GMIC
Annual Meeting

Workshop

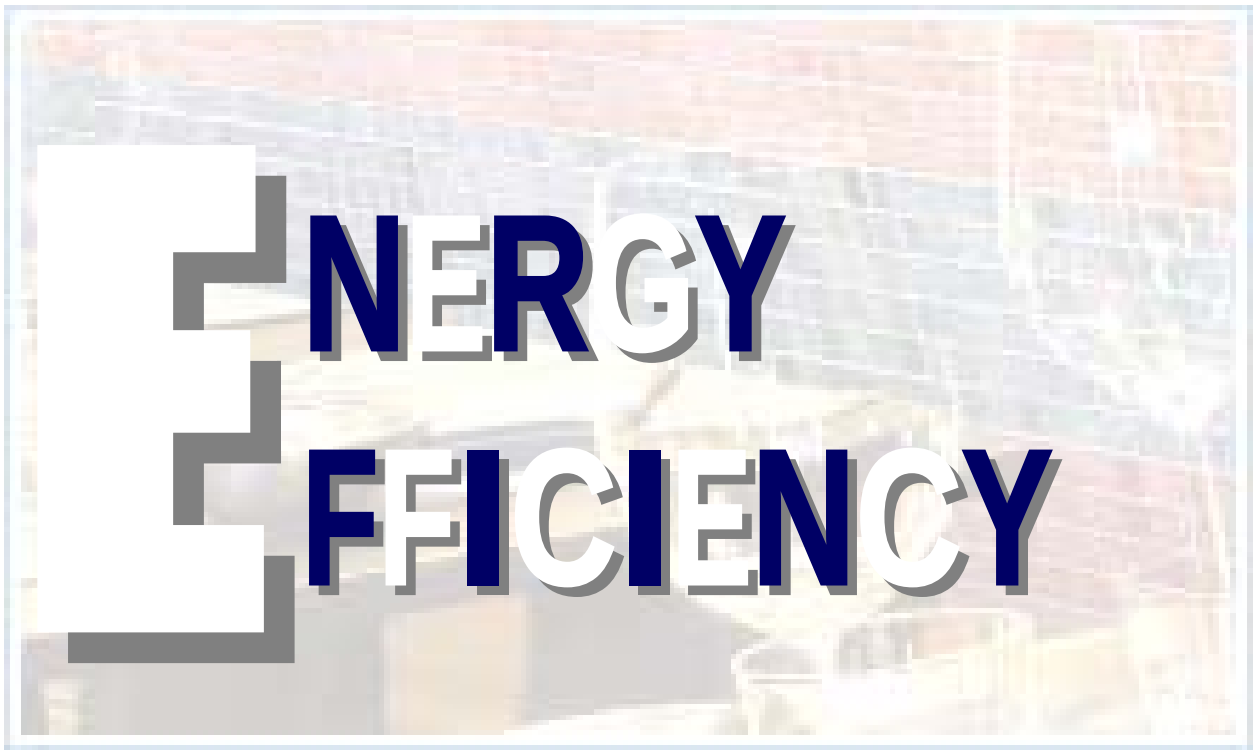
Thursday October 15, 2009

8:00 a.m. 5:00 p.m.

University Plaza Hotel

3110 Olentangy River Road
Columbus, Ohio 43202

600 N. Cleveland Avenue Suite 210 Westerville, Ohio 43082
+1-614-818-9423 Phone - +1-614-818-9485 Fax
Michael Greenman , Executive Director
www.gmic.org



Workshop

600 N. Cleveland Avenue
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GMIC Energy Efficiency Workshop
Schedule

Thursday October 15, 2009

10:05 a.m. to 5:00 p.m.

Presentations

10:05 a.m. – 10:35 a.m.	**New Glass Plant Energy Performance Indicators (EPIs) for Rating Glass Plant Energy Efficiency** – *Elizabeth Dutrow, U.S. Environmental Protection Agency, Washington, D.C. USA*
10:35 a.m. – 11:05 a.m.	**Energy Efficiency and Low-CO_2 Footprints of Industrial Glass Melting Processes** – *Ruud Beerkens, TNO Science & Industry, Eindhoven, The Netherlands*
11:20 a.m. – 11:50 a.m.	**How to Save Energy Using Advanced Predictive Modeling Tools Offline and Online** – *Erik Muijsenberg, Glass Service B.V.,Maastricht, The Netherlands*
11:50 a.m. – 12:20 p.m.	**Heat Recovery for Full-Oxy Float Furnaces with ALGLASS SUN Burners: First Industrial Results** – *Joussef Joumani, Air Liquide, Paris, France*
12:20 p.m. – 12:30 p.m.	Lunch served
12:30 p.m. – 1:00 p.m.	(working lunch) **Impact of Heat Recovery on Air Pollution Control Strategies** – *Rod Gravley, Tri-Mer, Owosso, MI USA*
1:00 p.m. – 1:30 p.m.	**Use of High Emissivity Coatings to Lower Glass Tank Fuel Consumption** - *Thomas Kleeb, North American Refractories Company, Moon Township, PA USA and William Fausey, Owens Corning, Granville , OH USA*
1:30 p.m. – 2:00 p.m.	**Batch Solutions Can Reduce Energy Demand and Carbon Footprints** – *Charles Merivale, Amalgamet, Toronto, Canada*
2:00 p.m. – 2:30 p.m.	**Heat Recovery in the Glass Industry – This Is How We Do It!** - *Niels Rozendaal, Optimum Environmental & Energy Technologies, Arnhem, the Netherlands*

2:30 p.m. – 2:45 p.m.	Break
2:45 p.m. – 3:15 p.m.	**Waste Heat Recovery Made Simple – and Profitable** - *Sean Casten, Recycled Energy Development (RED), Westmont, IL USA*
3:15 p.m. – 3:45 p.m.	**Thermafficient™ Thermal Engine – As Power Source from Glass Plant Waste Heat** – *Tim Held, Resource Thermionics, Akron, OH USA*
3:45 p.m. – 4:15 p.m.	**General Questions & Answers**
4:15 p.m.	Adjourn

Energy Efficiency Workshop
Presenters Abstracts & Biographies
Thursday October 15, 2009
10:05 a.m. to 5:00 p.m.

Presentations

10:05 a.m. – 10:35 a.m.

New Glass Plant Energy Performance Indicators (EPIs) for Rating Glass Plant Energy Efficiency

Elizabeth Dutrow, U.S. Environmental Protection Agency, Washington, D.C. USA

Abstract

EPA, through its ENERGY STAR program, works with individual manufacturing sectors to help them improve energy performance and manage energy well. For the past two years, EPA has worked with the glass industry to develop two energy management tools to evaluate and rate the energy performance of flat and container glass plants in the U.S. These models, called energy performance indicators (EPIs) are now complete and available for use. This presentation will describe the new tools.

About the Speaker

Elizabeth Dutrow directs the U.S. Environmental Protection Agency's ENERGY STAR for industry program, a voluntary partnership with manufacturers to improve their energy efficiency. In 2000, she designed ENERGY STAR's current approach for engaging industries and for providing the high level attention necessary for corporate energy programs to succeed.

Ms. Dutrow has been with EPA since 1984. During this time, she served as a member of the Board of Directors for the National Environmental Laboratory Accreditation Conference, a governing body established to standardize a national system for accrediting environmental laboratories in the U.S. From 1994 to 1999, Elizabeth designed industrial programs for reducing emissions of long-lived greenhouse gases for semiconductor, chemical, and magnesium production, and electric utilities. The agreement negotiated with the semiconductor industry has resulted in substantial reductions and avoidance of perfluorocarbon emissions from the worldwide semiconductor industry.

From 1984 through 1993, Elizabeth conducted the EPA studies which documented airborne asbestos levels in schools and buildings in the U.S., oversaw development of analytical methods for detecting airborne fiber contamination, prepared regulations to control airborne asbestos levels in schools, and managed the design of national accreditation programs for light and electron microscopy laboratories in the U.S. Ms. Dutrow also initiated EPA's early monitoring studies of worker lead exposure.

Ms. Dutrow has a degree in chemistry.

10:35 a.m. – 11:05 a.m.

Energy Efficiency and Low CO2 Footprints of Industrial Glass Melting Processes

Ruud Beerkens, TNO Science & Industry Endhofen, The Netherlands

Abstract

The costs of energy for glass production constitutes an increasing part of the total production costs of glass. In some sectors the energy bills contribute to almost 30 % of the overall production costs in Europe. Apart from that, it is expected that changes in the CO_2 emission trading scheme in Europe, called EU-ETS, with a decreasing availability of CO_2 allowances in future periods will drive CO_2 prices to high levels. Also electricity prices will increase due to the CO_2 allowances required for fossil fuel fired power plants. Increases of 2.5 dollar cents per kWh might be expected.

The typical ranges of energy consumption in the different sectors of the glass industry in the European Union will be given as well as the lowest achieved energy consumption levels using benchmark studies and comparisons. However, it will be argued that the furnaces showing the lowest energy consumption might not be representative for the glass sector. New furnaces, will high pull and rather low glass quality demands using high levels of recycling cullet, may show very high energy efficiencies (low values of energy consumption per ton glass), but such situation is not always feasible or realistic and can be misleading for policy makers..

The presentation will show the effect of furnace capacity, age of furnace, fraction of recycling cullet and type of raw materials on specific energy consumption.

Energy balance studies for typical industrial glass furnaces will show possibilities for energy savings. These possibilities include: optimization of water content in the batch, use of alternative batch recipes, optimization of the air excess in the combustion process, proper sealing of the superstructure, increasing flame luminoscity.

On average more than 30 % of the energy input of glass furnaces is lost by the flue gas heat contents. Partly recovery of this heat by extra air preheating or batch & cullet preheating offers one of the most promising ways to improve energy efficiency of glass melting. However, such systems are rather expensive and still developments are needed to reduce drawbacks such as maintenance issues or carry-over problems when charging dry preheated batches to glass furnaces.

A short discussion on future furnace designs with higher energy efficiency performance will be presented. It will be shown that, energy consumption levels of glass furnaces can be drastically reduced when average glass residence times in the melting tank (24 to 70 hours in most industrial processes) could be decreased to much lower residence times

About the Speaker

Ruud Beerkens started to work on Glass Technology in 1982. In 1986 he received a PhD on the chemistry of flue gases from glass furnaces at the Eindhoven University of Technology in the Netherlands.

Between 1986-2001 he worked at TNO in the field of modeling of glass melting processes, energy and environmental aspects of glass production, thermo-chemistry of glass, fining and refractory behavior.

In 1997 (until 2003) he started as part-time professor at the Eindhoven University of Technology. In the period 2001-2003 he was department leader of the glass technology group of LG Philips Displays.

In spring 2003, he went back to TNO in the Glass Group as senior scientist. He became TNO Senior Research Fellow in June 2005.

Current Activities

Consultant for EU and Netherlands glass industry sector, chairman of TC 18, Glass Trend, member of ICG Coordinating Technical Committee, Senior Scientist at TNO, member of several advisory boards, Founder and chairman of Glass Trend. Working for more than 30 glass companies world-wide on a regular basis.

Awards: He received in 1992, the German (DGG) Glass Industry Award, in 1997 the Otto Schott Award and in 1994 the Gottardi Award from the International Commission on Glass (ICG). In 2008 he received the ICG Turner Award.

11:20 a.m. – 11:50 a.m. **How to Save Energy Using Advanced Predictive Modeling Tools Offline and Online**

Erik Muijsenberg, Glass Service B.V., Maastricht, The Netherlands

Abstract

Glass furnace modeling (often referred to as Computational Fluid Dynamics, CFD) has been used widely by glass industry now for over 20 years. It has become a standard offline tool for optimizing new furnace designs. CFD allowed us to design much more energy efficient furnaces or optimize them during production.

In the past decade modeling tools moved from offline application to online, closed loop, applications. Advanced model based predictive control (MPC) has found its way also into the glass industry. Today a growing amount of glass furnaces and forehearths have been equipped with a supervisory control system. Daily regulation of fossil fuel firing and electric energy supply is no longer in the hands of the operator but fully taken over automatically by the ESIIITM MPC controller, which is a consistent process control, 24 hours per day, focused to operate the entire glass production process in the most efficient way.

11:50 a.m. – 12:20 p.m. **Heat Recovery for Full-Oxy Float Furnaces with ALGLASS SUN Burners: First Industrial Results**

Joussef Joumani, Air Liquide, Paris, France

Abstract

The presentation deals with the use of new heat recovery technology for oxy-furnaces and especially Float furnaces. The technology is combined with a burner technology called ALGLASS SUNTM. The presentation will specifically focus on safety management due to oxygen preheating. A summary of the pilot furnace trials using ALGLASS SUNTM burner adapted to preheated reactants will be presented as well as a brief description of the reliability long term tests of downscaled air/oxygen heat exchangers. On

last part, results obtained at pilot industrial scale on a glass furnace equipped with heat recovery technology will be described.

About the Speaker

Ph. D in Mechanical Engineering, Youssef Joumani is graduate of Ecole des Mines in France. He joined Air Liquide in 2002 as R&D Engineer of the modeling team in which he participated to the simulations of combustion processes for the glass industry. During five years, he studied the phenomena of oxy-combustion in full-oxy furnace (Flame interaction, model validation, corrosion and volatilization, glass flow patterns…) and started to work on the development of heat recovery technology. In 2007, he became Project Manager of ALGLASS SUN technologies and, the year after, leader of the project aiming at developing heat recovery technology in Float furnaces

12:20 p.m. – 12:30 p.m. **LUNCH SERVED**

12:30 p.m. – 1:00 p.m. (Working Lunch) **Impact of Heat Recovery on Air Pollution Control Strategies**

Rod Gravley, Tri-Mer Corporation, Owosso, MI USA

Abstract

The use of heat recovery on the exhaust of glass melting furnaces has been of interest to manufacturers over the last 20 years. The obvious advantages of heat recovery are a reduction in both fuel consumption and green house gas emissions. Some less obvious advantages are reductions in the capitol and operating costs of air pollution control systems and overall improvements in the reduction of mass emissions for both particulate matter and SO2. Heat recovery in combination with air pollution control produces secondary reductions in energy usage and green house gas emissions realized through the overall reduction of volumetric air flow that must be treated. In other words there is a fixed energy consumption and green house gas production per cfm of exhaust gas treated. The use of heat recovery to reduce temperature instead of the traditional dilution air approach can reduce the total quantity of gas to be treated by a factor of 3.

This presentation will present data that shows the differences in the composition and volumetric air flow of exhausts when traditional dilution air methods are used versus heat recovery. In addition data will be presented that not only shows the heat available for other uses but the savings in energy and other operating cost that are realized by reducing the volume of gas to be treated. These savings will be shown in terms of capitol cost, construction, utility costs, maintenance, and green house gas reductions.

Finally the options for air pollution technologies will be discussed for these more concentrated and cooler exhaust streams as well as the impacts of these systems on minimum achievable emissions at the stacks.

About the Speaker

With an educational background in chemistry and physics, Rod worked for twenty years in the air pollution control industry for one of the largest engineering consulting firms in the world. During that time he created an air toxics laboratory that specialized in the characterization of industrial sources for both particulate and gas phase species and executed projects focused on improving the performance of

various control technologies. This work lead to eventually founding and spearheading the technology development of several air pollution systems at an independent subsidiary. Success in that endeavor lead to his current position as Technology Director for Tri-Mer Corporation, one of the worldwide leaders in pollution control innovation. He has direct responsibility over the Cloud Chamber Scrubber (CCS) Systems and the MultiPhase VOC BioSystems both of which are enjoying success in a number of industries including glass, wood products, stationary diesel, syngas, incineration, and chemical production. Rod lives in Corvallis, Oregon and is an expert in technology commercialization.

1:00 p.m. – 1:30 p.m.

Use of High Emissivity Coatings to Lower Glass Tank Fuel Consumption

Thomas Kleeb, North American Refractories Company, Moon Township, PA USA and William Fausey, Owens Corning, Granville, OH USA

Abstract

Owens Corning has been using NARCO high emissivity coatings for almost two years to lower fuel consumption of Oxy-fuel fired wool furnaces. This presentation will discuss the technology of these coatings, the tank operational changes required to effectively use them, and the effect of the coating on glass tank fuel consumption.

About the Speakers

Tom Kleeb has worked in the refractories industry for 36 years, holding various R&D and Marketing positions for Harbison-Walker Refractories and North American Refractories Companies. He is currently Manager- Product Technology for NARCO's Glass Business Unit.

Bill Fausey has worked for Owens Corning for 31 years, holding various R&D and Technology Leadership positions. He is currently R&D Leader - Batch and Melting for Owens Corning's Insulating Systems Business of the Building Materials Group.

1:30 p.m. – 2:00 p.m.

Batch Solutions Can Reduce Energy Demand and Carbon Footprints

Charles Merivale, Amalgamet, Toronoto Canada

Abstract

Environmental and commercial pressures on glassmakers seem unrelenting. Growing concerns about climate change combined with consumer demands for improved glass properties at lower costs to preserve traditional markets have replaced energy as the main issues today. The glass industry has explored capital intensive furnace configurations almost to their maximum, so the next logical step is to examine possible changes in batch composition for improvements.

Much has been written concerning various chemical modifications for many types of glass although little has been publicized about actual production changes for competitive reasons. Adding more powerful flux combinations to reduce operating temperatures will prolong furnace life, reduce greenhouse gas (GHG) and CO2 emissions while also reducing energy demand. Although the impacts on properties and

processing from certain changes in batch formulations are somewhat known, much has not been completely disclosed delaying wider implementation. Reducing or eliminating feedstocks containing CO2 or H2O also has very beneficial impacts on profits in several ways.

As most companies struggle to improve their bottom lines, exploring these options individually will be expensive and difficult with limited available resources. A combined, coordinated industry approach to establish baselines for further research into batch solutions will maximize knowledge, reduce costs to achieve compliance and help with cullet in future by promoting consistency. This approach will also provide a demonstrable industry wide program targeting environmental issues thereby improving the industry's collective image amongst consumers of our manufactured products much as other industries have been promoting their actions to minimize climate change emphasizing their environmental concerns.

In addition to discussing these aspects of glassmaking, this paper will look at some possible batch solutions and outline the objectives, strategy and status of investigations championed by the GMIC's Batch Committee.

About the Speaker

Charles is employed by Amalgamet Canada, part of the Amalgamated Metal Corporation that was founded in 1919 and is based in London, England. The AMC Group's prime focus is trading metals on the London Metal Exchange but includes many related businesses. Charles joined Amalgamet Canada in 1976 where he is the group's industrial minerals specialist. Charles advocates lower melting temperature batch compositions for the benefits they can provide, which he will address at this session.

2:00 p.m. – 2:30 p.m.

Heat Recovery in the Glass Industry – "This Is How We Do It!"

Niels Rozendaal, Optimum Environmental & Energy Technologies, Arnhem The Netherlands

Abstract

Early 2007 OPTIMUM Environmental Technologies b.v. implement a waste heat boiler with in-line boiler cleaning system at AGC flat glass (formerly Glaverbel) in Tiel The Netherlands. The system was installed after a 500 MT/day dual fuel fired float line

The system has been in operation for over 21/2 years without any stops for cleaning while a constant and reliable operation of both furnace and boiler was achieved.

Today OPTIMUM is involved in multiple projects in the Glass industry. The focus lies more on finding applications for the Thermal Energy and the optimal integration of the waste heat recovery system in the plant. An important aspect to keep in perspective when designing the process, is that heat recovery is only a secondary objective to operating the glass furnace to produce glass, so the heat recovery system must be kept simple and straightforward with high reliability. A simple energy recovery system with an acceptable ROI is much more important than trying to gain higher efficiency but at the expense of greater complexity.

In the presentation we will focus on differences between furnace types, like float, container, oxy fuel, or multi fuel and the implications on a heat recovery system.

Evaluating potential applications for heat recovery systems we have learned that the flue gas treatment system often dictate the way the heat recovery system should be implemented. We will discuss the impact between Bag houses, ESP's, semi dry scrubbing and SNCR DeNOx systems.

With respect to the potential of the applications for the steam or hot water produced, there are different applications we have evaluated and are implementing, typical are:

- Heating purposes, buildings, fuel oil heat
- Generation of electrical power with a steam turbine / engine genset
- Preheating furnace feed streams, Cullet, Soda Ash, Sand (max. 250 C)
- Generation of cold water (4 C) by means of a absorption chiller
- Preheat natural gas or oxygen (max temp approx. 250 C)

During the presentation we will discuss several cases based on typical furnaces and heat recovery options, amongst which is a case for a batch and cullet preheating system using recovered steam based on a Solex Thermal Science - Alpha Series solids heater. This approach gets round the problems that exist with the current cullet preheat designs.

2:30 p.m. – 2:45 p.m. **BREAK**

2:45 p.m. – 3:15 p.m. **Waste Heat Recovery Made Simple – and Profitable**

Sean Casten & Melissa DeValles, Recycles Energy Development (RED), Westmont, IL USA

Abstract

No responsible investor would build a dairy just to make cream and pour the skim milk down the drain, nor would they make skim milk alone and throw out the cream. And yet that is exactly what we both in the glass industry and the US electric sector. Modern US electric plants burn fuel to make high temperature gases than they can then convert into power – while the float glass industry pours huge volumes of comparably hot gases down the drain every day. Meanwhile, the electric industry wastes prodigious amounts of heat that could be put to more profitable use preheating combustion air in the glass industry. Taken in combination, this provides a significant opportunity for the glass industry to "have their cake and eat it too", by integrating their manufacturing facilities in with a power plant that is less wasteful, more fuel efficient and more economic than the electric grid with which it competes. However, it also raises a host of complex technical, regulatory, and commercial issues that lie outside the core competencies of a glass manufacturer.

About the Speakers

Sean Casten is the President and CEO of Recycled Energy Development LLC (RED), a company specializing in the development, ownership and operation of power plants that convert waste energy into heat and power at industrial facilities. The company's mission is to profitably reduce greenhouse gas emissions, which it accomplishes through a unique contract and financial structure, coupled with over 50 years of combined experience among the company's senior management in industrial energy outsourcing.

From 2000 - 2006, Sean was the President and CEO of Turbosteam Corporation, a company specializing in the design and sale of capital equipment to recover waste energy into electric power in industrial facilities. Turbosteam is now a subsidiary of RED. Prior to joining Turbosteam, Sean as a Manager in Arthur D. Little's Energy practice where he specialized on technology and strategic issues surrounding alternative fuels and emerging power generation technologies.

Sean holds a B.A. from Middlebury College, a M.S. in Biochemical Engineering from Dartmouth College and a Master's in Engineering Management from Dartmouth College.

Melissa DeValles is a Project Developer at Recycled Energy Development LLC (RED), a company specializing in the development, ownership and operation of power plants that convert waste energy into heat and power at industrial facilities. Melissa has been at RED for two years. She specializes in techno-economic analysis of co-gen and energy recycling projects for a range of energy-intensive industrial manufacturing processes including Glass, Carbon Black, Cement, Biomass CoGen, Charcoal, Pulp& Paper as well as Metals such as Iron Ore and Zinc. Melissa is leading REDs effort to reduce furnace losses and maximize energy efficiency for the Glass industry.

Prior to joining RED, Melissa was an Energy Engineer as well as Project Engineer at NORESCO, a company specializing in energy management and efficiency solutions for commercial and industrial markets. In these positions, Melissa led assessments at the pre and post-contruction stages to optimize energy efficiency through technological and operational solutions. She also helped design several co-generation projects and was charged with overseeing project compliance with Federal Energy Management Program (FEMP) standards for over 25 projects.

Melissa holds a B.S. in Marine/Mechanical Engineering from Massachusetts Maritime Academy, maintains a US Coast License as an Engineer and is an officer in U.S. Merchant Marine Reserve.

3:15 p.m. – 3:45 p.m. **Thermafficient™ Thermal Engine – As Power Source from Glass Plant Waste Heat**

Tim Held, Resource Thermionics, Akron, OH USA

Abstract

Waste heat recovery is an important process for reducing energy costs and CO2 emissions from many industrial processes, including glass manufacturing. We will discuss several methods for converting waste heat to electrical power, along with the technical challenges associated with that process. The ThermafficientTM Heat Engine under development at rexorce, Inc. provides key advantages over traditional steam or Organic Rankine Cycle solutions, and will be well-positioned to improve the net energy efficiency of the glass manufacturing process.

About the Speaker

Dr. Timothy Held joined Rexorce in October of 2008 as VP of Engineering, where his primary focus is concurrent development and commercialization of a waste heat recovery system for industrial applications. Prior to joining Rexorce, Dr. Held spent 13 years at GE Aviation in Cincinnati in low emissions combustor technology development and commercialization for both flight engines and industrial gas turbines. He also served as GE's technical leader for alternative fuels development and fuel

flexibility. He is a graduate of Purdue University, with graduate degrees from Princeton University in Mechanical and Aerospace Engineering.

4:15 p.m. **Adjourn**