GLOBAL GAS TURBINE NEWS

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ASME GAS TURBINE SEGMENT
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Now in its 64th year, ASME Turbo Expo is recognized as the must-attend event for turbomachinery professionals. Whether you are a student, professor, engineer, or other industry professional—there is something for you!

KEYNOTE
Turbomachines for Clean Power and Propulsion Systems

Janet L. Kavandi
Center Director
NASA Glenn Research Center

Andrew “John” Lammas
Vice President & CTO
Gas Power Systems
GE

Thomas Alley
Vice President of Generation
Electric Power Research Institute (EPRI)

NETWORKING EVENTS
Female registrants are invited to join their colleagues for a networking event that will feature a motivating talk by Katharina Kreitz, Co-Founder, of Vectoflow. Attendees will have the opportunity to network with women in the industry and learn about the career paths of some successful women in the industry.

If you are a student or early-career engineer, network with your peers at the mixer on Wednesday night.

Join your colleagues for complimentary light refreshments during the welcome reception. The casual atmosphere of these events is ideal to catch up with friends and meet the thinkers from around the world who are shaping the future of the turbomachinery industry.

The Advance Program is online, which allows you to look over the technical sessions and decide, now, which sessions you would like to attend. See if there is anything new that sparks your interest—perhaps a new technology that could be of great significance in the future. For a small additional registration fee, consider attending one of the eight Pre-Conference Workshops.

Plan now to join 3,000 turbine colleagues from around the world at ASME Turbo Expo, ASME’s premier turbine technical conference and exposition!

PLENARIES

Plenary: Power Focus
Wednesday, June 19

Kunal Chandra
Global Head for New Energy Business
Siemens Power & Gas

MODERATOR
Richard Dennis
Technology Manager, Department of Energy, NETL

Plenary: Aviation Focus
Tuesday, June 18

Guy DeLeonardo
Executive Product Manager
GE Gas Power

Yasushi Fukuizumi
Vice President, Power-Systems
MHI
ASME Gas Turbine Segment

OVERVIEW OF CURRENT STATUS

Hello! I’m here again to provide an overview on the status of ASME’s Gas Turbine Segment (GTS).

Turbine-based technologies continue to be at the center of clean, reliable, and affordable power generation. Highly efficient, natural gas–fueled, combined-cycle plants; hydrogen-fueled turbines supporting renewable energy sources; hybrid electric propulsion; and geared-turbofan engines will all help power the future. Please know that these topics—and more—will be addressed at Turbo Expo, June 17–21, 2019, in Phoenix, Arizona. Mark your calendars and join us!

Turbo Expo is already the preeminent event for the world-wide turbine community. Nevertheless, the GTS Leadership Team and the International Gas Turbine Institute (IGTI) Executive Committee continue to find opportunities and implement changes to bring more value to Turbo Expo delegates. For instance, Turbo Expo Best Papers will now be published online in the ASME Digital Collection, at no charge. All authors have responded positively to this approach, which will start in 2019 based on Best Papers from Turbo Expo 2018. Beginning this year, to support applicants for IGTI awards who are students and young professionals, candidates will now have their applications submitted into the larger ASME award system. This approach will provide a broader range of award opportunities for our delegates for the same level of effort by the applicant.

In another exciting development, GTS hosted the 2019 Advanced Manufacturing and Repair for Gas Turbines Symposium (AMRGT 2019), in March in Berlin, Germany. This inaugural event was designed to present the latest in advanced manufacturing and repair technologies for gas turbines. Because of the overwhelming response to the call for abstracts, two tracks were established—Advanced Manufacturing and Advanced Repair—in total supporting up to 24 peer-selected presentations. Plans are already underway to host AMRGT 2020 next March. Please watch for future posts about this event.

Succession planning for GTS and IGTI Executive Committee members is well underway. Before June 2019, we will have the team of new members and leadership for the GTS and its subcommittees in place for fiscal year 2020. Because of the number of qualified candidates, and a desire to create the appropriate demographic balance for the organization, GTS succession planning is competitive. We appreciate all of the candidates who have applied for these positions and hope the enthusiasm to serve on the GTS and its subcommittees continues.

Looking forward to seeing you at Turbo Expo!

Rich Dennis
Gas Turbine Segment Leader
As the Turbine Turns...

#38 MAY 2019

Lee S. Langston
Professor Emeritus
University of Connecticut
Mechanical Engineering Department

Gas Turbine Powered Campus Update

Here at the Storrs campus of the University of Connecticut (UConn), we have been provided for all our electricity, heating and cooling needs by natural gas fueled gas turbines since 2006. As an update to what I have written about them in the past, [1,2] let me use my column here to give a brief account of 13 years of our very successful gas turbine power plant operation.

COMBINED HEAT AND POWER

Gas turbines (aka, combustion turbines) have been the fundamental element of most of the growing number of combined heat and power plants in use today.

CHP (also called cogeneration) is an energy efficient technology that generates electricity from fuel combustion and captures waste heat to also provide useful thermal energy for space heating, cooling and industrial processes. Gas turbines used for both aviation propulsion and electric power, were first successfully operated in 1939. By the late 1900’s efficiency improvements brought gas turbine exhaust temperatures up to levels (about 900°F and above) such that the exhaust gases could be used in heat recovery steam generators (HRSGs) to provide useful thermal energy.

WHY UCONN?

In 1993 I proposed building a gas turbine CHP power plant for the Storrs 15,000 student campus to our University of Connecticut president. Ten years later, in 2003, construction started on a 25 MW CHP plant. The U.S. Environmental Protection Agency portrayal in Fig. 1 clearly shows the advantage UConn had in going to gas turbine CHP.

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**Figure 1.** EPA Portrayal of a gas turbine CHP system. (“Overall Efficiency” is also referred to as an energy utilization factor [6]).
Up to 2003, UConn’s Storrs campus had its dormitories, kitchens, classrooms, laboratories, and other facilities heated by steam generated in central plant natural gas-fired boilers. During warmer months, campus buildings were cooled by individual electric-powered air conditioning units or by central plant chilled water, cooled by central plant refrigerant units. All campus electric power was purchased from the local regulated electric utility company and dispatched to the rural Storrs campus via a dedicated power line. In 2002, this amounted to annual energy costs of $15 million, substantially consuming 20% of the campus physical plant budget.

THE UCONN CHP PLANT

In 2006 the 25 MW CHP plant was completed, and went on line to supply all of the campus electricity, heating and cooling needs. The plant is described in detail in the schematic given in Fig. 2. (More details are given in [1] - [5]).

The plant’s initial cost was $81 million, a figure which included modifications to existing utility facilities. An estimate of its true cost is about $50 million, or $2000/kW. It is expected to save the University $180 million in energy costs over its forty year design life. (More recently, it has been reported the expected savings are twice that by capitalizing on changing energy markets and more favorable refinancing [5]). Its overall efficiency (see Fig. 1) is about 80%. Other measures show that under a demand rate of 25 MW of electricity and 200,000 pounds/hr of steam, UConn’s CHP plant uses only 52% of the fuel consumed by conventional non-CHP means (see Fig. 1 and [6]).

The heart of the UConn CHP plant consists of three 7 MW gas turbines, driving water-cooled electrical generators, to produce 20-25 MW of electrical power distributed throughout the campus. The gas turbines are Taurus units, made by Caterpillar’s Solar Turbines, in San Diego, CA. They are fueled with natural gas, with fuel oil as a backup (despite their maker’s name and sunny location). Since online operation started in 2006, a Solar gas turbine is removed for refurbishment after about 40,000 hours of operation and replaced with a rebuilt Taurus unit.

Gas turbine exhaust heat (at about 900°F) is used to generate up to 200,000 pounds per hour of steam in heat recovery steam generators (HRSGs). The HRSGs provide high pressure steam (600 psi) to power a 4.6 MW steam turbine generator set for more electrical power, and low pressure steam (125 psi) for campus heating.

As shown in Fig. 2, the waste heat from the steam turbine contained in low pressure turbine exhaust steam is combined with the HRSG low pressure steam output, for campus heating. Thus, careful waste heat engineering and management allows three energy usages (gas turbines, steam turbine and campus heating) for only one unit of gas turbine fuel.

During the warmer months, when heating is only needed for some campus kitchens and laboratories, the low pressure steam (from both the steam turbine and the HRSGs) is used to power low pressure steam turbines which drive four refrigeration compressors to supply up to 8400 refrigeration tons of chilled water. The chilled water is distributed to campus buildings for air conditioning. A small part of the chilled water output can also be used to cool hot day inlet air to the gas turbines, thereby maintaining high gas turbine thermal efficiency (nominally 34% at 59°F inlet) and predictable electrical power output. Thus careful waste heat management also provides campus cooling and the maintenance of high electrical power needs during hot summer months.

Figure 2. Schematic of the UConn 25 MW gas turbine CHP plant.
ADDED SUPPORT

My own assessment is that since the CHP plant went online, the university administration pays more attention to campus energy issues. More heedfulness is now given to energy conservation and improving energy related infrastructure.

For instance, in the past, the UConn campus was known for “smoking” manhole covers during winter, since its old steam-heating condensate return piping system, dating back to the 1930’s, leaked. Recent work on the system has greatly improved the return of condensates to the plant—formally a low 30%—and now currently 65% and increasing.

The Second Law of Thermodynamics requires that a power plant must reject heat, no matter how efficient. Roof mounted cooling towers provide UConn’s means of heat rejection, but they used substantial amounts of the University’s fresh water supply, as much as 250,000-450,000 gallons/day. In 2013 a $30 million Reclaimed Water Facility went online to pump treated water from the University’s sewage treatment plant to the CHP plant for both cooling towers and for boiler makeup water, eliminating the need to use drinking water.

With the 13 year success of the UConn CHP plant and the continued growth of the University—now at about 30,000 students, faculty and staff—we are designing a second CHP plant. Called the Tri-Generation Supplemental Utility Plant it will also be gas turbine powered and construction is scheduled to start later this year.

EDUCATION BENEFITS

Let me finish by briefly listing some unique benefits provided by the UConn CHP plant for the purpose of the University—education.

Thus far, two engineering graduate students (one PhD, one Masters) have carried out research on the plant’s many interacting control systems. Through student employment, 20 engineering students have supplemented their education by working with the Plant Manager on various CHP plant projects.

The plant has a class room that is used for instruction not only for engineering students but also for those from other university disciplines. The classroom is outside the security areas of the power plant, so that students can come and go as in a regular class room.

We also use it to prepare for regular tours of the power plant, where trained tour guides can organize tours and issue safety equipment. This is a unique experience for many students since most power plants usually don’t encourage tours for safety, insurance and security reasons. The tours are very popular with our students, and outside groups.

In conclusion, our UConn more than a decade long experience has shown that a gas turbine CHP plant is a natural economic, environmental and educational resource for a university or college.

REFERENCES


Additive manufacturing revolutionized development and prototyping of gas turbine blades but also offers potentials for refurbishment and spare parts on demand.

Siemens is driving the industrialization of additive manufacturing (through digitalization).

Materials Solutions manufactures burner heads for Siemens gas turbines in series production.
Additive Manufacturing for Serial Production of High-Performance Metal Parts

MARKUS SEIBOLD  VICE PRESIDENT ADDITIVE MANUFACTURING
SIEMENS GAS & POWER

Additive manufacturing (AM) is a process that builds parts layer-by-layer from sliced CAD models to form solid objects. Just a few years ago, 3D printing was primarily used for rapid prototyping. Due to improvements in performance, AM has the potential to become a new key technology for serial production. Innovative advances like selective laser melting (SLM) enable the manufacture of high-performance metal parts. Modern printers contain several lasers, which enables the production of multiple parts at the same time. AM includes much more than just 3D printing: It’s an end-to-end process, from design and simulation to 3D printing to post-processing.

Siemens has been investing in AM technology right from its inception. With the opening of the new AM facility at Materials Solutions Ltd. in Worcester, UK, in mid-December 2018, the company is continuing to drive the use of AM for serial production, with a focus on high-temperature super alloys. The company is using the technology in-house for turbine components, and also provides solutions to fully digitalize the process, from design and engineering software to simulation tools and full machine and shop-floor automation for the aerospace, automotive, and other industries.

AM FOR DEMANDING COMPONENTS

The solutions for hot gas-path gas turbine components illustrate the potential of AM in serial production as well as the service business for both repairing components and manufacturing spare parts. In the area of rapid repair, in 2013 the burner-tip repair for industrial gas turbines of types SGT-700 and SGT-800 was the first commercially established method of repair for industrial gas turbines using AM. The SGT-700 has a simple cycle power output of 33 MW whereas the SGT-800 has a capacity of 57 MW. During operation, these components suffer thermo-mechanical fatigue, damage, and wear, especially to the burner tip. The conventional repair procedure required prefabrication of a large portion of the burner tip, which was then used for replacement after a specified burner operation period. AM machines have been customized to adapt to these kinds of repair scenarios. The newly implemented repair route via AM is about ten times faster than the conventional procedure, because it avoids quite a few manufacturing and inspection processes.

In the area of spare parts on demand, the axial swirler for the pilot burner in the Siemens gas turbine SGT-1000F combustion system was already serialized in 2016 and has accumulated over 11,000 operating hours in commercial operation since then. Previously, this kind of component was produced by investment casting. Instead of requalifying the existing cast vendor or performing a full qualification of a new vendor, a choice was made to produce the swirler using AM. Because the annual demand for this component is relatively low and can vary greatly, business case calculations clearly proved the benefit of changing the production technology to AM.

In 2017, Siemens began printing entire gas turbine burners using SLM. Each burner is now additively manufactured in one piece, compared with conventional manufacturing methods that required 13 individual parts and 18 welds. Design improvements—like the pilot-gas feed being part of the burner instead of the outside fuel pipe—allow the operating temperature to be lower, which contributes to a longer operational lifespan of the component and, ultimately, the gas turbine.

Just recently, the first gas turbine blades ever produced using AM have successfully finished performance testing under full-load conditions. The blades withstood an acceleration of 10,000 g while being exposed to temperatures up to 1,250° Celsius. The main reason for this breakthrough was the design freedom that AM offers: Should the cooling channel inside a component meander through the material instead of crossing it directly? In contrast to the usual production methods, now there’s no need to take the limits of drilling or casting into account: The engineer can select the optimal course in her CAD system and let the laser do the rest.

This is one way that AM can make a significant contribution to achieving efficiency goals and emission targets. In addition, components can be made lighter without sacrificing stability. And due to these optimized designs, components benefit from less wear and tear and a longer service life. The lead-time of product development cycles is reduced by 75 percent, because AM can provide functional prototypes that can be implemented and validated in short timeframes. Using AM as a vehicle for fast technology validation leads to the abandonment of traditional and sequential development processes. Now, testing and validation of new concepts are fully integrated in the development process, and any necessary changes can be implemented much faster. This approach significantly reduces both development risks and development costs.

REVERSE ENGINEERING

Reverse engineering is another application that benefits from AM. Siemens recently brought a 100-year-old Ruston Hornsby vintage car back to life using reverse engineering to recreate its steering box. With no original technical drawings available, Siemens digitally re-assembled the
parts of the broken steering box and created an improved working model that could be additively manufactured. It took just five days to rebuild the steering box more accurately than using conventional manufacturing processes; and it’s more robust because it’s engineered as a single piece. Reverse engineering starts with understanding the task and creating working ideas, continues with selecting the right material and optimizing printing, and ends with the post processing.

**SUMMARY**

AM holds enormous potential when rigorously applied in the production chain: 

**Rapid prototyping 75 percent reduction in development time**

Because production with AM is much faster than conventional manufacturing, testing and development time for components is reduced accordingly. Early validation of new designs is another advantage.

**Rapid manufacturing 85 percent faster manufacturing of entire burner set**

AM technology industrialization creates new opportunities for spare part and supply chain enhancements, including the manufacturing of spare parts on demand and even close to the site.

**Rapid repair 60 percent faster repairs to burners tips**

Replacing conventional repair processes with AM not only significantly reduces repair time, it also offers the opportunity to modify repaired components to the latest design.

In the future, materials research will progress so that even highly stressed components in large gas turbines will be 3D printed, and additional additive manufacturing methods will open the door to printing larger pieces for huge steam turbines.

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**Awards & Honors**

**ASME IGTI INDUSTRIAL GAS TURBINE TECHNOLOGY AWARD**

The Industrial Gas Turbine Award recognizes sustained personal creative scientific or technological contributions unique to electric power or mechanical drive industrial gas turbine technology. Eligible areas of accomplishment are gas turbine design, application, operations/maintenance, and research/development/deployment, performed in an industrial, academic or research laboratory environment in one or more of the following fields: Combustion, Fuels, & Emissions Abatement, Controls, Diagnostics, Electric Power Plant Integration, Fluid Dynamics & Thermal Sciences, Operation, Maintenance, & Life Cycle Cost, Manufacturing, Materials, & Metallurgy, Structures & Dynamics, Thermodynamic Cycles, Turbomachinery.

Nominating and supporting letters for the Industrial Gas Turbine Technology Award should be sent by October 15, 2019 to: igtiawards@asme.org.

**ASME IGTI DILIP R. BALLAL EARLY CAREER AWARD**

Early Career Awards are intended to honor individuals who have outstanding accomplishments during the beginning of their careers. Historically, there has been no such award to recognize early career engineers working in the area of turbomachinery.

The recipient of the Dilip Ballal Early Career Award will be presented with the award at Turbo Expo. The award consists of a plaque, funds to support the travel and registration costs to Turbo Expo, free ASME membership registration for five years, and a US $2000 honorarium.

Nomination packets are due to ASME on or before August 1, 2019. Send complete nomination to: igtiawards@asme.org.

**ASME IGTI AIRCRAFT ENGINE TECHNOLOGY AWARD**

The Aircraft Engine Award recognizes sustained personal creative contributions to aircraft gas turbine engine technology. Eligible areas of accomplishment are aircraft engine design, and/or research and development performed in an industrial, academic or research laboratory environment in one or more of the following fields: Aircraft Engine Propulsion, Airframe-Propulsion Integration, Combustion & Fuels, Controls, Diagnostics, Heat Transfer, Manufacturing Materials & Metallurgy, Operability, Structures & Dynamics, Turbomachinery.

Nominating and supporting letters for the Aircraft Engine Technology Award should be sent by October 15, 2019 to: igtiawards@asme.org.

For more award opportunities and complete application details, visit: https://community.asme.org/international_gas_turbine_institute_igtii/wiki/4029.honors-and-awards.aspx

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