Aluminum Melting Conference 2024

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AFS' Aluminum Specialty Conference

October 15-16, 2024

DoubleTree by Hilton Hotel Pittsburgh- Cranberry
910 Sheraton Drive
Mars, PA 16046

Tuesday, October 15th, 2024

Basics/Educational

Session Chair: Luke Schimmel, *Aluminum Division Chair*

8:00 a.m. *AFS' Aluminum Division Meeting*

12 p.m. **Registration**

1 p.m. **Welcome/Introductions**

1:15 p.m. **KEYNOTE Perspectives on Foundry Technology for Real-World Parts** 1
Kevin Anderson, *Mercury Marine, Fond Du Lac, WI*

Aluminum castings are continuing to provide ever-increasing design benefits for engineers, designers, and procurement agents that need real-world, high-quality parts. Molten aluminum inherently picks up hydrogen and oxidizes. Therefore, improved techniques that reduce hydrogen porosity and oxides and their resulting defects are essential. Once excellent metal quality is established, there are numerous tools and techniques that will further meet the needs of the design community where weight reduction, part integration, part performance, and reduced total cost are often the main drivers of designs. The speaker will discuss several of these tools and techniques such as improved alloys, computational modeling of fill and solidification, tooling advancements, prototyping advancements, and quality inspection and assessment techniques. The speaker will also discuss macro trends such as increasing consortia collaboration, the role of trade associations, sustainability, increasing part integration leading to larger and more complex but lower total cost castings, improved linkage between casting quality inspection techniques and engineering performance of parts, and the use of advanced statistical techniques leading to machine learning and AI for improved process understanding and control. At the end of the day, relationships and knowledge transfer along the entire casting supply chain are what secure the increased use of castings into the future.

2 p.m. **Producing High Quality Aluminum Castings** 31
Geoffrey Sigworth, *Harrisonburg, VA*

The quality index (Q) was first proposed by French foundrymen to explain the changes in strength and elongation of tensile bars during an aging heat treatment. This index was later given a theoretical basis by Caceres and co-workers, making it possible to answer the question: "Does this casting have the highest quality possible; or can further improvements be made?" The quality of A356-T6 castings made in an AA test mold are then considered. A considerable improvement in quality has occurred during the last 50 years. Improved degassing is the primary reason. The effect of Fe in A356-T6 B108 test bars is also presented. These results show that in rapidly cooled sections, a well degassed and low iron metal produces a quality close to the maximum theoretically possible. Recent tests of low-pressure suspension components show current best practices produce the same highest quality in commercial castings. Contrary to the claims of Campbell and co-workers, when only considering tensile properties, the

presence of oxide films is of lessor importance compared to good degassing and rapid freezing rates. Examples are presented. When fatigue strength is important, however, the situation is more complicated. Factors controlling fatigue life are discussed in some detail.

2:45 p.m. **Update on Aluminum & Light Metals Division Activities** 60
Brian Began, *American Foundry Society, Inc., Schaumburg, IL*

The AFS Aluminum & Light Metals division has achieved great success since the pandemic and this presentation will brief upon those activities. The divisional participants, structure, plant tours and meeting schedule, along with the mission will be introduced. The presentation will highlight the division's oversight of significant updates planned for the ASTM B26/B26M (sand casting), ASTM B108/B108M (permanent mold casting) and ASTM B618/B618M (investment casting) specifications for aluminum tensile bar testing. A review of AFS standards near completion for the reduced pressure test and specific gravity testing as well as a review list of future standards in incubation will also take place. Additional reviews are to include an overview of divisional research activities including both funded by AFS and AMC (American Metalcasting Consortium). Finally, the projects and status of the ACPI (Aluminum Casting Performance Initiative) congressional-funded research activities will be presented.

3:15 p.m. *BREAK*

3:30 p.m. **PANEL: Permanent Mold**
Hideki Gebken, *Standard Manufacturers Services, Winnipeg, Canada*; **Gordon Peters**, *Linamar Fruitport Operation, Reed City, MI* 53

Due to the high start up costs for adding HPDC capacity many Low Pressure and permanent mold casting suppliers are seeing request for converting HPTC parts to PM/LPPM processes.

While there is definite savings in capital equipment costs, tooling costs the challenge is duplicating the HPDC casting design. Compromises need to be made in minimum wall thicknesses and in minimum draft angles in order for HPDC designed parts to ne adapted to PM/LPPM processes.

Parts can additionally be redesigned utilizing the higher strength that Heat treatable alloys can provide in PM/LPPM processes and provide design alternatives to the casting designers when considering converting HPDC parts to PM/LPPM.

The panel will invite discussion on these challenges, compromises and solutions that can be used to adapt HPDC designed parts to PM/LPPM.

4:30 p.m. **Day 1 Speakers Panel**

4:45 p.m. **Day 1 Concludes**

5:15 p.m. **Networking Reception** *(Drinks & Appetizers)*

Wednesday, October 16, 2024

7 a.m. **Registration/Breakfast**

Basics/Educational *(continued)*

8 a.m. **Retrofitting Legacy Foundry Equipment with Low-Cost Sensors**

Nathaniel Bryant, *UNI, Cedar Falls, IA*

Internet of Things devices such as sensors transmit data to a central database where it can be stored and displayed in real time. This presentation covers data communication protocols and their applications for dashboarding foundry process data in this manner. Specifically, some standard architectures will be discussed and how they can be integrated with both legacy equipment and modern control systems. Open-source software platforms exist and enable low cost IoT implementation for the foundries with minimal IT resources. A few examples of which will be described in the presentation.

Sensor Applications in the Foundry

Session Chair: David Weiss, *Vision Materials, Manitowoc, WI*

SESSION 1

8:45-10 a.m. **Sensor Workshop: Quick Setup of Small Scale IoT Architecture**
Nathaniel Bryant; Jacob O'Dell, *UNI, Cedar Falls, IA*

Are you curious about the Internet of Things (IoT) and want to explore its possibilities? Join our workshop where you'll dive into the world of IoT and build your own small-scale system!
What to Expect:

- Hands-On Experience: Learn by doing! Build a mini IoT system that mirrors industrial-scale applications with low-cost hardware and open-source software.
- Guidance Along the Way: Our instructors will guide you through the process, answering any questions that arise and troubleshooting potential problems.

Alloy Development & Characterization

Session Chair: David Weiss, *Vision Materials, Manitowoc, WI*

SESSION 2

8:45 a.m. **Designing Secondary Aluminum Alloys for Structural Casting Applications** 89
Alan Luo, *The Ohio State University, Columbus, OH*

Aluminum is increasingly used for lightweighting applications in the transportation industries to reduce energy consumption and carbon footprint. However, primary production of aluminum is energy-intensive with extensive CO2 emission. Re-melting aluminum scrap only uses ~5% of the energy (and significantly reduced emission) required to produce primary aluminum from ores. The amount of aluminum available for recycling is estimated to double by 2050, providing a huge opportunity to achieve a near closed loop cycle (material circularity) for aluminum. The use of recycled aluminum in structural casting applications will improve the sustainability of the aluminum and manufacturing industries. The mechanical properties of secondary (recycled) aluminum alloys are often limited by their high "impurities" which can be refined during recycling or mitigated via microalloying in alloy design. Examples are given on designing secondary aluminum alloys for structural die casting applications using an integrated computational materials engineering (ICME) approach.

9:15 a.m. **Thermal Analysis for Aluminum Copper (2XX)**
Yohan Tremblay, *Foundry Solutions & Metal Services Inc.*

Aluminum-copper (Al-Cu) alloys, such as 201, are characterized by their high mechanical properties but their low castability can hinder material performance and processing. Grain refinement has been identified as a critical method to counterbalance this limitation; however, accurate measurement and validation of grain refinement have been challenging with traditional thermal analysis systems.

This study introduces a next-generation thermal analysis system capable of providing sensitive and precise measurements of grain refinement, phase formation, and solid fractions. The study compares the grain refinement level in comparison with the grain size by microstructure. Also, there are potential for Heat treatment optimization using the late eutectic temperature.

Notably, the system generates accurate fraction solid curves that can be directly incorporated into simulation software, enabling more reliable process validation and optimization. Comparative evaluations between the grain sizes and the grain refinement level. By providing a robust method for assessing the solidification process and validating the grain refinement approach in Al-Cu 201 alloys, our system offers new avenues for enhancing both material properties and manufacturing efficiencies.

9:45 a.m. *BREAK*

10 a.m. **Opportunities for Cast Aluminum in Automotive Chassis, Suspension & Brakes** 105
Andrew Halonen, *Mayflower Consulting, LLC, Calumet, MI*

The automotive business is a dynamic marketplace as new manufacturers are working to make an entrance and capture market share. New powertrains bring more selection to consumers, yet often at the expense of weight, cost and reliability. Electrification affects material selection in the chassis, suspension and brakes, and the value proposition for lightweighting. This presentation will explore innovations in materials, processes and applications, yet will be grounded with benchmark data on material selection across many OEMs and vehicle models.

Innovations

Session Chair: Hideki Gebken, *Standard Manufacturers Services Limited, Winnipeg, Canada*

10:45 a.m. **Optimizing Pour Basins for Safer & Cleaner Pours** 125
Roy Stevenson, *MAGMA Foundry Technologies, Schaumburg, IL;* **Dan Hoefert**, *Eck Industries, Inc., Manitowoc, WI*

Transferring molten aluminum into molds comes with the familiar challenge/goal to minimize splashing (a safety concern) and minimize turbulence (a casting-quality concern). A properly designed pour basin should prime (completely fill) the sprue quickly and allow the pourer to keep the pour basin full (without undo splashing) throughout the filling process. In addition to the safety concerns, splashing and turbulence create bubbles (wrapped in oxide film) that can enter the sprue and gating system. These can clog filters (if used), which can create variations in slower fill times. Films generated can also enter the casting to cause void and inclusion related defects. Typical pouring basins come in a wide range of shapes and sizes. This presentation will review several pour basin designs and sizes through simulation, to see how they perform in several common conditions: tall gating systems vs. short sprue systems and quicker fill times vs. slower fill times and smaller (hand-ladle) volume pours vs. higher volume (transfer-ladle) pours.

11:30 a.m. *LUNCH*

12:30 p.m. **Casting Design: Enabling Automated Core Determination, Parting Surface Optimization, and Gating System Design using Geometric Methods**
Charlie Monroe, *University of Alabama, Tuscaloosa, AL*

This study shows the utility of the CastView approach to improve casting design efficiency. Our research aims to automate core determination, identify parting surfaces, and design efficient gating systems using geometric methods. We propose a comprehensive framework that integrates techniques such as voxelization, distance fields, watershed algorithms to identify optimal cores and parting lines. Additionally, our approach considers factors like projected area, flatness, draw, draft angles, undercuts,

and dimensional stability to ensure accurate and manufacturable design outcomes. Furthermore, we investigate the use of ubiquitous 3D graphics tools for interactive visualization and estimation of finishing processes and costs. By combining these advancements, a tooling engineer can achieve higher levels of automation, optimization, and cost-effectiveness in casting design.

1:15 p.m. **IJMC Aluminum Research Update** 157
Tom Prucha, *Metamorphosis, Rochester, MI*

Aluminum alloys continue to be an important cast material because they provide good mechanical properties at a relatively low density. Accordingly, aluminum alloys are an often-researched alloy system. This presentation will review some key findings from a compilation of the most relevant recent papers published on aluminum metalcasting in the International Journal of Metalcasting (IJMC). Among the likely topics are better treatments, alloy developments, new applications, and improved manufacturability.

1:45 p.m. **Exploring Foundry Adoption of Industry 4.0** 175
Adam Kopper, *Mercury Marine, Fond du Lac, WI*

The subject of Industry 4.0 has generated much attention in discussion of possibilities, research, and implementation in manufacturing operations. The foundry industry is no exception. The American Foundry Society membership is comprised of varied businesses across North America of differing numbers of employees, annual revenues, markets served, materials poured, and processes utilized. Such diversity can make it difficult for companies to engage in discussion on the topic of Industry 4.0. For the same reason, it is very challenging for a Professional Society like AFS to develop a one size fits all approach to foundry implementation of Industry 4.0. Nevertheless, it is critical that AFS understand where the foundry industry currently stands and what the needs are to help drive our industry forward on the path of Industry 4.0. This presentation delves into the findings of a comprehensive survey conducted by the AFS Industry 4.0 Committee on the state of readiness and adoption of Industry 4.0 across the foundry industry.

2:45 p.m. *BREAK*

Factors Influencing Variability in Quality Castings

Session Chair: Hideki Gebken, *Standard Manufacturers Services Limited, Winnipeg, Canada*

3:00 p.m. **Quality Variability Consequences of Aluminum Casting Design Geometry** 192
Mike Gwyn, *Metalcasting Design LLC, Mt. Pleasant, SC*

Metalcasting alloys differ in their “likes” and “dislikes” for the design geometry that they flow into. Cast aluminum alloys have their own “likes” and “dislikes” for the design geometry they find in the mold cavity. Metal molds, with their rapid heat transfer rates, and ceramic shell investment molds, with their low heat transfer rates, can affect cast aluminum alloy attitudes about design geometry. However, across the whole process spectrum, the consequence of those “attitudes” is casting quality variability. Not realizing the cast aluminum alloy “likes” or “dislikes” about their design geometry, OEM design and QA teams often tighten their specifications, hoping to resolve variability that actually has a different cause. This panel will discuss diagnosis and solutions for this design geometry root cause for casting quality variability as well as other quality variables that have their root in production processes.

3:30 p.m. **Casting Surface Variability: Appearance Quality Challenges** 150
Ted Schorn, *Enkei, Columbus, IN (production variability)*

While many castings have modest cosmetic requirements, some are used in such a way that they must meet stringent appearance standards. This presentation will discuss the various casting defects that create challenges to appearance quality and the many factors that need to be controlled to produce a uniform texture and cosmetic appearance suitable for painting. This material will be presented with a focus on permanent molding processes.

4:00 p.m. **How to Use Alloy Variations to Enhance Mechanical Performance** 205
David Weiss, *Vision Materials, Manitowoc, WI* *(Post Process v. Process vs. Design)*

The aluminum casting industry has done a lot of work to improve the quality of molten metal alloys, such as proper de-gassing and cleaning, grain refinement and modification. The mechanical properties of properly prepared materials are expected to meet standards when cast within the allowable chemical compositions of the alloys. If the customer is asking for more, or if section size differences and other factors make it difficult to achieve those properties, the chemical composition range can be used to optimize properties. This presentation will discuss maximizing properties in three commonly used aluminum alloys, A356, E357 and A206 through heat treatment and adjustments to alloy chemistry within the allowable chemistry ranges of those alloys.

4:30 p.m. **Day 2 Speakers Panel**

5:00 p.m. **Conference Concludes**

Thursday, October 17, 2024

9 a.m. **Shuttle departs hotel**

9:30 a.m. **Tour of Harmony Castings**

- **Max attendance: 30**
  - LIMITED Parking
    - Require all attendees to use bus
- **Sign in** *(Attendees information provided to Harmony Castings prior to event)*
- **Plan on about 90 minutes for the tour**
- **Special PPE:**
  - Safety Glasses
  - Hearing Protection
  - Closed toe shoes

11 a.m. **Shuttle departs Harmony and returns to hotel**