stages of pursuing that goal, he learned of the Firestone & Robertson Distilling Co. from Fort Worth South—the development group with which both he and F&R were working. Rob contacted F&R and learned that they were in need of a head distiller. After meeting with Leonard Firestone and Troy Robertson, and realizing they all had similar visions for bringing whiskey to Fort Worth, Rob left school early with his master's degree and joined the F&R team in 2011.

O-29
Automated quantification of budding *Saccharomyces cerevisiae* using a novel image cytometry method

Presenter: Leo L. Chan, Nexcelom Bioscience, Lawrence, MA
Coauthors: Daniel J. Laverty, Alexandria Kury, Dmitry Kuksin, Alnoor Pirani, and Kevin Flanagan, Nexcelom Bioscience, Lawrence, MA

Concentration, viability, and budding percentages of *Saccharomyces cerevisiae* are routinely measured in the biofuel and brewing industries. Measurement of these parameters is of great importance in a manufacturing setting because they can aid in the estimation of the product quality, quantity, and fermentation time of the manufacturing process. Specifically, budding percentages can be used to estimate the reproduction rate of yeast populations, which directly correlates with metabolism of polysaccharides and bioethanol production, and can be monitored to maximize production of bioethanol during fermentation. The traditional method involves manual counting using a hemacytometer, but this is time-consuming and prone to human error. In this study, we developed a novel automated method for the quantification of yeast budding percentages using Cellometer image cytometry. The automated method utilizes a dual-fluorescent nucleic acid dye to specifically stain live cells for imaging analysis of unique morphological characteristics of budding yeast. In addition, cell cycle analysis is performed as an alternative method for budding analysis. We were able to show yeast budding percentages that were comparable between manual and automated counting, as well as cell cycle analysis. The automated image cytometry method was used to analyze and characterize corn mash samples directly from fermenters during standard fermentation. Since concentration, viability, and budding percentages can be obtained simultaneously, the automated method can be integrated into the fermentation quality assurance protocol, which may improve the quality and efficiency of the bioethanol production process.

Leo Chan currently serves as the technology R&D manager and senior scientist at Nexcelom Bioscience LLC, Lawrence, MA. His research involves the development of instruments 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).

O-30
Pioneer wort boiling process with innovative internal calandria

Presenter: Tobias Becher, Ziemann International GmbH, Ludwigsburg, Germany
Coauthor: Klaus Wasmuht, Ziemann International GmbH, Ludwigsburg, Germany

Modern wort boiling systems must work with individual process recipes, which can be divided into three phases: heating, simmering, and evaporating. To provide these three phases, an internal calandria usually relies on additional wort circulation pumps. Otherwise a huge effort is necessary for cleaning if the boiling time is increased and heat supply

is damped down. The innovative design introduced here provides a solution without such disadvantages. It consists of two interconnected heating segments, each of which can be activated separately. The two segments reflect three boiling phases. The essential function is achieved by means of Venturi effects. The required product circulation can be combined with the lowest possible heat supply. The heating segment in use always operates in optimum heating-flow conditions. Simmering can be introduced as a rediscovered procedure. A series of tests was performed in a pilot brewery to prove functionality. In 2013 two breweries with a cast out wort of approximately 80 bbl successfully installed the novel equipment. Using the same occupancy time, a lower evaporation rate can be achieved, the tendency to fouling can be reduced, and thus, product quality (TBI, free DMS, DMS precursor, protein fractions, aroma profile) can be maintained. Moreover, an efficient use of energy can be achieved. The presentation describes the novel calandria design, the respective process technology, and the technological results in practice.

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

O-31
From barley to the glass—Create your own beer

Presenter: Johannes Preiss, Kaspar Schulz, Bamberg, Germany
Coauthors: Jörg Binkert, Johannes Lauer, and Dietram Haertl, Kaspar Schulz, Bamberg, Germany

Until the middle of the last century the malthouse was an integral part of many breweries. Thus, brewers were able to control all technical and technological operations. Nevertheless, at least in Germany, the professional title is still "brewer and maltster." As a result of this capability brewers could directly affect the characteristics and quality of their malts, which led to an unlimited variety of types and flavors. Currently, the trend toward individualization of beers is experiencing a strong revival, but at the moment, brewers are depending on the raw materials offered by the markets, with all that implies. The history of the 336 year old company Kaspar Schulz contains chapters where malting technology played a big role. Already at the beginning of the last century machinery for malthouses was produced in Bamberg. This technology should be recovered and adapted to the current needs of brewers and maltsters. For this purpose a compact malting plant was developed by Kaspar Schulz. The system includes the needed ventilation technology and fits into an area of just 20 m^2 for an output of 2 tons/week. The largest drum is designed for a maximum output of 25 tons/week. The process steps steeping, germination, and kiln-drying are automatically operated in a drum system and a consigned steep. Careful conveying and gentle agitation are realized by the slow rotation of the drum in combination with an integrated screw conveyor. Modern manufacturing technologies guarantee an optimized hygienic design of the plant. Besides compact construction, the modularity of the system offers many advantages. Thus, the system can be easily expanded, e.g., by a further drum for germination and kiln-drying. This additional drum may use the existing steep, the burner and glass tube heat exchanger of the ventilation system, as well as the handling and processing equipment for grain and malt. All process steps are fully automated and customizable. It's possible to produce all common types of malt. In combination with the handling and processing equipment for grain and malt, the brewer can independently create his own product from corn stalk to the glass. The prototype of this system was successfully tested at the beginning of this year at Kaspar Schulz in Bamberg. The results of this research project, as well as the easy use of this system, will be presented in this work.

Johannes Preiss' 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 Krones AG, Germany, as a project manager in the Research & Development Department. The main focus of his work was brewhouse and cleaning technology, as well as energy optimization. His main topics were lautering technology and integration of solar heat into breweries. As a result of his work, Johannes published several patents and scientific papers. Since the end of 2012 he has been working as the technical director for Kaspar Schulz, Bamberg, Germany. Besides his profession, Johannes is a talented musician. In 2009 he received the cultural award from the City of Nuremberg, Germany.

O-32
Engineering and design of brewery water deaeration systems

Presenter: J. David Duff, FleetwoodGoldcoWyard, Romeoville, IL
Coauthor: Joshua Brickel, FleetwoodGoldcoWyard, St. Louis, MO

This paper covers the basic principles involved in deaerating water. Based upon these principles, this paper details the critical design parameters that need to be taken into consideration by brewers to help identify the operational specifications they need to be aware of for ensuring the right design. There are different technologies available for controlling dissolved oxygen. This discussion will identify the options and describe their benefits, capabilities, and limitations. A relatively comprehensive review of selection of components, determination of the level of automation, and considerations that need to be taken into account for properly integrating the deaeration system with existing brewery operations will be covered. Finally, an estimate of the costs associated with purchasing and installing a brewery water-deaeration system is provided to help brewers budget for this improvement.

David Duff has been a member of MBAA since 1982 and has held positions in his local district, as well as contributed on the Technical Committee as an organizer and session moderator. He has presented at MBAA Annual Conferences on several occasions, covering brewery pasteurization technologies. David began his career with Labatt Brewing Company in Canada. In 1997 David left Labatt to join forces with the Stroh Brewing Company as director of packaging operations. He

now holds the position of North American sales executive with FleetwoodGoldcoWyard, part of the Barry-Wehmiller Group of Companies, where he specializes in brewery process equipment technologies.

O-33
An economical brewery temperature control and monitoring system built using commercially available components

Presenter: Adam DeBower, Austin Beerworks, Austin, TX
Coauthor: Ken DeBower, Austin Beerworks, Austin, TX

Brewery temperature control systems are often expensive and uni-dimensional, i.e., capable of consistent control but incapable of remote control and monitoring. Existing commercially available integrated systems are expensive and inflexible. Austin Beerworks has developed a flexible system that utilizes a standard PC, freeware programmable software, and readily available PLC and other hardware components to monitor and control the temperature of all fermentation vessels, brite tanks, and hot and cold liquor tanks. Further brewery process monitoring and control has been integrated into this system with minimal additional capital expenditures. All components are readily available, with the exception of a simple signal conditioning device that was fabricated in-house. Analog data are fed from the temperature probes (Johnson Controls A99-B) to the signal conditioners, which in turn are processed by analog-to-digital (A/D) converters and ultimately interpreted by a PLC. The PLC controls the opening and closing of glycol valves at the tanks or steam valves in the case of the hot liquor tank, and a positive confirmation mechanism feeds back glycol valve position information to the PLC. Temperature probes, glycol control power, and glycol valve position data are all connected to the PLC via a CAT 6 data cable that consists of 4 twisted pairs of 23 AWG wire. The PLC is programmed and monitored by a server running on Microsoft Server 2008 via machine-to-machine (M2M) programmable freeware, and all data are archived and searchable on the server. The server and PLC are physically connected via local area network (LAN) and RS-232. The data and control features are made available via any Internet browser and on any computer or device with Internet connectivity anywhere in the world. Programming is accomplished in-house and can be augmented to add or subtract functionality as needs change. Data returned from the tanks are constantly monitored for noise or unusual values, and the program actively monitors for such anomalies and alerts plant management when any occur. Other processes that have been added include automatic hot liquor tank filling and recirculating during heating, brewhouse and cellar pump control, flow meter monitoring, and various packaging counting processes. Archived data are exportable to Microsoft Excel and Quickbooks.

Adam DeBower is co-founder and co-owner of Austin Beerworks, a canning craft brewery in Austin, TX. In addition to managing fermentation, filtration, and packaging operations, Adam spends a large amount of his time maintaining brewery physical plant systems and special project procurement and installation. Adam worked at Flying Dog Brewery in Frederick, MD, and at Real Ale Brewing in Blanco, TX, prior to founding Austin Beerworks. A native Texan, Adam was born and raised in Austin and is an alumnus of Baylor University.

O-34
The effect of platelet-activating factor on yeast attenuation

Presenter: Phillip Callihan, University of South Carolina School of Medicine Greenville, Greenville, SC
Coauthor: William E. Roudebush, University of South Carolina School of Medicine Greenville, Greenville, SC

Studies have reported that beer (moderate consumption) can have a positive impact on health and disease prevention (reviewed in *Beer in Health and Disease Prevention*, V. R. Preedy, ed., Academic Press, London, 2009). Additionally, there is emerging evidence demonstrating the antioxidant capacity of beers (Zhao et al., J. Sci. Food Agric. 93:910-917, 2013). The health benefits of beer may be tied to its overall quality. Beer quality is strongly influenced by the biochemical performance of yeast (*Saccharomyces cerevisiae*) during fermentation, with performance defined as the capacity of yeast to exhibit cell growth, attenuation, flocculation, and flavor. A number of biochemical compounds are produced by yeast, including lipids. Yeast lipids have a substantial influence on beer quality due to sterol synthesis controlling yeast growth. In particular, yeast cells synthesize a unique and novel lipid, i.e., platelet-activating factor. Platelet-activating factor (1-*O*-alkyl-2-*O*-acetyl-*sn*-glycero-3-phosphorylcholine; PAF) is a potent signaling phospholipid that appears to be critical for many of the events surrounding cell development and metabolism. Yeast synthesis of PAF appears to control the cell cycle phase in budding yeast. In a preliminary study, we described temporal PAF production in ale and lager yeast at different culture temperatures (Roudebush et al., Am. J. Brew. Chem. 64:135-138, 2006). Little information is known on the direct impact PAF has on the physiological biochemistry of yeast. Therefore, the study objective was to determine the effect of exogenous PAF on brewer's yeast (*S. cerevisiae*) attenuation. A proprietary strain of brewer's ale yeast (No. 1028; Wyeast Laboratories, Inc., Odell, OR) was cultured in sterile dried malt extract (DME; 13.8°P; Crosby and Baker, Westport, MA) in water. Individual static yeast cultures (50 mL total volume; 5 mL head volume) were anaerobically incubated at 20°C. Samples (500 µL) of yeast-conditioned DME culture media were obtained at specific intervals (0, 24, and 48 hr of culture), and specific gravities (°P) were measured by refractometry (Grand Index, Hong Kong; model RSG-100/ATC) and recorded. There was a significant difference ($P < 0.05$) between the control (5.8°P) and PAF (4.6°P) group attenuation at 24 hr. At 48 hr (final attenuation), differences between the control (4.8°P) group and the PAF (4.6°P) group approached significance ($P = 0.065$). The data demonstrate that brewer's yeast responds to PAF with a lower attenuation and in a shorter time period. Additional studies are warranted to determine the impact of PAF on yeast fermentation time (potentially increasing beer production throughput efficiency) and attendant beer quality.

Phillip Callihan completed his Ph.D. degree in pharmaceutical and biomedical sciences at the University of Georgia in 2012 and is currently pursuing an M.D. degree at the University of South Carolina School of Medicine Greenville. He is a member of the American Society of Pharmaceutical Scientists and the American Medical Association. In 2011, he delivered an invited talk at the Southeastern Regional Lipid Conference titled "Distinct Generation, Pharmacology, and Distribution of Sphingosine 1-Phosphate and Dihydro-sphingosine 1-Phosphate in Human Neural Progenitor Cells." Phillip has

authored multiple biochemistry and pharmacology publications and is now investigating the potential roles of beer in improving human health.

O-35
Operating a secondary location for barrel-aged wild and sour beer production

Presenter: Chad Yakobson, Crooked Stave Artisan Beer, Denver, CO

The ability to segregate processes that could pose potential hazards for contamination has always been crucial in the brewery setting. In large breweries that could mean physical separation via different levels of production or storage spaces that are adequately confined. To many medium-large to smaller brewers, introducing wild yeast and bacteria poses a threat that is not always visible, and the segregation of equipment can be tedious. Building and operating a secondary off-site location is commonplace when it comes to cold storage of the finished product. The off-site model poses a solution for the conscious brewery looking to separate wild and sour beers from production beers. The dramatic increase in wild and sour beer production is evident in every size brewery, and the secondary location model poses a solution for breweries looking to branch out and maintain consistency, while still having the ability to not tie-up production space with barrels and wild yeast. This presentation covers the considerations for running an off-site barrel warehouse from initial start-up and equipment considerations to daily operations and considerations for transport and scheduling.

Chad Yakobson is the owner and director of operations of Crooked Stave Artisan Beer Project in Denver, CO. After initially studying winemaking in New Zealand, Chad switched his focus to the brewing industry, concentrating on various microorganisms present during barrel aging of sour beer. In 2010 Chad completed his master's thesis, "Primary Fermentation Characteristics of Brettanomyces *Yeast Species and Their Use in the Brewing Industry," and was awarded an M.S. degree in brewing and distilling from Heriot-Watt University and the International Centre for Brewing and Distilling in Edinburgh, Scotland.*

O-36
Innovations in antimicrobial tubing eliminate bacteria and biofilm growth in closed draught systems and brewery environments

Presenter: Greg Kinney, Eldon James Corp., Denver, CO
Coauthor: Bill A. Coulson, Eldon James Corp., Denver, CO

In the brewing environment, there are a few microorganisms capable of growing in and deteriorating beer. Four industry isolates were found to be most common in the formation of biofilm in beer dispensing and brewing environments. These include *Acetobacter lovaniensis*, *Wickerhamomyces anomalus*, *Lactobacillus brevis*, and *Pseudomonas aeruginosa*. The presence of these beer spoilers gives insight into the hygiene conditions of a brewery or dispensing system. Biofilm growth is common on equipment components and in niches that are difficult to clean. They come in contact with the product and provide ideal growth conditions for a multitude of germs that affect flavor, aroma, and the overall quality of beer. Utilizing a breakthrough in silver ion technology, a newly developed PVC-free tubing co-extruded with a silver lining has been verified to be effective against these top four beer-spoiling bacteria and the growth of biofilm. Third-party test results have proven that this new innovation is capable of reducing the concentration of all the selected biofilm microorganisms by up to 100% over a 24 hr test period.

Gregory W. Kinney has been with the Eldon James Corporation for one year. His primary role has been to expand precision manufacturing to the food and beverage markets. Greg has seven years of experience in the beer industry, with a deep knowledge of draught systems and quality challenges for on- and off-premise accounts. He has served in many roles, including draught system quality assurance, brand development, and sales management.

O-37
Relationships between dry hopped beers and diacetyl formation

Presenter: Kara M. Taylor, White Labs, Inc., San Diego, CA

Far too often people are encountering diacetyl in beers made today. Many times, diacetyl is found in beers that should stylistically have zero: pale ales, India pale ales, and double IPAs. This style of beer, typically fermented with a clean profile yeast strain, should have no diacetyl present, and yet more and more cases are being found with a plethora of diacetyl. One untested theory of the source of excess diacetyl is the relationship between the fermentation and the addition of hops after fermentation begins. What is the interaction between added hops and krausen? Are hops helping with the transition from acetolactate to diacetyl? Using controlled fermentations and gas chromatography, we can make some determinations about when diacetyl is forming and suggest how it can be prevented in dry-hopped beers.

Kara Taylor received a B.S. degree in biology from Loyola Marymount University in Los Angeles, CA. She began employment at White Labs in San Diego, CA, in 2009 as a yeast laboratory technician. Since 2011, she has functioned as the analytical laboratory specialist in White Lab's analytical laboratory. She is a member of MBAA and ASBC and serves on multiple subcommittees.

O-38
Beer filtration—Present and future

Presenter: Fred Scheer, Krones, Inc., Franklin, WI
Coauthor: Michael Skroblin, Krones, Inc., Franklin, WI

Beer filtration is inherently a balancing act. Precoat filtration technology is the most widespread method of filtration used. It has been developed over the last decades into an increasingly efficient filtration technology. We have to discuss the removal of haze particles, haze-producing substances, and removal of organisms. Filtration must be tight enough to remove these unwanted components, without losing the essential quality of the beer filtered. It is the unique design of powder filters, and the twin flow system (TFS) filter in particular, that allows for the use of many types of filter aids, including replacements for

kieselguhr, some of which are being researched or are close to market release. In powder filtration, the brewing industry has relied on a proven, effective, and flexible system, with a high flux rate producing high-quality results.

Fred Scheer graduated in 1976 from Doemens Brewing Academy (Munich, Germany) with a brewmaster's degree in brewing and malting. He worked at several breweries in Europe before emigrating to the United States in 1983 to help establish Capital Brewery in Madison, WI. Later, he was technical director for the Frankenmuth Brewery, a 50,000 bbl brewery in Michigan. He also worked for Pabst Brewing in Milwaukee, WI, in corporate brewing and for their China operation. In 2011 Fred accepted the position of director of brewing and process technology with Krones Inc. in Franklin, WI.

O-39
New approach in beer clarification with the focus on precoat filtration

Presenter: Joerg Zacharias, Krones AG, Neutraubling, Germany

Precoat filtration technology is the mostly widely used method of filtration. It has been developed over the last decades into a highly efficient filtration technology. In addition, when compared with alternative filtration methods it has advantages, especially in its variability with regard to malt quality influenced filtration problems and also with regard to cost minimization. More than 80% of beer clarification is done using precoat filtration with kieselguhr as the filter aid. Its handicap is the increasing demands associated with disposal of kieselguhr. Changing legislation is leading to strong requirements, especially in central Europe. This uncertainty is unsettling the brewing guild. Starting with well-developed precoat filtration, possibilities, limitations, and alternatives must be discussed. This is forcing increasing engagement in finding the best alternative processes or media for kieselguhr. All the previously applied alternative techniques have in common is that they cannot deliver the same technological flexibility with the same technological and sensory quality over the whole process. Breweries with a wide variety of products, in particular, will have this main objection to performance. As a main focus, therefore, the well-proven Krones technology, the twin flow system, is an ideal exceptional base for using alternative filter aids. A new approach will be presented and discussed with regard to the following aspects underlined by the expertise provided by the last year's work. In the development of new strategies to substitute for the kieselguhr filtration process the approach is driven by the quality of filtrate, flexibility due to malt quality and raw materials, harmlessness of possible filter aid, disposal, energy consumption, and adaption to manpower. In summary, sustainability has to be considered.

As a student of food technology in Weihenstephan, Joerg Zacharias obtained his doctorate at TU in Munich in the Chair for Fluid Mechanics and Process Automation. It was there that he also lectured for several years on food process technology and measurement technology used in biotechnology. He has been an employee of Krones AG since 2005, working in the R&D Process Technology Division for the beer, water, milk and juice sectors. As an expert on rheological and process engineering issues, as well as on the requirements of hygienic design in process technology, Joerg plays an important role in the current development projects performed at Krones AG.

O-40
Direct oxidation of amino acids—An unrevealed pathway leading to the formation of staling aldehydes in bottled beer?

Presenter: Philip C. Wietstock, Technische Universität Berlin, Berlin, Germany
Coauthors: Thomas Kunz and Frank-Jürgen Methner, Technische Universität Berlin, Berlin, Germany

Off-flavor in lager beer is often associated with the appearance of staling aldehydes such as 3-methylbutanal, 2-methylbutanal, methional, phenylethanal, and benzaldehyde. Previous storage experiments revealed that elevated concentrations of Fe and oxygen promote the rate of beer flavor staling. Known mechanisms, such as Strecker degradation of amino acids, alone give no explanation for this phenomenon. Additional storage trials were conducted to further assess this observation. A commercially available lager beer was dosed with varying level of amino acids and Fe, respectively, and stored over a period of 6 months (dark, 28°C, with and without oxygen in headspace). Bottles without additions served as references. Staling aldehyde levels were measured during storage via SAFE-GC/MS, and oxidative beer stability was determined using electron spin resonance (ESR) spectroscopy. The experiment confirmed that staling aldehyde levels in bottled beer positively correlate with both amino acid and Fe levels and are increased by the presence of oxygen. Bench trials using model solutions (acetate buffer, pH 4.3, 5 vol.-% EtOH) revealed that oxidation of leucine, isoleucine, and phenylalanine via Fe-H_2O_2 yields 3-methylbutanal, 2- methylbutanal, phenylethanal, and benzaldehyde, respectively. Furthermore, radical concentration as measured using ESR spectroscopy directly correlated with the formation of these aldehydes. A so far unrevealed staling mechanism via direct oxidation of amino acids by hydroxyl radicals in bottled beer is proposed.

Philip Wietstock is a scientific assistant at the Technische Universität Berlin, Germany. After graduating with a Dipl.-Ing. degree in biotechnology from the Technische Universität Berlin (2009), he worked for one year as an intern at the Department of Food Science and Technology at Oregon State University, Corvallis, OR. In 2011, he transferred to his present profession, where he is working on his dissertation, for which he is investigating parameters influencing oxidative beer stability.

O-41
Are U.S. brewers ready for beer membrane filtration (BMF)?

Presenter: Rik Schuurman, Pentair Haffmans, Venlo, The Netherlands

The filtration of beer with membrane filters is gaining a serious foothold in beer markets worldwide. Brewers recognize the advantages of this relatively new technology. From the perspective of beer quality, membrane filtered beer is consistently and significantly better for turbidity, physical/chemical stability, and taste stability. Next, by eliminating diatomaceous earth (DE), disposal and health issues are no

longer a concern for the brewery. The operation of membrane filtration is simple and straightforward, with very short stop-start-stop times and fast brand changes. In addition, CAPEX and OPEX are competitive, especially with the new BMF compact unit. Beer membrane filters (BMF) have been on the market for more than 10 years. In the first quarter of 2013, Pentair wrote its 50th order for a BMF, but no U.S. brewery has a BMF installed even though U.S. breweries produce about 10% of the world's beer. In this presentation the latest BMF design will be discussed, along with the results of an analysis on how BMF, and especially the new compact unit, fits into the U.S. brewing industry. In addition, misconceptions like the need for a centrifuge and compatibility to stabilization methods will be discussed.

Rik Schuurman has more than 25 years of experience in the brewing industry and has been a senior process engineer at Pentair since 1999. He is a brewmaster specializing in the design and engineering of all kinds of brewery systems. For the last 10 years, his work has focused on beer membrane filtration as an alternative to diatomaceous earth filtration.

O-42
Factors influencing the losses of bitter substances and possibilities to increase the yield during brewing

Presenter: Frank-Jürgen Methner, Technische Universität Berlin, Berlin, Germany
Coauthors: Thomas Kunz and Mario Marinoff, Technische Universität Berlin, Berlin, Germany

Bitter substance utilization during conventional beer production is quite low and still a major problem for the brewing industry. Brewing trials were conducted to evaluate the effect of pH and iron on bitter substance yield. In addition to fermentation trials, hopped and unhopped worts with and without iron addition were adjusted to different pH values. Bitter substance yield was significantly influenced by both pH and iron concentration. Acidifying the system yielded reduced bitter units, hop acid, and iron concentration. Regardless of the initial pH, bringing the pH to alkaline conditions again caused the highest results. Iron content in unhopped wort was unaffected by pH adjustment. The results suggest that reversible, pH-dependent hop-acid-iron complexes are formed and are mainly responsible for the loss of bitter substances during fermentation. Additional trials are presented that demonstrate that the outcomes of this research can be used to recover hop acids from hot trub.

Frank-Jürgen Methner conducted studies in brewing science at Berlin Institute of Technology (TU) from 1975 to 1981. After the studies, he began working as an operating supervisor at the Schlösser Brauerei, Düsseldorf. From 1982 to 1986, he was a scientific assistant with teaching duties at TU Berlin. Research projects and Ph.D. thesis, "Aroma Formation of Berliner Weissbier with Special Focus on Acids and Esters," were further tasks. For 18 years, starting in 1987, he held a leading position as a director at the Bitburger Brauerei, Bitburg, Germany, with responsibilities in fields such as research and technology, as well as quality assurance. Beginning with the winter semester 2004/2005 he took over the Chair of Brewing Science within the Department of Biotechnology at Berlin Institute of Technology (TU Berlin).

O-43
Evaluation of the brewing properties of the new German hop varieties

Presenter: Andreas Gahr, Hopfenveredlung St. Johann GmbH & Co. KG, Train-St. Johann, Germany
Coauthor: Adrian Forster, HVG Hopfenverwertungsgenossenschaft e.G., Wolnzach, Germany

The brewing properties of new hop varieties, once registered, are mostly evaluated empirically, although systematic trials are often missing. This applies also to four new German varieties, the so-called "flavor hops": Mandarina Bavaria, Polaris, Huell Melon, and Hallertau Blanc. The 2012 crop is the first crop to provide hops from the four new varieties from mature plants harvested using standard picking methods. These were used to conduct all malt lager brewing trials with brews of 2 hL each together with established varieties. Apart from an extensive analytical characterization of all hop-relevant ingredients in hops and beers, sensory evaluations also were performed. The results cover the following principal points: the general brewing properties of the hops, particularly their influence on bitterness and the flavor of single-variety beers; the character and suitability of the varieties for dry-hopping and comparison to their late-hop aroma; comparison of aroma, flavor, and bitterness of the new varieties to their established counterparts (late- and dry-hopping); the stability of late- and dry-hop aroma; and the transfer rates of aroma substances and polyphenols from hops to beer (late- and dry-hopping).

Andreas Gahr was trained on the job as a brewer and maltster at the Augustiner Brewery, Munich, Germany. He received a brewmaster 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 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 entire brewing industry. Together with his co-authors he received the MBAA Inge Russell Best Paper Award in 2010.

O-44
The effect of kilning air temperature on hop essential oil content and aroma

Presenter: Thomas P. Nielsen, Sierra Nevada Brewing Co., Chico, CA
Coauthors: Val Peacock, Hop Solutions, Inc., Edwardsville, IL; Scott Garden, John I. Haas, Yakima, WA; Patrick Smith, Loftus Ranches, Moxee, WA

During the 2012 hop harvest, the craft brewers hop quality group (HQG) conducted a study focusing on drying air temperature and aroma quality of dried hops. The commercial method of drying hops in the United States utilizes an upward flow of dry, heated air through a single tier, or bed, of hops. Variables, such as air velocity, air moisture content, bed depth, and air temperature contribute to the effectiveness of drying and the resulting aromatic, physical, and storing properties of dried hops. The effects of air temperature were studied in two hop varietals and two hop kilns located in the Yakima Valley

in Washington. The primary goal of the study was to gauge the overall quality effect of drying hops at 130 and 150°F. Results show a wide range of moisture contents from the bottom to top bed heights in both 130 and 150°F dried hops; however the stratification was significantly greater in 150°F dried hops. The total essential oil content for Citra hop samples showed greater losses in the bottom and middle third of the drying beds, whereas Cascade samples were uniform in total essential oil content throughout the drying bed depth. A statistically significant number of samples was analyzed by SPME-HS-GCMS, along with multivariate analysis, inferring quality implications of drying hops at 130°F versus 150°F. Caryophyllene oxide proved to be an excellent marker for oxidation incurred by the drying method. Qualitative measurements of caryophyllene oxide, as well as other volatile hop components, are greatly elevated in 150°F hop kiln samples compared to 130°F hop kiln samples. These results outline some major differences produced by varying air temperature when drying hops. Further study of the brewing quality of hops dried at low and high temperatures is needed in a follow up of this study.

Thomas (Tom) Nielsen has been working in an R&D capacity at the Sierra Nevada Brewing Company for more than nine years. Much of his work has involved basic and applied flavor research on hops and malt. Prior to starting his career at Sierra Nevada, Tom obtained a B.S. degree in food science and technology from Rutgers University, focusing on food chemistry. Tom is currently the technical chair of the Hop Quality Group, as well as Sierra Nevada's representative to the Hop Research Council, American Malting Barley Association, and Brewing and Malting Barley Research Institute.

O-45
Dry hopping perspectives and beer stability

Presenter: Thomas Becker, Technische Universität München, Freising, Germany

Dry hopping, the addition of hops in the fermenting or lager cellar, in the United Kingdom is, and for about 25 years in the United States, widely used and enjoys increasing popularity in Germany as well. Until now dry-hopping has barely been investigated scientifically. For dry-hopping, many different methods are used that differ mainly in terms of their technical complexity, the raw material (pellets or cones) used, contact time, and temperature. Each method has its own characteristic and raises a plethora of issues and problems and often brings classic beer analytics to their limits. The focus of our study was to compare in a first step different hopping techniques regarding their ability to dissolve hop components like hop oils, polyphenols, and bitter substances. In a second step we systematically investigated how dry-hopping effects beer haze. In addition, the investigation of aging and flavor stability of dry-hopped beer was part of the focus of our work. The aim was to get answers about the stability of hop aroma and the masking effects of hop aroma in beer aging.

Thomas Becker is currently a full professor and the head of the Institute of Brewing and Beverage Technology (Lehrstuhl für Brau- und Getränketechnologie) at the Technische Universität München, Weihenstephan. From 1986 until 1991 Thomas performed academic studies on the "Technology and Biotechnology of Food" at the Technische Universität München. He finished his Ph.D. there on "Development of a Computerized Enzyme Integrated Flow Line Injection System and Its Application in Biotechnological Process Control Engineering and Quality Control." From 1996 until 2004 he worked as an assistant professor at the Chair of Fluid Mechanics and Process Automation at the Technische Universität München, Weihenstephan. With the topic "Management of Bioprocesses by Means of Modeling and Cognitive Tools" he completed his habilitation in 2002 and graduated with "Venia Legendi" in the field of bioprocess engineering. In 2005 he was appointed to a full professorship at the Chair of Process Analysis and Cereal Technology at the Universität of Hohenheim, Stuttgart, where he worked in the field of process analysis. In 2009 the Technische Universität München appointed him to a full professorship of the Institute of Brewing and Beverage Technology in Weihenstephan. He is a member of several scientific boards and committees, as well as government organizations for food and beverage issues.

O-46
Accelerated malting using elevated steeping and germination temperatures with a focus on malt quality and homogeneity

Presenter: Christian Mueller, Technische Universität Berlin, Berlin, Germany
Coauthor: Frank-Jürgen Methner, Technische Universität Berlin, Berlin, Germany

Production of malt is a time and energy consuming process. Time savings during malting, thus, are advantageous for maltsters, but the resulting malt quality and homogeneity must stay in the range of the brewer's specifications. The literature suggests relatively low temperatures should be used during steeping and germination (13–17°C) to produce malts with a high quality. In these investigations, constant steeping temperatures between 15 and 35°C were used. Up to 25 and 30°C, faster germination rates, higher germination energies, and improved malt qualities, as well as increased malt homogeneities, compared with a "normal" temperature of 15°C could be achieved. Furthermore, trials with germination temperatures between 16 and 28°C, whereby green malt samples were taken at the third to six germination day, resulted in a faster attainment of similar or better malt qualities up to 24°C depending on barley variety. Time savings of about 1.5 processing days are possible using high steeping and germination temperatures and also are necessary to compensate for the extract losses due to accelerated growth. The outcomes of this research could have big benefits for future malting procedures and could change the view of suggested low temperatures during malting, which may not be completely relevant using modern barley varieties and malting process parameters.

Christian Mueller apprenticed as a brewer from 1998, followed by employment as a brewer and assistant in quality control at the Tuborg/Carlsberg brewery, Mönchengladbach, Germany. Afterward, he studied brewing technology at the Technische Universität Berlin from 2002 to 2008, including student jobs on several research projects. Since qualifying for his engineer degree he has been working as a scientific assistant in the Department of Brewing Science at TU Berlin.

O-47

Influence of special malt and coloring agents on the oxidative beer stability and aging components

Presenter: Thomas Kunz, Technische Universität Berlin, Department of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany
Coauthors: Till Stoffregen, Cecilia Cruz Palma, Chaochao Xu, and Frank-Jürgen Methner, Technische Universität Berlin, Department of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany

The effects of special malt and coloring agents on oxidative beer stability and flavor during storage are controversially discussed in the literature. The Maillard reaction products generated by high temperatures during kilning or roasting of malt and then further by boiling processes are jointly responsible for the characteristic color and flavor of the final beer. Due to their complexity, these products can participate in numerous reactions during brewing and beer storage. Thanks to our previous investigations using roasted/color malt or the addition of caramel color and roasted malt beer in the brewing process, it was possible explain the contradictory interpretation of the influence of specific intermediate Maillard reaction products with a reductone/endiol structure on reduction power and pro-oxidative activities. Novel investigations using ESR spectroscopy (EAP and T values) and different methods for the determination of reduction power or potential (Chapon, MEBAK) demonstrate the correlation of two significant key factors in special malt and coloring agents that are responsible for the effects on oxidative beer stability. One is the extremely high iron entry caused by the significant iron release from malt during the kilning and roasting process. The second factor arose from the strong reduction properties of specific Maillard reaction products with a reductone/endiol structure that can rapidly reduce oxidized metallic ions such as Fe^{+3} to Fe^{+2}. Both factors are responsible for an acceleration of oxygen activation and intensification of the Fenton-Haber-Weiss reaction system. Consequently, an acceleration of oxidative processes and a stronger radical generation of very reactive radicals ($OH^{\cdot}$) can be observed in the wort and beer matrix. This fact results in a faster consumption rate of specific antioxidative substances such as SO_2 and, thus, lower oxidative beer stability indicated by the decrease of the EAP value and a stronger increase in specific aging compounds during storage, especially typical oxidation indicators like 3-/2-methylbutanal, phenylethanal, etc.) analyzed via GC-MS. Altogether the results present the influence of the reduction power and pro-oxidative effects of special malt and coloring agents like caramel color, roasted malt beer in the wort, and beer matrices. Additionally, the study gives advice on how to reduce or respectively avoid the pro-oxidative effects through optimized handling during the brewing process or the use of alternative coloration substances to adjust beer color.

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 starting to study 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 at the Research Institute of Brewing Sciences, Berlin Institute of Technology (Technische Universität Berlin). His main research focus lies in analyzing radical reaction mechanisms in beer and other beverages using ESR spectroscopy.

O-48

Analysis of wort sugars using fluorescent biosensors

Presenter: Jasper Akerboom, HHMI, Janelia Farm Research Campus, Ashburn, VA
Coauthors: Jonathan S. Marvin, Benjamin Basanta, and Loren L. Looger, HHMI, Janelia Farm Research Campus, Ashburn, VA; Matthew Hagerman, Lost Rhino Brewing Company, Ashburn, VA

The most routine measurements performed in the brewing industry are gravity measurements of unfermented wort and (fermenting) beer. These measurements give the brewer a value, expressed either as Plato, Brix, or dimensionless (specific gravity). This value is directly related to the percentage of extract per weight of the liquid (mainly the concentration of dissolved carbohydrates) and is an essential parameter to assess the status and potential of the product. However, this value is a sum of several different compounds and does not give insight into the actual composition and concentration of each fermentable sugar in the wort or beer. Worts giving identical gravity readings can differ widely in composition, due to use of different malts, adjuncts, and mashing regimes. Current methods (HPLC, enzymatic assays, biosensors) to determine wort and beer composition are expensive and laborious. Here, we will present a complete set of protein-based fluorescent biosensors to measure wort sugars. Each of these has a high affinity for either glucose, maltose, or maltotriose—the three most abundant carbohydrates in wort. We will describe the design and development of these biosensors in detail and give examples of commercial applications. These sensors give direct accurate insight into wort composition and fermentability potential, are less laborious to use than current HPLC and enzymatic assays, and show great promise for the commercial brewing industry.

Jasper Akerboom received his B.S. degree in molecular sciences from Wageningen University in The Netherlands. During his following M.S. research, he worked for a year at Sheffield University, U.K., on the crystallization and structure determination of proteins involved in glycolysis and gluconeogenesis in the lab of David W. Rice. Afterward, he returned to Wageningen University and joined the lab of John van der Oost in the Department of Microbiology and identified and characterized the gluconeogenic enzyme fructose-1,6-bisphosphatase from the hyperthermophile Pyrococcus furiosus. He stayed with the Department of Microbiology at Wageningen University for his Ph.D. research, where he studied enzymes and structural, binding, and regulatory proteins involved in carbohydrate metabolism in hyperthermophilic life under the supervision of Willem M. de Vos and John van der Oost. After receiving his Ph.D. degree in food science and nutrition in 2007, he joined the lab of Loren L. Looger at Howard Hughes Medical Institute in Ashburn, VA, where he was responsible for the development of fluorescent biosensors for in vivo brain activity detection. Since January 2013, he is also a part-time laboratory manager at Lost Rhino Brewing

Company in Ashburn, VA. Jasper has published more than 30 peer-reviewed articles and book chapters.

O-49
A new beer design tool—Use of Malt-Aroma-Wheel for the prediction of beer characteristics

Presenter: Jens Voigt, University Trier, Trier, Germany
Coauthors: Andreas Richter and Thomas Kraus-Weyermann, Weyermann Specialty Malts, Bamberg, Germany

The development of the Malt-Aroma-Wheel allows new approaches for generating new beer styles and recipes. The definition of a malt mixture of various specialty malts and consideration of the original gravity lead to a calculated projection of the expected aroma profile and the color of the resulting beer. The basis is the Malt-Aroma-Wheel, which was recently developed for a wide range of different malts. The projected beer profiles are compared with tasting results. This indicates the intensities of characteristic aroma components of the original malts and how much of those are found in the final beer. This tool is a big help for the development of new beer types and variation of existing beer styles.

Jens Voigt received a Dipl.-Eng. (M.S.) degree in brewing and beverage technology from TU München-Weihenstephan, Germany, in 1985. He started his career with A. Steinecker GmbH, Freising, Germany, as a technical engineer in brewhouse, fermentation, and filtration equipment. He held sales, product, and management positions with Steinecker until 1995. From 1988 until 1992 he worked on his doctorate in brewing technology on beer foam from Weihenstephan (Prof. Narziss). In 1996 he joined Doemens Brewing School in Munich, Germany, as managing director. In late 1997 he joined Heinrich Huppmann GmbH, Kitzingen, Germany, as key account manager for brewery equipment and was managing director of brewmaxx, a supplier of software solutions for the brewing industry. From 2004 to 2012 he was a research associate with Prof. Karl Sommer (mechanical engineering and process technology) at WZW (Wissenschaftszentrum Weihenstephan [Center of Life Science, Technische Universität München-Weihenstephan]), working on brewing and beverage process technology issues. In 2012 he joined the University of Applied Sciences, Trier, as a professor in beverage technology. He is member of MBAA and IBD, a member of the editorial board in the Journal of the Institute of Brewing*, and honorary associate professor of the University of Nottingham, U.K.*

Poster Presentations

P-50
Urethane cements or epoxy toppings as flooring in a brewery

Presenter: Angel Llanes, International Coatings, Inc., Franklin Park, IL

The focus of the presentation will be a detailed discussion pertaining to the use of urethane cements versus epoxy floor toppings in areas of high use, mechanical wear, and routine chemical and water wash down. It will also discuss the long history of successes and failures of some epoxy formulations and/or similar products and the rise of urethane cements over the past 10 years as a potential solution. The presentation will include detailed information on physical properties such as tensile and compressive strengths of both formulations and will also outline chemical and temperature resistance, wearability, slip resistance, and overall appearance and longevity. Also to be addressed are the basic issues dealing with surface preparation techniques, as well as a brief discussion on the most common concerns about moisture in concrete, its effect on proper installation, and long-term life cycle for both systems. Finally, the presentation will include input from installation contractors for both systems that includes ease of installation, workability, time factors for installation, installation techniques (slurry systems, troweled systems, top-coated or non-coated), and methods for repair in the event of compromise or failure. The presentation is an original work.

Angel Llanes, who has more than 30 years of experience in the field, initially as an installation contractor, then as a pioneer in rental and sales of surface preparation equipment, and now functioning as the vice president of sales for International Coatings Inc. Angel holds a B.S. degree in agriculture and M.S. degree in plant pathology from the University of Arizona.

P-51
Brewing with fermentable and non-fermentable carbohydrates addition—Impact on oxidative reactions and formation of specific aging compounds

Presenter: Niklas O. Brandt, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany
Coauthors: Thomas Kunz and Frank-Jürgen Methner, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany

Carbohydrates are very important in human nutrition since they are used in the food and beverage industries. In this study the influence of fermentable and commonly used non-fermentable sugars on oxidative processes and the formation of specific aging compounds during beer production were evaluated. In previous investigations, the reducing potentials against Fe^{3+} of different sugars at low pH were determined using an optimized Chapon method. These results were in conflict with widely accepted general classifications of sugars into reducing and non-reducing species. The properties of carbohydrates at alkaline pH are well known, but in pH areas of wort and beer the properties of carbohydrates change depending on the type of sugar. For example, the so-called reducing sugar glucose loses its reducing potential, whereby the reducing capacity of sucrose rises because of an acidic hydrolysis splitting and the strong reducing capacity of the generated fructose at low pH ranges. The aim of these investigations was to gain better insight into the influences of different carbohydrates during brewing, with a focus on oxidative wort and beer stability. Thereby, the influence of sugar additions on aging compounds (oxygen indicator: 3-/2-methylbutanal) were evaluated in wort and beer by GC-MS and compared to the antioxidative potential measured via EPR spectroscopy

(EAP and T values), as well as reducing potentials against Fe^{3+} (optimized Chapon method) and SO_2 contents. In correlation with the measured reduction potential, the sugars show the opposite effect on oxidative processes during wort boiling by the formation of specific intermediate Maillard reaction products with a reductone/endiol structure. An acceleration of radical generation by the Fenton-Haber-Weiss reaction mechanism and the formation of specific aging compounds follows. On the other side, sugars raise the osmotic pressure on yeast during fermentation, leading to higher sulfur dioxide production, which could act as an antioxidant by scavenging ROS and binding aldehydes in carbonyl complexes. The results show that sugars influence the pro- and antioxidative system of beer directly and lead to the suggestion for improvement of beer's shelf life by adding non-fermentable sugars just before fermentation, so the negative effect on radical generation during wort boiling can be avoided and the positive influence on SO_2 formation during fermentation is utilized.

Niklas Brandt started his brewing career with an internship in a craft brewery in Lower Saxony, Germany. Afterward, he began an apprenticeship as a brewer and maltster at the Brauerei Beck & Co. in Bremen (AB InBev Germany), which he successfully completed (2007–2009). Since October 2009 Niklas has been studying brewing and beverage technology at the Technische Universität Berlin. His bachelor degree study was finished in April 2013, and he is currently working on his master's degree studies. In addition to these studies, Niklas began research work in January 2011 as a student assistant at the Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science. It was here that his bachelor degree thesis work, dealing with research on sugars during brewing, was done. Niklas also works on the EPR spectrometer and assists with different projects in the laboratory and pilot brewery.

P-52
Novel image cytometric method for detection of physiological and metabolic changes in *Saccharomyces cerevisiae*

Presenter: Leo L. Chan, Nexcelom Bioscience, Lawrence, MA
Coauthors: Alexandria Kury, Alisha Wilkinson, and Alnoor Pirani, Nexcelom Bioscience, Lawrence, MA; Charlotte Berkes, Merrimack College, North Andover, MA

The study and monitoring of physiological and metabolic changes in *Saccharomyces cerevisiae* has been a key research area for the brewing, baking, and biofuels industries, which rely on these economically important yeasts to produce their products. Specifically for breweries, physiological and metabolic parameters such as viability, vitality, glycogen, neutral lipid, and trehalose content can be measured to better understand the status of *S. cerevisiae* during fermentation. Traditionally, these physiological and metabolic changes can be qualitatively observed using fluorescence microscopy or flow cytometry for quantitative analysis of fluorescently labeled cellular components associated with each parameter. However, both methods pose known challenges for the end-user. Specifically, conventional fluorescent microscopes lack automation and fluorescence analysis capabilities to quantitatively analyze large numbers of cells. Although flow cytometry is suitable for quantitative analysis of tens of thousands of fluorescently labeled cells, the instruments require a considerable amount of maintenance, highly trained technicians, and the system is relatively expensive to both purchase and maintain. In this work, we demonstrate the first use of Cellometer Vision for the kinetic detection and analysis of vitality, glycogen, neutral lipid, and trehalose content of *S. cerevisiae*. This method provides an important research tool for large and small breweries to study and monitor these physiological behaviors during production, which can improve fermentation conditions to produce consistent and higher quality products.

Leo Chan currently serves as the technology R&D manager and senior scientist at Nexcelom Bioscience LLC, Lawrence, MA. His research involves the development of instruments 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).

P-53
Capital projects—From vision to completion

Presenter: Anders Hummer, ICC Inc., St. Louis, MO

Since the early days of industrial brewing operations brewers have been faced with the challenges of converting their visions of capital projects into successful project completion. This is relevant for both expansion and replacement projects and also is relevant for small breweries to large mega plants. The challenge is multi-functional, and the variables are complex, such as in-house capability, previous project experience, project time versus cost, and relationship to third-party stakeholders, but also carry a great amount of subjective belief. The presentation will elaborate on a comparative analysis of various project execution methodologies and provide pros and cons for various scenarios. The presentation will also draw upon a global network of brewery capital project specialists in order to add a cultural element to the analysis from the five main continents where capital projects take place. The presentation will not make any specific recommendation but will bring audience members into a position where they can decide what will make sense for their individual needs. Finally, comparative analysis will show an academic approach to how the right methodology can be described as a function of internal competence and number of project units.

Anders Hummer, who is a partner of ICC Inc., draws on more than 20 years of international management and consulting experience and is educated in chemical engineering, master brewing, and business administration. Previous employment includes a partner position in Alfred Jørgensen Laboratory and international management positions at Danbrew. Anders also obtained management experience from Carlsberg Breweries and GlobalBrewer.

P-54
Beverage antioxidative index (BAX)—An innovative method for the evaluation and improvement of the beer flavor stability

Presenter: Victoria Schiwek, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany
Coauthors: Thomas Kunz, and Frank-Jürgen Methner, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany

For the prediction of beer flavor stability electron spin resonance (ESR) spectroscopy has been used for determination of lag time in the last decades. Previous investigations demonstrated that the lag-time measurement used up to now falsifies the results for oxidative flavor stability due to an increasing pH value during the analysis caused by the spin trap reagent (PBN). Against this background, a new EAP determination was developed that excludes falsifications and offers a new index number for the evaluation of flavor stability: the beverage antioxidative index (BAX). As a complement to EAP determination, BAX provides additional information about the interplay of anti- and pro-oxidative beer ingredients independent of SO_2 content and about the consumption rate of the antioxidative potential during storage. In this study, BAX determination was used to demonstrate the influence of metal ions, pH, and Maillard reaction intermediates. Additionally, the correlation between BAX, beer color as an indicator of Maillard reaction products in the beer matrices, and formation of typical aging compounds during storage could be demonstrated. The investigations clearly demonstrate that lower pH values improve oxidative beer stability, as reflected by higher EAP, lower radical generation, and higher BAX values. Iron entry caused by raw materials and kieselguhr filtration deteriorate oxidative stability, and polyphenols do not change EAP and BAX significantly. Furthermore, it could be illustrated that hop ingredients like alpha- and beta-acids can act as a chelating agents and influence radical generation significantly and reduce oxidative processes. It could also be verified that specific intermediate Maillard reaction products with a reductone/endiol structure formed during kilning and wort boiling can decrease oxidative stability by the acceleration of the Fenton-Haber-Weiss reaction system and can have pro-oxidative properties. Corresponding to this, stronger generation of specific aging compounds (oxygen indicator) with higher color and lower BAX is detectable during beer aging. EAP determination facilitates a genuine examination of flavor stability. In combination with BAX determination, it is possible to get a deeper insight into the influences of different beer ingredients on flavor stability. An additional advantage of BAX is the indirect determination of SO_2 content by linear regression.

Victoria Schiwek studied pharmaceutical and chemical engineering at the Beuth University of Applied Sciences from 2002 to 2007. The topic of her diploma thesis was "Optimized Analytical Methods for the Determination of SO_2 in Beer and Malt." After graduating, she worked as a chartered engineer in the field of instrumental analysis, particularly HPLC and IC, at VLB-Berlin (2007–2009). Since 2010 she has worked as vice head of laboratory for the Research Institute of Brewing Science, Technische Universität Berlin (Berlin Institute of Technology).

P-55
Evaluation of pectin application as a stabilizing and fining agent for the brewing process

Presenter: Thomas Kunz, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany
Coauthors: Gunnar Dingel, Kerstin Rudolph, and Frank-Jürgen Methner, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany

Fining agents are used to improve the filtration performance and reduce the production time of clear and bright beers, wines, and juices. Established fining agents like isinglass or gelatin are animal derived, and due to their allergenic potential, labeling is mandatory. In the literature pectin is described as a possible non-allergenic, plant-derived alternative to conventional fining agents. The aim of this study was to evaluate the application of pectin as a fining agent in the brewing process and to get a deeper insight into the mechanism of flocculation. Furthermore, the stabilizing effect of an aqueous pectin solution that contains sodium citrate, citric acid, and potassium metabisulfite was investigated to verify the possible suitability of pectin as a stabilizing agent as described in the literature. Lastly, a potential concept for the use of pectin was created. The results reveal that a pectin solution without additives does not increase the colloidal stability of beer by the removal of haze active polyphenol-protein compounds as described in the literature. Rather, the additives used, such as citric acid and particularly SO_2, are responsible for a higher colloidal stability by increasing oxidative stability. Nevertheless, the suitability of pectin as a fining agent in the brewing process could be clearly verified. The efficiency of clarification depends on the pectin type used described by the degree of esterification, respectively amidation and the ratio of the beverage matrices (pH, AE, Ca^{2+}). Due to these complexities it is difficult to choose the right pectin for a new beer matrix without a testing method. For the creation of a potential concept for the pectin application in the brewing process and for the assessment of the fining suitability of pectins in a given beer matrix it was necessary to develop a laboratory quick test. Through the application of pectin two key factors of filtration, flow rate and filtrate haze, could be improved significantly. Lower filtrate haze did not lead to significantly better colloidal stability, but the possible reduction of filtration time by about 33% is emphasized. Residual galacturonic acid was not detectable (IC) in the final beer, which indicates that pectin is completely removed after filtration. With the right application of pectin in the brewing process and further optimization, pectin seems to be an efficient option to the established fining agents used in 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 starting to study 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 at the Research Institute of Brewing Sciences, Berlin Institute of Technology (Technische

Universität Berlin). His main research focus lies in analyzing radical reaction mechanisms in beer and other beverages using ESR spectroscopy.

P-56
Silica hydrogel removes gluten cross-reactive material from beer

Presenter: Kenneth A. Berg, PQ Corporation, Conshohocken, PA

Three different beers were treated anaerobically in the laboratory with a range of doses of silica hydrogel. The beers were then analyzed for colloidal stability using a forcing test and the sensitive protein test provided by a tannometer. Unforced samples were also tested for gluten cross-reactive material using a simple dip stick test. The sticks were analyzed to collect quantitative information, which was then compared with the dose of the hydrogel and the colloidal stability results. Silica hydrogel quantitatively removes all gluten cross-reactive material at doses similar to those used to provide colloidal stability. Comparison with the sensitive protein test shows the sensitive protein measurement to not be specific for protein. Comparison to forcing results shows multiple beer changes due to the forcing itself. Colloidal stability is too complex to be adequately indicated by the gluten test.

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 postdoctoral appointment at NCSU, Ken designed protein purifications for Lee Scientific in St. Louis, MO. For the last 28 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, microscopy, and the chemistry of foods and silica. Ken lives near Philadelphia, PA, with his music teacher wife Shelley.

P-57
Inhibition of oxidative aging compounds in beer using active packing material vs. SO_2-addition

Presenter: Constanze Ruff, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany
Coauthors: Thomas Kunz, and Frank-Jürgen Methner, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany

The origin of beer off flavors caused by oxidation has been attributed to the formation of specific aging compounds. The formation mechanisms, as different they are, mostly involve reactive oxygen species (ROS), highlighting the importance of intercepting oxygen reactions in the beer matrices or avoid oxygen entry during the brewing process and storage. The aim of this study was to figure out the different influences of oxygen entry and oxygen entry inhibition using active packaging material in the crown cap compared to the antioxidative activity of SO_2 addition on the formation of aging indicators during storage. In this correlation also the combined application of active packaging material and SO_2 addition on oxidative stability was investigated. Could the well-tried SO_2 addition obtain the best results or is it possible to offer brewers new knowledge to improve beer flavor stability? Previous investigations have shown that techniques combining EPR spectroscopy and ascertainment of specific aging compounds as oxygen indicators via GC-MS can be used to investigate the influences of SO_2 addition and different crown liners with O_2-scavenger properties on oxidative beer stability. The results after addition of oxygen to fresh beer samples verifies that the formation and increase in aging compounds is accelerated over storage time. In summary, the inhibition of oxidative processes by adequate SO_2 addition in combination with after filling O_2-scavenger material in the crown liner is the best way to increase oxidative beer stability during storage. However, the achievable increase in oxidative stability using different crown liner materials is strongly dependent on O_2-scavenger properties. The compound with the lowest O_2-scavenger properties showed an effect only after a longer storage time by the inhibition of oxygen diffusion through the crown cap and wasn't able to compensate for the advantage effect of SO_2 addition at 6 mg/L on oxidative stability. The best O_2 scavenger acted directly after filling, as well as during storage, and was able to compensate for SO_2 addition at higher than 6 mg/L. A remarkable and, for the mechanism, important point is that a comparable increase in oxidative stability with SO_2 addition or O_2 scavenger leads to a different positive effect on the formation of aging compounds during storage. In this connection with use of O_2-active packing materials, a stronger reaction inhibition in the generation of specific aging compounds (oxygen indicators) was detectable. Altogether this research offers brewers useful further knowledge about how to proceed to increase oxidative beer stability through SO_2 addition and/or active packaging material.

*Constanze Ruff started her scientific career by participating in chemistry summer school at the Freie Universität Berlin before graduating. After school she interned for three months at Herbstreith & Fox Company in Neuenbürg, Germany. She then began studies in chemistry at the Freie Universität Berlin. In March 2011 she switched to TU Berlin to the Department of Food Chemistry to complete her course of diploma studies in food chemistry. At the moment she is working on her pre-diploma (*Studienarbeit*). She began her research work in November 2010 as a student research assistant at the Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, where she works on GC/MS detection of aging compounds and improvement of oxidative beer flavor stability.*

P-58
Application of gallotannins to prevent gushing in beer and carbonated beverages

Presenter: Jan O. Schneidereit, Technische Universität Berlin, Berlin, Germany
Coauthors: Thomas Kunz and Frank-Jürgen Methner, Technische Universität Berlin, Berlin, Germany

The spontaneous overfoaming of carbonated beverages upon opening a bottle without agitation is a problem that is well-known in the beverage industry. Although the decoding of the occasion and mechanism of the "gushing effect" has been part of several research activities, a complete explanation has not been found yet. Numerous factors causing and contributing to gushing have been discussed. A first step toward solving this problem has been research to distinguish two types of gushing based on the origin of the gushing inducer. On the one hand

there is malt-related gushing, known as primary gushing, which is caused by fungal metabolites. On the other hand secondary gushing is a consequence of technological faults during production. An important role in the formation of primary gushing is assigned to low molecular weight proteins, especially to fungus-specific hydrophobins. These proteins are secreted by various filamentous fungi. An important characteristic feature is the presence of eight conserved cysteine residues that build four intramolecular disulfide bridges. Furthermore, metallic ions like iron could be identified as an important influencing factor on gushing effect. Our previous investigations have shown that these kinds of metallic ions are involved in haze-active protein-polyphenol complexes and support or initiate the formation of equivalent complexes with protein-polyphenol compounds. The agglomeration of the described low molecular weight hydrophobin proteins that are co-complexed with these kinds of metallic ions are able to integrate and stabilize CO_2 bubbles because of their high hydrophobin surface activity. Upon the release of pressure, the stabilized microbubbles, and in consequence the absorbed oversaturated CO_2, expand and rise. Thereby, the bubbles entrain the surrounding liquid, resulting in overfoaming of the beverage. For the prevention of this process the responsible complexes of low molecular weight hydrophobin proteins, including metallic ions, need to be reduced or removed. An promising approach is reaction and complexation with gallotannins, which belong to the group of hydrolyzable tannins. Due to their chemical structure, gallotannins react primarily with SH-group containing proteins like cysteine by adsorption and precipitation. Thereby, the emerging complexes, including the important gushing acting factors, can be removed nearly completely during the clarification steps. The gallotannin-protein complexes containing hydrophobin proteins and metallic ions are removed completely by whirl pooling, maturation, and filtration. Our studies have shown that the application of specific gallotannins in the right quantity and dosing point during the production or brewing process can be used to significantly reduce or avoid the gushing effect in beverages.

Jan Ole Schneidereit started his brewing career with an apprenticeship as a brewer and maltster at the Brauerei Beck and Co. in Bremen (AB InBev Germany), which he successful completed. Since October 2009, Jan Ole has been studying brewing and beverage technology at the Technical University Berlin. His bachelor degree studies were completed in June 2013, and he is currently working on his master's degree. In addition to these studies, Jan Ole began research work in November 2011 at the Technical University Berlin, Institute of Food Technology and Food Chemistry, Lab of Brewing Science. It was here that his bachelor's degree thesis work, dealing with the application of gallotannins to avoid gushing, was done. Jan Ole also works as a student assistant at the Technical University Berlin, Institute of Biotechnology, Laboratory of Microbiology.

P-59
Gallotannins—A useful tool to improve colloidal and oxidative beer stability

Presenter: Christof Reinhardt, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany
Coauthors: Thomas Kunz and Frank-Jürgen Methner, Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Berlin, Germany

In a highly competitive market place quality and consistency of beer have become of paramount importance. Besides beer flavor, color, and foam stability, one major attribute of beer quality is colloidal stability. If it comes to an undesirable haze during beer storage, the product is classified by the consumer as inedible. Although a variety of substances can be responsible for colloidal instability and haze formation, the most frequent and important form of non-biological haze formation has been identified as the interaction of proteins and polyphenols naturally occurring in beer. Our previous investigations have shown that metallic ions like iron with specific oxidation steps also have an important influence on the colloidal stability of beer caused by their influence on complex formation with protein-polyphenol compounds and oxidative stability. In order to obtain high colloidal product stability for a long period, it is necessary to remove the haze-active proteins and/or polyphenols using technological measures during the brewing process. Polyphenols are normally removed by nylon 66 or PVPP, while proteins can be removed with the help of silica gel or bentonite. In this correlation in the brewing industry it is increasingly popular to use gallotannins, as a high molecular weight tannic acid, to improve colloidal stability. When they are used in the process before filtration, they react primarily with haze-active acid SH-group containing proteins by adsorption and precipitation. The protein complexes that are formed are removed completely by filtration and are responsible for an increase in colloidal stability. Complexes that involve metallic ions like iron are also removed in this way. Consequently, a deceleration of oxygen activation and radical generation by the Fenton-Haber-Weiss reaction system is observable, resulting in a further advantage for colloidal and flavor stability as confirmed using EPR (EAP and T values), GC-MS (aging comp.), and other analytical methods. Our studies have shown that for the appropriate procedure (quantity, dosing point) the application of gallotannins is a good tool to increase oxidative and colloidal beer stability, resulting in lower formation of haze and typical aging compounds during storage.

After apprenticing as a brewer and maltster at the Braugold Brauerei Riebeck GmbH & Co. KG Erfurt (2004–2007), Christof Reinhardt started his studies at the Technische Universität Berlin in biotechnology with a concentration in brewing technology (2008–2013). He began his research in January 2011 as a student research assistant at the Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science. He is working on determining the impact of fermentable and nonfermentable carbohydrates and gallotannins on the flavor and oxidative and colloidal stability of finished beer using EPR spectrometry.

P-60
Correlation of automated Total SO_2 DTNB method to EBC/ASBC para-rosaniline methods

Presenter: Mari Klemm, Thermo Fisher Scientific, Vantaa, Finland
Coauthors: Paula Ranta, Liisa Otama, and Annu Suoniemi-Kähärä, Thermo Fisher Scientific, Vantaa, Finland

Sulfur dioxide (SO_2) in beer primarily originates from yeast metabolism. SO_2 reacts with carbonyl compounds to form hydroxysulfonates, which increase the flavor threshold of carbonyl compounds responsible for stale flavor. SO_2 also

has an important role as an antioxidant and is known to exert antimicrobial properties at high concentrations. SO_2 level is controlled at the end of beer production due to human health and beer quality reasons. Total SO_2 in beer typically is measured using EBC Method 9.25.3 or the similar ASBC Beer-21 *p*-rosaniline method. This paper shows the correlation of beer samples measured using the *p*-rosaniline method to the total SO_2 method, which is based on DTNB (5,5′-dinitrobenzoic acid) measurement at 405 nm. In this study, commercial beer samples and cider samples were analyzed using a Thermo Scientific Gallery discrete photometric analyzer. This rapid 2-reagent Gallery system method was performed without any sample pretreatment before the analysis. A fully automated bench-top photometric analyzer concept enables simultaneous analysis of multiple parameters, like color, from the same sample. According to this study, all samples tested using the total SO_2 method with Gallery system showed result levels similar to the EBC (9.25.3) and ASBC Beer-21 *p*-rosaniline methods. The easy-to-use Gallery system method is a robust method for total SO_2 measurement for both cider and beer samples. Ready-to-use Thermo Scientific liquid reagents eliminate reagent preparation, saving time in testing, and the volume-optimized system kits minimize reagent waste. The method is linear from 2–50 mg/L, and using automated dilution total SO_2 can be measured up to 300 mg/L.

Mari Klemm received an M.S. degree in analytical chemistry from the University of Helsinki in 2008. She joined Thermo Fisher Scientific in 2008 in their Research and Development Department, where she worked as an R&D scientist. Mari is a member of the R&D team responsible for development of important beer analyzing applications, like beta-glucan and NOPA, as well other food and environmental chemistry tests for discrete analyzers. She specializes in SO_2 analytics, starting in 2007 with automating wine SO_2 analysis. Since January 2013 she has functioned as the technology manager responsible for new industrial applications.

P-61
A review of the cost analysis of iso-octane regeneration for re-use in beer bitterness analysis

Presenter: Benjamin T. Bailey, Troegs Brewing Co., Hershey, PA

The cost of purchasing and properly disposing of iso-octane (2,2,4-trimethylpentane) for testing bitterness in beer is considerable. It is by far the most expensive reagent used in the ASBC beer bitterness test. The method of regeneration described by Schild and Weyh in 1963 can regenerate iso-octane to the purity required for bitterness analysis in a modern brewery. Using their method of regeneration, savings can be realized almost immediately by any lab or brewery performing IBU analysis. In a lab that runs 10 bitterness tests/day following the ASBC method, a return on the investment in required equipment can be realized as quickly as eight months. When the costs of proper disposal of this hazardous chemical are considered, significant savings can be realized in less than eight months. By clarifying iso-octane through the column two times, it was possible to confirm that the IBU tests done with regenerated iso-octane are as accurate as those done with HPLC-grade iso-octane purchased from a chemical supplier. The beers tested during this trial ranged from 5.2 to 74.3 IBU, confirming the effectiveness of this method across a large range of beer styles.

Benjamin Bailey has been an MBAA member since 2010. His paper "The Influence of Hop Harvest Date on Hop Aroma in Dry-Hopped Beers" received the Inge Russell Best Paper Award in 2010. He received a B.A. degree in German from the University of Texas in Austin in 2000. After a three year apprenticeship at Live Oak Brewing Co. in Austin, TX, he enrolled at the University of Munich at Weihenstephan, graduating as a diploma master brewer in 2008. He then worked as a quality assurance engineer for MillerCoors in Trenton, OH, before taking on his current role in 2010 as quality assurance team leader at Troegs Brewing Co. in Hershey, PA.

P-62
Comparison of Cascade hops grown in the U.S.A. and Germany

Presenter: Andreas Gahr, Hopfenveredlung St. Johann GmbH & Co. KG, Train-St. Johann, Germany
Coauthor: Adrian Forster, HVG Hopfenverwertungsgenossenschaft e.G., Wolnzach, Germany

Due to the huge demand, especially in craft brewing, more and more Cascade hops are grown in the United States and the high alpha market stagnates. So, other hop growing areas are looking for diversification. In 2012 German farmers harvested 6.1 tons of Cascade without hardly any knowledge of the comparability of their crop. The commonalities and differences of Cascade hops of different origin found in this work are presented. Cascade hops of U.S. and Hallertau origin were analyzed for bitter and especially aroma components, as well as for total and low molecular weight polyphenols, and used for all malt lager brewing trials. The single-variety brews focused on hop-derived sensory properties such as bitterness, late-hop, and dry-hop aroma. Analytical values were assessed and compared as well in order to obtain information about transfer rates of hop aroma compounds and polyphenols. Furthermore, some tests describe the losses of some individual aroma components during beer storage.

Andreas Gahr was trained on the job as a brewer and maltster at the Augustiner Brewery, Munich, Germany. He received a brewmaster 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 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 entire brewing industry. Together with his co-authors he received the MBAA Inge Russell Best Paper Award in 2010.

P-63
Use of microscopic pressurized shockwaves generated by controlled cavitation as a non-shear method for increased alpha-acid extraction in beer for later isomerization during the boil

Presenter: Santiago Gomez, Apotek Solutions, Northville, MI

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 is explored as a non-shearing mixing method for increased alpha-acid extraction prior to boil while maintaining specific hop characteristics (as opposed to using hop extracts). As cavitation bubbles form and collapse they generate intense pressurized shockwaves that travel through the liquid (water or wort) and hop resins increasing the surface area and mass transfer. A system specifically designed for this trial submits the liquid and hop cone/pellet mixture to cavitation and is subsequently boiled for 60 min for isomerization. The product was tested using the iso-octane extraction method and the iso-alpha method.

Santiago Gomez has been an MBAA Member (District Michigan) since 2012. Santiago has been a recognized BJCP judge since 2006, writer for the Michigan Beer Guide *since 2011, and a home brewer since 2011. He has a B.S. degree in mechanical, electrical, and industrial engineering from Anahuac University in Mexico City and since 1993 has been involved in operation, design, engineering, and sales in the food and beverage industries. Santiago's primary areas of expertise include heat transfer and heat exchangers, mixing and homogenization, fermentation, enzyme treatments, extended shelf life, plant and equipment sanitation, pasteurization, and packaging. From 2001 to 2010 Santiago was responsible for the sale, design, engineering, manufacture, installation, and commissioning of food/beverage processing systems in countries such as the United States, Mexico, Canada, Colombia, Venezuela, Chile, Spain, the United Kingdom, Ireland, Belgium, The Netherlands, Italy, Russia, Thailand, and Taiwan, among others. Santiago currently works as an independent consultant in the food and beverage industries.*

P-64
WITHDRAWN

P-65
"It's all a matter of taste"

Presenter: Javier Gomez-Lopez, FlavorActiV, Henley-On-Thames, U.K.
Coauthors: Richard Boughton and Marie Pohler, FlavorActiV, Henley-On-Thames, U.K.

The United States is seeing explosive growth in beer styles and brands, which, in turn, has led to thousands more engaged in brewing, serving, and selling. Meanwhile hundreds of thousands more consumers are enjoying new beers and becoming enthusiasts wanting to learn more. Such a contrast has required new thinking on beer education, both in supply and consumption, as it is vital to maintain this wave of growth and choice. This paper will address how our global industry has and is responding to meet this challenge of educating our supply chain and reaching the consumer about taste.

Javier Gomez Lopez joined FlavorActiV in 2006 as a global sensory manager and covers the Spanish and Portuguese countries in Europe, Latin America, and Africa. He also looks after the craft brewers market in the United States and internationally. He has delivered many training courses in acceptance warehouse release, food and beer matching, train the trainer, sensory science and statistics. Javier is an expert in advanced and bespoke training courses, in addition to being FlavorActiV's in-house beer sommelier. Javier has recently played a key role in the development of web validation tools, making taster management quicker, easier, and more efficient. Javier has a Ph.D. degree in physical chemistry from Queen's University Belfast (2003); he worked as a research fellow at the university from 2003 to 2006.

P-66
Automated piping systems for increased product quality and reduced operating expenses in breweries

Presenter: Jeremy Hauser, Pentair Sudmo, Delavan

Increasing product quality, which in turn increases shelf life, is a continuous goal for brewers. Piping systems used for beer transfer can have a negative effect on beer quality as it can introduce oxygen (O_2) through manual connections and open piping systems. This presentation will look at different valve options to prevent O_2 pick up to increase plant efficiency and reduce operating expenses in breweries. It will look at advantages and disadvantages of current systems that are available and discuss an under tank matrix system that overcomes all of the disadvantages of the present systems. It will also discuss control-top technology for monitoring the valve system to ensure safe brewery operation. Swing panels were, and still are, used widely to route product and cleaning solutions through brewery piping systems and has the advantage of lower investment costs. However, operational costs are considerably more with it than an automated system because it is very operator dependent. It is also much more difficult to clean and to eliminate O_2 pick up in a swing-bend system. The first matrix systems were standard manifolds that were positioned at the tank or in a central location. In recent years a new generation of piping system was introduced that is particularly suited to the brewing industry and eliminates many of the problems associated with the traditional valve matrixes, e.g., long pipelines between the vessel and the valve manifold are eliminated; as valves are close coupled to the vessel the problems of bacteria growth in the outlet pipes is eliminated; reduced space requirements; reduced investment costs; reduced O_2 pick up; reduced product losses; and ease of installation with reduced costs. The matrix valves are used in conjunction with the IntelliTop control unit to ensure safe operation of the process. The IntelliTop monitors the valve position and gives continuous feedback to the control system for monitoring purposes. If the IntelliTop sends an alarm signal to the control system, the system will be set in a safe position to ensure the safety of product and personnel. There is also a clear visual signal from LEDs that are fitted to the top of the control head that easily identifies the valve position or fault mode. During maintenance of the valve matrix a lockout feature is available to protect maintenance and operation personnel from contact

with cleaning chemicals or other harmful liquids. The mix proof valve matrix system gives brewers the best possible piping option for their brewing vessels. Not only does it have lower investment and operating costs, it also ensures the highest quality product with the lowest possible O_2 content, which will result in longer beer shelf life. Brewers around the world are embracing this technology as it gives them many benefits over conventional systems.

Jeremy Hauser, technical manager at Pentair Südmo, a supplier of process components and solutions to the brewing and beverage industries, has been involved in the automation of beverage and food plants for the past 13 years. He has been very active in advancing mix proof valve technology to increase plant efficiencies and reduce downtime. A member of MBAA, he attends regional meetings and training classes. He holds a bachelor's of mechanical engineering degree from the University of Illinois.

P-67
Coupled energy and water systems—The key to become a sustainable and self-sustaining brewer

Presenter: Felix Wagner, M&L Engineering GmbH, Hofheim am Taunus, Germany

Sustainability is a major topic among brewers of the world. Large breweries strive to become "the greenest brewer." But, small and midsize brewers are interested as well, as sustainability combines economics and consumer decisive soft facts, like trust and credibility in a brand. In times of climate change and limitation of resources, self-sustaining brewers are less prone to taking risks. This is not only valid for developing countries, but for developed ones as well—just remember power outages, rising energy costs in grid dependent systems, and other influences that might result from changes in legislation and possible future market regulations. When analyzing the material and energy flows into the system brewery, it comes down to electric energy and one form of combustible primary energy on the energy side, as well as fresh water on the material flow side. On the out-feed side, the major flows are product (thankfully!) but even more waste water (figures!). All energy usage can be calculated as CO_2 effluent, depending on the energy mix used. Under this precondition, a sustainable and self-sustaining brewer minimizes the in-feed of water and primary energy and the out-feed of wastewater and CO_2 effluent, while being as grid independent as possible. With the CorEvapEnergy system, a brewer can make a tremendous leap to become more sustainable and self-sustaining. Especially for American brewers, with the dawn of widely available natural fracking gas this system provides electricity and heat energy at unbeaten efficiency levels, as well as being economically related to the carbon footprint. On the other side, it enables a reduction in freshwater consumption and amount of wastewater effluent—truly a revolution! The CorEvapEnergy system consists of coupling natural gas-fired combined heat and electrical power generation with sophisticated evaporator technology. A highly efficient power generator transforms up to 43% of the primary energy into electricity. The residual thermal energy produced can be utilized either as process heat within the brewing process or to evaporate wastewater and recover the condensate as process water. Due to the continuous available heat sink of the evaporator, the electricity production can be continuously driven without the need to balance the energy streams of the brewery, even in non-continuous production phases. Process water recovery can be even increased by utilizing a vapor recompression unit to electrically drive the evaporation process. A total of up to 95% of the invested primary energy can be utilized.

After his apprenticeship in a small Bavarian brewery, Felix Wagner continued his education at the Technical University of Munich-Weihenstephan, where he graduated as a diploma engineer in brewing. He started his professional career with KHS Till in 1999, where he was responsible for R&D in the field of kegging. During this time he concluded his doctorate at Weihenstephan. From 2005 he led the mechanical design team for KHS Process Technology in Bad Kreuznach, Germany, before moving to China to work for the KHS China Joint Venture as plant manager and deputy general manager. In 2010 he returned to Germany, taking the lead as head of the KHS Competence Centre for Filling and Kegging Technology. In 2012 Felix switched to M&L Engineering GmbH, which is focusing on evaporator technology, a part of the corosys group. corosys GmbH was founded in 2001 by partners with long-time experience in the field of process technology, automation, and instrumentation. Its focus is the production and supply of high-quality sensors, complete process systems and skids, components, and automation to the brewing industry.

P-68
Holistic heat storage system for breweries—Interface for renewable energy resources

Presenter: Tobias Becher, Ziemann International GmbH, Ludwigsburg, Germany
Coauthor: Klaus Wasmuht, Ziemann International GmbH, Ludwigsburg, Germany

Breweries are highly dependent on the environment for resources and, consequently, have a high level of environmental awareness. Therefore, an energy supply system is introduced that works using heat storage. It implies the change from steam-driven to hot water-driven operation. Utilization of fossil fuels is reduced and can be replaced by renewable energy resources. Natural sources such as solar thermic energy require a form of storage. The heat storage system functions with thermal stratification, which is advantageous for processes that require energy. The functionality of the system is explained by means of scientific survey, scenario simulation, and lead user experience (case study). How brewery equipment and technology can be adapted are described. With a holistic approach, the successful principle of energy recovery is extended and intelligently linked to all energy sources and sinks arising in the industrial operation. A functional interface for utilization of any available renewable energy is described.

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

P-69
Optimizing brewing production with modular on-demand boiler systems

Presenter: Jason P. Smith, Miura North America, Inc., Atlanta, GA

Boilers account for nearly half of industrial energy consumption and represent one of the most energy-intensive systems in the brewing industry. Breweries must manage production cycles that include highly variable heating loads that coincide with intermittent brewing, pasteurization, and CIP processes. Boiler energy management in brewery applications can often be constrained by the performance limitations of conventional, large-mass boilers that often exhibit overshoot and lag when operating in response to load swings resulting in a "tail wagging the dog" situation whereby the operation of the utility is driven by the capabilities of the boiler rather than by following sound energy management best practices. Tapping into years of experience with Japan's most well-known breweries, Miura has learned many lessons from lean manufacturing ("kaizen") principles that can be translated to the U.S. brewing industry to address waste related to overproduction via a "just in time" approach to process heating utilizing on-demand boiler systems, eliminating excessive energy consumption related to boiler idling, and stand-by losses during periods of reduced process loads. Much like tank-less/instantaneous water heaters in residential applications, compact on-demand boiler systems offer increased energy efficiency (approximately 20–30%) adapted to larger industrial applications. Given the large amount of energy consumed and the sharp minute-to-minute variations in process steam demands in the brewing industry, on-demand steam generation can play a significant role in reducing utility costs per unit of production, achieving the primary goal—more beer, fewer BTUs. These technology advances offer breweries significant benefits in their utility-side management, including reduced boiler footprint for optimized space utilization of utility versus production equipment; optimized energy management of variable loads during production; optimized back-up capacity with built-in N+1 via modular design; flexibility to grow utility capacity with production via modular design; optimized staff utilization via on-demand operation and system automation; optimized boiler system O&M via plug-and-play design; optimized safe operation due to minimal water content design; and reduced environmental impact from harmful emissions.

Jason Smith has a background in architecture and engineering with more than 15 years of experience with the design and construction of high-performance "green" buildings and more than 8 years of experience as an LEED Accredited Professional integrating sustainable design solutions into facilities that address energy efficiency and contribute to reducing their environmental impact. Jason is celebrating four years with Miura North America directing energy and environmental initiatives with a focus on energy efficiency advocacy and education in the area of thermal energy systems. Jason currently chairs the Energy Efficiency Deployment Subcommittee of the Department of Energy's ITP Steam Systems Best Practices Steering Committee and is an active member of the following organizations devoted to energy efficiency and sustainability: ESC, ACEEE, ASE, IDEA, APPA, ASHE, AEE, and USGBC. Jason is an active member of MBAA, having provided technical presentations for several MBAA Districts across the United States and Canada, as well as having presented at the 2012 World Brewing Congress.

P-70
Brew water treatment—Chemical reduced process

Presenter: Henri Fischer, Krones Inc., Franklin, WI
Coauthor: Fred Scheer, Krones Inc., Franklin, WI

Water quality is one of the single most important factors for beverages. Making up over 80% of the product itself and having contact with the product during processing, there is an increasing focus on the microbiological quality of the water used in product processing. Since there is a formation of unwanted by-products when using chlorine as a disinfectant, one modern philosophy is a chlorine-free process.

Henri Fischer, brewmaster, has been the product manager of Process Technology at Krones, Inc., Franklin, WI, since 2013. Henri was team manager of the Process Technology 2 Division at Krones AG, Germany, until 2012. He worked in the Technology Department of Steinecker, Germany, until 2006. Henri conducted his brewmaster studies at TUM Weihenstephan and Doemens Academy, Germany, finishing in 2003. He completed brewer and maltster training and was a brewer in a German brewery (Freiberger Brauhaus AG) from 1993 to 1998.

P-71
Standardizing cell concentration by weight method

Presenter: Annie Hammang, White Labs, Davis, CA
Coauthor: Troels Prahl, White Labs, San Diego, CA

Yeast cell counts are an essential check on brewing operations, as fermentation is very sensitive to yeast concentration. Traditional cell counts under a microscope are a relatively simple and inexpensive method for validating yeast concentrations, but they are also time-consuming and cumbersome. Other cell counting methods are in use, each with their own down side for applications in the brewing industry: spectrophotometry (less accurate), plating (more time-consuming), flow cytometry (more expensive), and electrical resistance (more complicated operating procedures). The aim of this project is to validate and standardize a faster method for determining cell concentration that is still reasonably simple and inexpensive: cell concentration by weight. Cell concentration was determined by cell count in 70 yeast culture strains. Yeast cultures were then centrifuged and weighed in a test tube. A table has been constructed of the factor to correlate the weight of each strain to a cell concentration.

Annie Hammang has worked at White Labs' research and development lab for the past two years. She studied microbiology at the University of California at Davis and graduated in 2013 with a B.S. degree.

P-72
Use of spent brewer's yeast as a natural source of supplemental nitrogen in yeast propagations

Presenter: Neva Parker, White Labs, Inc., San Diego, CA

Nitrogenous compounds, in the form of free amino nitrogen (FAN) or amino acids, are essential nutrients for proper yeast growth. These compounds are necessary building blocks for production of yeast biomass, including cellular proteins, as well as synthesis of critical enzymes required for metabolism and fermentation. Nitrogen supplements can be introduced to yeast as either amino acids or inorganic salts; however, typical inorganic ammonium such as diammonium phosphate, do not provide long-term benefits. Due to their more complex nature, mixtures of amino acids provide better yield and exert more positive effects, since they are also capable of providing a further carbon source during metabolism. Many commercial blends of assimilable nitrogen are available for both propagation and fermentation, but can spent brewer's yeast be used as a sole source of nitrogenous compounds? This presentation will discuss methods for extracting nitrogenous compounds from spent or discarded yeasts in the form of yeast extract, as well as a look at the free amino nitrogen content provided by yeast extract alone. The presentation will provide some potential methods for reprocessing spent brewer's yeast, as well as producing an affordable organic yeast nutrient source.

Neva Parker has been with White Labs, Inc. since 2002. She earned her B.S. degree in microbiology from Gonzaga University in Spokane, WA, and first became interested in the brewing industry while studying abroad in London. Neva currently manages laboratory operations and has been responsible for the development of new products and services, as well as researching the effects of various brewing aspects on yeast performance using lab-scale fermentation trials. She has presented at several workshops and conferences and published articles in brewing magazines. She is a member of MBAA and ASBC.

P-73
Practical application of qPCR for monitoring and improving brewery sanitation

Presenter: Leon W. Fyfe, Craft Brew Alliance
Coauthors: Jamie DeMerritt, Craft Brew Alliance, Portland, OR; Danielle Wedral, Pall Corporation, New York; Dave Schleef, Pall Corporation, Portland, OR

The growth of unpasteurized and unfiltered craft-style beers has increased the urgency around monitoring and improving brewery sanitation. The need for quicker methods, such as qPCR, provides an alternative method for detection of beer-spoiling microorganisms before product is released into the marketplace. Traditional methods for detecting beer spoilers are limited and require a minimum of 5 to 7 days for results. Using quantitative PCR (qPCR) techniques, brewers can detect potential beer spoilers more quickly with higher sample throughput, as well as identify the type of spoiler they have detected. The authors will compare traditional plating methods with qPCR and describe how this information has been used to improve brewery sanitation in a large craft brewery. Actual examples from the brewery will be cited where traditional methods alone either were impractical or incapable of enumerating especially hard to detect bacteria, whereas the use of qPCR was able to identify the spoiler, as well as help identify opportunities for improved sanitation and new critical control points.

Leon Fyfe left academic research in 2011 and assumed the role of brewery microbiologist for the Craft Brew Alliance in Portland, OR. Leon's pursuit of a life in science started after an honorable discharge in 2005 from a 12 year career as a United States Marine. Leon graduated from Washington State University with a degree in biology and is currently a graduate student in the School of Molecular Biosciences. Leon has taken an active role in the MBAA Northwest District as a member of the Technical Committee. He continues his passion for high-quality craft beer through the spirit of education and collaboration.

P-74
Engineering a biosensor to detect a secreted yeast protease in beer

Presenter: Matthew J. Farber, University of the Sciences, Philadelphia, PA

Proteases are responsible for the cleavage and breakdown of other proteins. Previous studies have demonstrated that the yeast protease, proteinase A (PrA), also called saccharopepsin, is secreted in beer during fermentation. This protease hypothetically degrades foam-promoting proteins, thus decreasing head retention of the beer. Because the concentration of secreted PrA during fermentation has been correlated with yeast viability and proper nutrition, the precise measurement of PrA activity is important for quality control. Previous assays to measure PrA activity have demonstrated non-specificity, low sensitivity, and high cost. Therefore, we have developed a novel, genetically encoded PrA sensor using engineered antibodies that fluoresce after cleavage by PrA. Using less than a drop of beer as the source of PrA, we can measure PrA activity over time. Thus far, we have demonstrated that mechanical disruption of yeast and prolonged storage of yeast increases the activity of PrA. In the future, we hope to use our PrA sensor to measure PrA activity induced by variables such as different yeast strains, improper handling of yeast, and prolonged back slopping. In addition, our platform will allow us to develop sensors for additional yeast proteases that might be relevant to the brewing industry.

Matthew Farber received a B.S. degree in biology from Seton Hall University (South Orange, NJ) and a Ph.D. degree in molecular and cellular biology from the University of Pittsburgh (Pittsburgh, PA). He is currently a postdoctoral fellow under Peter Berget at the University of the Sciences (Philadelphia, PA), specializing in cell biology and protein purification. Specifically, he engineers and produces biosensors capable of measuring the activity of proteases. His interest in brewing led him to apply these sensors to yeast targets relevant to the brewing industry. In addition to research, Matt teaches a graduate course in biotechnology and is currently developing the curriculum for an undergraduate course on the molecular biology of brewing.

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Wednesday, October 23

2:00–6:00 p.m.	Exhibit Set-up

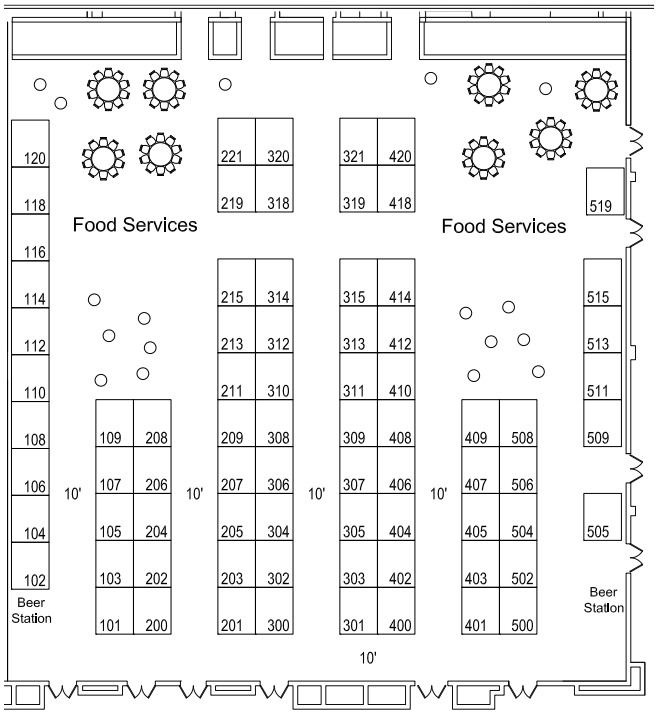
Thursday, October 24

8:00–11:00 a.m.	Exhibit and Poster Set-up
11:45 a.m.–2:00 p.m.	Lunch, Exhibits, and Posters *(even-numbered poster authors present, 12:00–12:30 p.m.)*
3:45–5:00 p.m.	Happy Hour with Exhibits and Posters *(poster authors present)*

Friday, October 25

11:45 a.m.–2:00 p.m.	Lunch, Exhibits, and Posters *(odd-numbered poster authors present, 12:00–12:30 p.m.)*
3:15–4:30 p.m.	Happy Hour with Exhibits and Posters *(poster authors present)*
4:30–5:00 p.m.	Poster Take-down
4:30–7:00 p.m.	Exhibit Take-down

Exhibit Hall • Hilton Austin
Grand Ballroom HJK



Numerical Exhibitor Listing

101	Plastic Kegs America
102	BSG CraftBrewing
103	DME Brewing Solutions
104	Weyermann Specialty Malts
105	Pall Corporation
106	Hach Company
107	Briggs of Burton, Inc.
108	Krones, Inc.
109	R-Biopharm, Inc.
110	Kosme
112	Gusmer Enterprises, Inc.
114	Esau & Hueber GmbH
116	Butterworth, Inc.
118	Heuft USA, Inc.
120	UC San Diego Extension
200	Malteurop North America, Inc.
201	DuPont Nutrition & Health
202	Miura North America
203	Ecolab, Inc.
204	Paxton Products
205	Kathabar Dehumidification Systems, Inc.
206	White Labs, Inc.
207	GEA Brewery Systems
208	Mettler Toledo Ingold
209	GEA PHE Systems
211	GEA Tuchenhagen North America
213	GEA Westfalia Separator
215	ProLeiT Group
219	Prospero Equipment Corp.
221	Five Star Chemicals & Supply, Inc.
300	PerkinElmer
301	Cargill, Inc.
302	GKD-USA, Inc.
303	Hopsteiner
304	BeerRun Software
305	Hopsteiner
306	Sealed Air Food Care
307	Commodity Specialists Company
308	Enerquip, LLC
309	DSM Food Specialties
310	optek-Danulet, Inc.
311	McClain Ozone
312	Andritz Separation, Inc.
313	Petainer Manufacturing USA, Inc.
314	Thermo Scientific
315	PQ Corporation
318	Hansen-Rice, Inc.
319	Nexcelom Bioscience
320	SMT Food & Beverage Systems
321	Therma-Stor LLC
400	Cargill, Inc.
401	Pentair Haffmans
402	Siebel Institute & World Brewing Academy
403	Pentair Valves & Controls
404	Anton Paar USA
405	Kagetec Industrial Flooring
406	Flottweg Separation Technology, Inc.
407	Pro Refrigeration, Inc.
408	Cloud-Sellers
409	Hamilton Company
410	ChemTreat, Inc.
412	Tank Cleaning Technologies
414	SPX
418	Kieselmann
420	Centec LLC
500	Bühler, Inc.
502	Separators, Inc.
504	Symbiont Science, Engineering, and Construction, Inc.
505	Ziemann USA, Inc.
506	Comptoir Agricole Hops
508	3M Purification, Inc.
509	VitalSensors Technologies LLC
511	Profamo, Inc.
513	American Tartaric Products, Inc.
515	Ashland Specialty Ingredients
519	Alfa Laval

Exhibitor Descriptions

Descriptions are listed as supplied by exhibitor in alphabetical order.

508 3M Purification, Inc., 400 Research Pkwy., Meriden, CT 06450; +1.203.237.5541; 800.243.6894; Fax: +1.203.238.8857; Web: www.3Mpurification.com. 3M Purification Inc. (formerly CUNO) provides a wide range of filtration products for the brewing industry. Brewers rely on 3M Purification for clarification, sterile filtration, DE trap filtration, water filtration, and air and gas filtration. Featured are Zeta Plus™ depth filter cartridges for clarification and reduction of spoilage yeast and bacteria.

519 Alfa Laval, 955 Mearns Rd., Warminster, PA 18974; +1.215.443.4004; Web: www.alfalaval.com/brewery; E-mail: customerservice.usa@alfalaval.com. Alfa Laval is the leading global supplier of brewing components, modules, and separation systems tailored specifically for the brewery industry with a proven history of innovation and engineering expertise—to help efficiently brew the highest quality beer at the lowest possible operating cost.

513 American Tartaric Products, Inc., 1865 Palmer Ave., Larchmont, NY 10538; +1.914.834.1881; +1.815.357.1778; Fax: +1.815.357.6221; Web: www.americantartaric.com; E-mail: rolf@americantartaric.com. ATP is proud to present a range of products to the brewing industry. Our product range includes brewing process aids, antifoams, cleaning chemicals, clarifiers, DE, 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, Dextens, Lambrechts, Padovan, and others.

312 Andritz Separation, Inc., 1010 Commercial Blvd. S., Arlington, TX 76001; +1.817.465.5611; 800.433.5161; Fax: +1.817.468.3961; Web: www.andritz.com; E-mail: separation.us@andritz.com. Andritz beer clarifier concepts especially developed for the craft brewing industry. Our stainless steel skid-mounted clarifier systems are custom designed to clarify beer at any stage efficiently, reliably, and with use that's operator-friendly at capacities to 600 bbl/h. Compare us with the competition on price, innovative design, and support.

404 Anton Paar USA, 10215 Timber Ridge Dr., Ashland, VA 23005; +1.804.550.1051; Web: www.anton-paar.com. Visit our booth to learn about comprehensive solutions for beer analysis in the laboratory and for direct monitoring of beer in the main line offered by Anton Paar. All systems are designed and manufactured with an emphasis on high precision and ease of use. For more information, visit: www.anton-paar.com.

515 Ashland Specialty Ingredients, 8145 Blazer Dr., Wilmington, DE 19808; +1.302.594.5000; Web: www.ashland.com; Twitter: @Ashlandinc. Ashland is the leading supplier of PVPP stabilizers for beer. Polyclar PVPP colloidal stabilizers are used by the world's leading breweries to extend the shelf-life of beer and thus improve the quality of beer. In addition, the company provides specialist support service in the field of beverage stabilization.

304 BeerRun Software, 5 Regent St., Suite 520, Livingston, NJ 07039; 877.979.5462; Web: www.beerrunsoftware.com; E-mail: brian.dunn@swktech.com. BeerRun is used by craft breweries that produce 500 to 50,000 barrels annually. It runs in a browser on your PC, Mac, tablet, or smartphone. With BeerRun you can plan batches, view schedules and forecasts, purchase ingredients, do billing, produce and pack, and file your TTB form.

107 Briggs of Burton, Inc., 400 Airpark Dr., Suite 40, Rochester, NY 14624; +1.585.426.2460; Web: www.briggsplc.co.uk; E-mail: sales@briggsusa.com. Briggs, with a history going back 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.

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500 Bühler, Inc., 13105 12th Ave. N., Plymouth, MN 55441; +1.763.847.9900; Fax: +1.763.847.9911; Web: www.buhlergroup.com; E-mail: buhler.minneapolis@buhlergroup.com. Buhler 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.

116 Butterworth, Inc., 13767 W. Hardy Rd., Houston, TX 77060; +1.281.812.7300; Fax: +1.281.821.5550; Web: www.butterworth.com; E-mail: sales@butterworth.com. For over 88 years, Butterworth has engineered and manufactured automated tank cleaning devices for all types of tanks in a variety of industries to remove workers from the inside of the tank. Today, we sell, rent, and lease machines and complete systems for vessels from 5 gallons up to 10,000,000 gallons. Please visit www.butterworth.com.

301/400 Cargill, Inc., 15407 McGinty Rd. W., Wayzata, MN 55391; Sweeteners: +1.937.237.1236; Malt: +1.313.882.5248; Sweeteners Fax: +1.937.237.2529; Malt Fax: +1.952.249.4063; Web: www.cargill.com. Let Cargill help you create great beverages. As the leading

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307 **Commodity Specialists Company**, 10733 Sunset Office Dr., Suite 260, St. Louis, MO 63127; 800.767.4092; Fax: +1.314.909.9366; Web: www.csc-world.com; E-mail: twilkinson@csc-world.com. CSC is a national marketer of all feed by-products and for 35 years has been the number one in tonnage sales of wet brewers grains in the United States. We have experienced personnel nationwide who understand feed values to farmers and logistic needs of breweries, ensuring maximum returns to brewer.

506 **Comptoir Agricole Hops**, 35 route de Starsbourg, Hochfelden, 67270, France; +33.388.89.09.45; +33.631.299.543; Fax: +33.388.89.09.22; Web: www.hops-comptoir.com; E-mail: francis.heitz@cophoudal.fr. Comptoir Agricole is the main French organization offering fine aroma hops. Strisselspalt is fruity, spicy, and floral. Ideal for late and dry hopping. Aramis provides a nonlingering bitterness with spicy and slightly citrus notes. Triskel is fruity and floral, with a complex aroma. Also distributed by Hopunion in the United States.

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201 **DuPont Nutrition & Health**, 4 New Century Pkwy., New Century, KS 66031; 800.255.6837; +1.913.764.8100; Fax: +1.913.764.8639; Web: food.dupont.com ; E-mail: simon.walley@dupont.com. The DuPont™ Danisco® range of specialized brewing enzymes offers robust and sustainable solutions for modern breweries. DuPont strives to understand the link between the industry's needs and the optimal functionality to define enzyme characteristics and ultimately to obtain the perfect solution. Imagine doing better business with DuPont.

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221 Five Star Chemicals & Supply, Inc., 4915 E. 52nd Ave., Commerce City, CO 80022; +1.303.287.0186; Fax: +1.303.287.0391; Web: www.fivestarchemicals.com; E-mail: nicole@fivestarchemicals.com; Facebook: www.facebook.com/pages/Five-Star-Chemicals-Supply-Inc/1388355021382466. Five Star Chemicals & Supply creates industry leading cleaners and sanitizers for the brewing industry. We offer expert advice along with a large inventory of parts and supplies. At Five Star we pride ourselves on our service and our products. We are the trusted partner for brewers around the world.

406 Flottweg Separation Technology, Inc., 10700 Toebben Dr., Independence, KY 41051; +1.859.448.2300; Fax: +1.859.448.2333; Web: www.flottweg.com; E-mail: sales@flottweg.net. Flottweg strives to deliver its very best quality products to the brewing industry. Our portfolio includes Sedicanters for beer recovery from spent yeast, high-speed separators for green beer clarification and beer pre-Kieselghur clarification, decanters for hot wort separation from trub, and belt presses for spent grain dewatering for combustion.

207 GEA Brewery Systems, 1600 O'Keefe Rd., Hudson, WI 54016; +1.715.386.9371; Fax: +1.715.786.9376; Web: www.gea.com; E-mail: gea-pe.us@gea.com. GEA Brewery Systems provides custom brewery solutions to meet your specific requirements. We supply process units, complete brewhouses and cellars, process automation and utilities, training, consulting, as well as complete turnkey plants. We will highlight our complete line of Huppmann craft brewhouses, including the Compact-Star™ and Craft-Star™.

209 GEA PHE Systems, 100 GEA Dr., York, PA 17406; +1.717.268.6200; Fax: +1.717.268.6162; Web: www.gea-phe.com/usa; E-mail: info.phe-systems.usa@gea.com. GEA PHE Systems has over 80 years of experience in providing brewers with quality plate heat exchangers, now also manufactured in York, Pennsylvania, for faster delivery. Stop by our booth to learn how our technologically advanced line of plates can help save energy and improve your brewing process.

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213 GEA Westfalia Separator, 100 Fairway Ct., Northvale, NJ 07647; +1.201.767.3900; Fax: +1.201.767.3901; Web: www.wsus.com; E-mail: info.wsus@gea.com. GEA Westfalia Separator is a leading manufacturer and distributor of high-quality separators, decanters, and ceramic membrane filtration for the brewing industry. With full-service repair facilities on both East and West coasts, the company offers a complete maintenance, testing, engineering, training, repair, and spare parts capability.

302 GKD-USA, Inc., 825 Chesapeake Dr., Cambridge, MD 21613; +1.410.221.0542; 800.453.8616; Fax: +1.410.221.0544; Web: www.gkdusa.com; E-mail: johnt@gkdusa.com. Worldwide technical metal weaver GKD will be showing NeverLeak beer filter leaves. Quality weaving and manufacturing technology go into every mesh and every filter element we sell. The world's beer is filtered clear with the help of GKD! See our technical sales professionals in the GKD booth.

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118 Heuft USA, Inc., 2820 Thatcher Rd., Downers Grove, IL 60515; +1.630.968.8767; Web: www.heuft.com; E-mail: Thomas.Brooks@heuft.com. Heuft USA, Inc., is a technological leader in quality assurance for the food and drink industry. The product range includes sorting and rejection systems as well as highly efficient applications for increasing line efficiency in addition to innovative automation solutions for the sustainable quality inspection of empty and full containers.

303/305 Hopsteiner, 1 W. Washington Ave., Yakima, WA 98903; 800.339.8410; Fax: +1.509.457.4638; Web: www.hopsteiner.com; E-mail: sales@hopsteiner.com. For nearly 170 years Hopsteiner has supplied hops to brewers large and small throughout the world. Hopsteiner quality—the proof is in the pour. Meet us at the MBAA 2013 Convention/Austin to learn about new and experimental hop varieties that are leading the way. Come see for yourself.

405 Kagetec Industrial Flooring, 24631 Saint Benedict Rd., Jordan, MN 55352; +1.612.435.7640; Fax: +1.612.435.7642; 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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418 Kieselmann, W140 N9103 Lilly Rd., Menomonee Falls, WI 53051; +1.262.251.8209; Fax: +1.262.251.8376; Web: www.kieselmann.de. Kieselmann supplies sanitary butterfly valves, mix-proof valves, single-seat valves, pressurized tank-top units, sanitary tubing, and related components to fabricate a brewery from the ground up.

110 Kosme, 9600 S. 58th St., P.O. Box 32101, Franklin, WI 53132-6241; +1.414.409.4000; Fax: +1.414.409.4100; Web: www.kosme.com. Kosme, a subsidiary of Krones, manufactures a full range of bottling and packaging equipment designed for the beer and beverage industry. The company serves the North American market from its Franklin, Wisconsin, facility. Kosme offers a complete product portfolio including filling, labeling, packing, and palletizing as well as conveyors.

108 Krones, Inc., 9600 S. 58th St., P.O. Box 32101, Franklin, WI 53132-6241; +1.414.409.4000; Fax: +1.414.409.4100; Web: www.krones.com; E-mail: salesusa@kronesusa.com. Krones is a leading manufacturer of integrated brew houses, bottling lines, IT systems, and automated warehouse management solutions. Krones will feature its brewing process systems that cover all aspects of brewing, from malt intake to filtered beer, including brew house and filter plants, as well as fermentation and storage cellars.

200 Malteurop North America, Inc., 3830 W. Grant St., Milwaukee, WI 53215; +1.414.671.1166; +1.414.649.0205; Fax: +1.414.671.1385; Web: www.malteurop.com; E-mail: amy.germershausen@malteurop.com. Malteurop North America Inc. produces barley malt for brewing, distilling, and food uses from our four plants in North America.

311 McClain Ozone, 1768 Tanen St., Napa, CA 94559; +1.707.254.0576; Fax: +1.707.224.0543; Web: www.mcclainozone.com; E-mail: info@mcclainozone.com. McClain Ozone is the industry leader in ozone sanitation systems. Ozone is a standalone organic sanitizer in breweries that simplifies sanitation, is cost effective, is safe to use, saves water/energy, and is environmentally friendly. Ask us about our brewery client list, testimonials, ozone brewery applications, cost savings.

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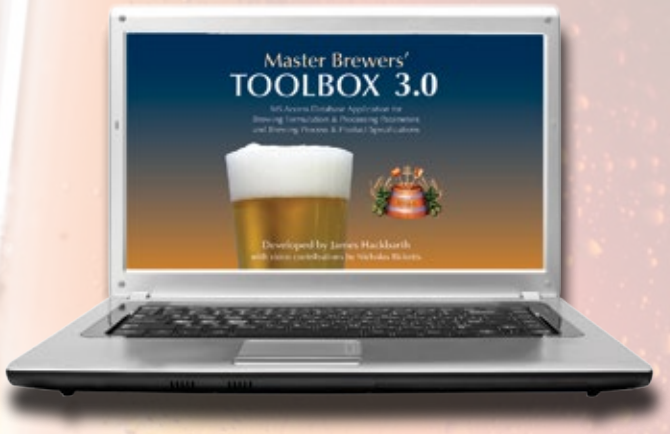

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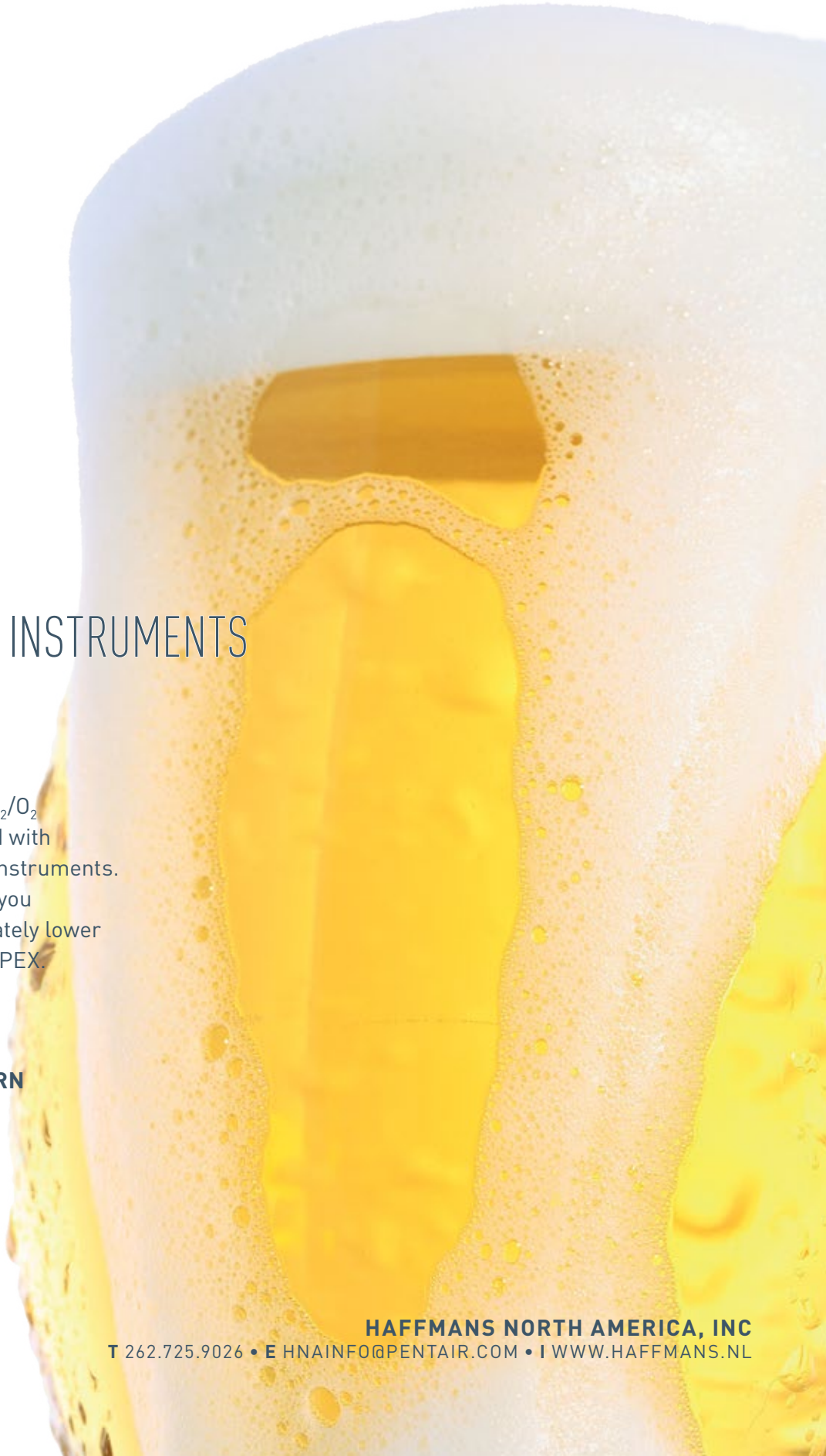

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