NEWSLETTER 2019

Chairman's Corner

Welcome to the latest issue of the Gas Turbines for Energy Network newsletter. It's been a few years since our organization has released a newsletter and much has changed in that time, including our brand.

In the last decade or so there have been some relatively significant changes to energy infrastructure across the continent. Off-coal initiatives, increased availability of affordable natural gas, heavy investment in renewables, decommissioning of some nuclear and investment in other, have all played a role in changing the energy landscape. At the same time there has been an explosion in information sharing; and the public seems to be far more involved in the conversation, and so they should be. Energy is something that affects the quality of all of our lives; and it's encouraging to see the general public becoming interested and engaged in the conversation, whether it be from the standpoint of environmental and health concerns, affordability, sustainability or reliability.

We at the Gas Turbines for Energy Network recognize the importance of the conversation and the role we can play in providing information and technical training. That's why we rebranded ourselves from our previous name of "Industrial Applications of Gas Turbines Committee" in 2018. The new brand is intended to highlight our focus toward the use of gas turbines to produce energy, whether it be used directly in an industrial process, to provide electricity to businesses and homes, or to deliver natural gas to heat businesses and homes. Gas turbines play a vital role in the quality of life we enjoy as Canadians. With combined cycle, cogeneration or pipeline compression systems, they have and will continue to contribute greatly to the reduction of air emissions across our country. Our vision at GTEN is one of increased awareness among Canadians and acceptance of gas turbines as part of a diversified energy portfolio that is efficient, clean, reliable and complementary to all renewables. So we tailor our events to providing information that delivers on this vision.

I invite you to read our newsletter and visit our website to get a glimpse of what is going on in the gas turbine industry and see how gas turbines have recently contributed to the energy sector. In October, we will be hosting our biennial Symposium at the Fairmont Banff Springs hotel:

Powering Canada's Energy and Economic Future

I invite you to join us so you can really engage in the conversation with the industry experts who make up our network. We hope to see you there!

Bob Wellington
GTEN Chair

Pipeline Compression Additions

Three General Electric aero-derivative LM2500+ units have been installed on the Spectra/Enbridge natural gas mainline in British Columbia in 2017 are now in service at T-South stations, replacing the Rolls Royce Spey units at compressor stations 6B and 8A, and old Westinghouse W92's at station 9. The 31 MW GE units were done as part of T-South Pipeline reliability improvement program initiated in 2014. The upgrade program is adding five more units in 2018-19 other southern stations as part of the Spectra/Enbridge Reliability and Expansion program.

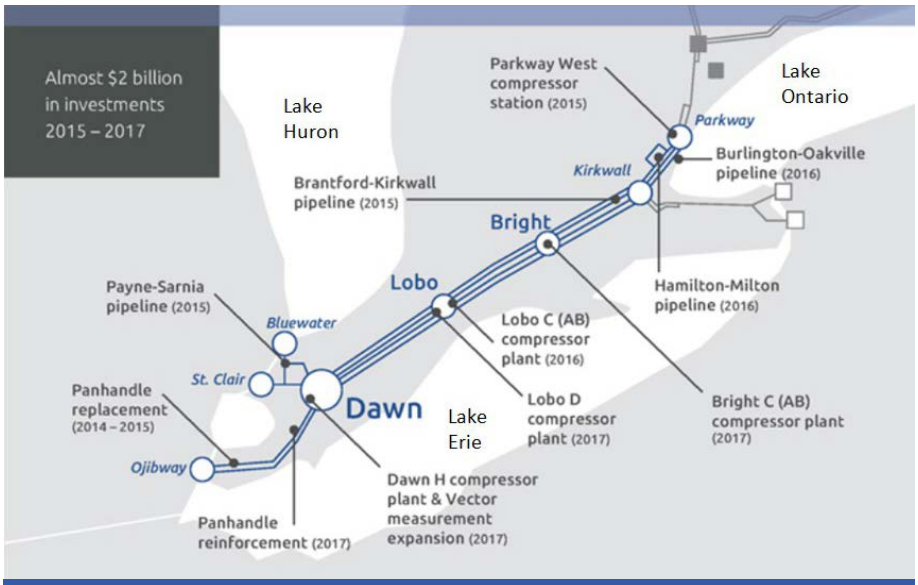
LNG Canada has selected an initial order for four 100 MW GE LMS100-PB dry low emission gas turbines and eight centrifugal compressors for Phase 1 its proposed gas liquefaction plant for the export of LNG in Kitimat, BC. The LMS100 is a hybrid aeroderivative gas turbine available with compressor intercooling technology for increased unit efficiency of about 45 %. Several GE LM2500+ driven compressor units have also been ordered for Phase 1 of the associated Coastal GasLink 670 km pipeline. These efficient systems, working with some renewable energy in BC, will contribute to a very low GHG emission profile for the LNG Canada project.

TransCanada (now TC Energy) is installing at least seven SGT-A35 aero-derivative compressor drive units in the northern Alberta region, and on the NGTL western leg pipeline expansion. The 30-34 MW gas turbine generators with low NOx combustion are manufactured in Montreal (formerly Rolls Royce Energy), power turbines in Houston, the RFA36 gas pipeline centrifugal compressors made by Siemens/Dresser in Olean, New York, with assembly packaging done in Norway.

The TCPL Maple compressor station north of Toronto has also been expanded over the past four years, with additions of three 11 MW Solar Mars 100 gas turbine compressor sets with SoLoNOx combustion systems.

Union Gas 'Dawn to Parkway' Expansion Projects

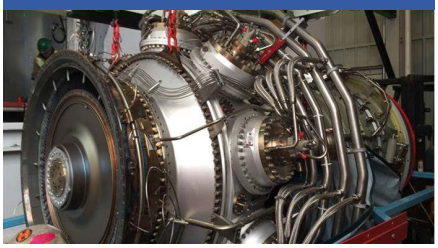
The Union Gas Limited Dawn-Parkway natural gas transmission pipeline and compressor system (called the Dawn-Parkway System), moves natural gas through Ontario from the Dawn Hub near Sarnia all the way east to the Parkway facility near Mississauga via a series of pipelines and compressor stations. At Parkway, the system connects with other pipelines that serve residents in the Toronto area, Quebec, eastern Canada and the U.S. northeast. Between 2015 and 2017, Union Gas invested nearly $1.5 billion in new pipelines and compressors along the Dawn to Parkway corridor, and nearly $2 billion across its transmission system to grow its capacity and serve increasing natural gas markets in these regions.



Union Gas's Transmission System Map and 2015-2017 Expansion Projects

To satisfy the additional compression demands at the Dawn, Lobo, Bright and Parkway West stations, Union Gas standardized on the 30MW Siemens RB211-24GT-DLE, now known as the SGT A35, to drive a range of Siemens RFB compressor sets for a total of 6 new plants. By standardizing elements of the compressor design and copying these elements from one site to the next, the project team was able to expedite design and procurement activities, increase construction efficiency, and improve maintenance efficiency.

Siemens SGT-A35 (RB211-24GT-DLE) Being Prepared for Installation

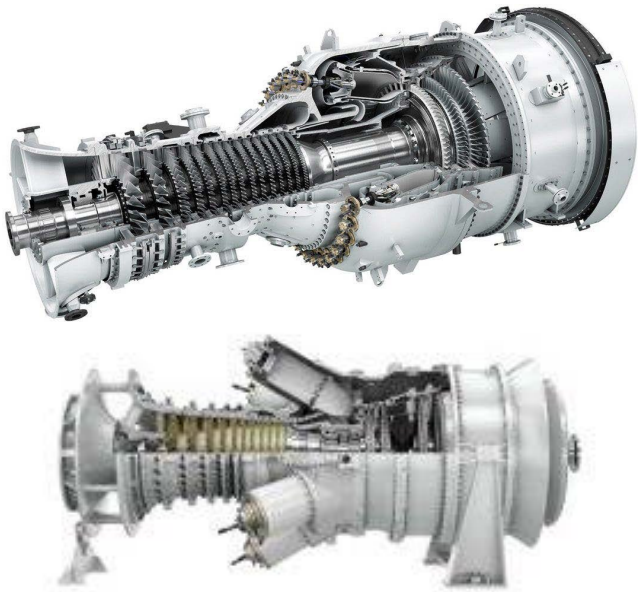


Siemens Gas Turbine for Mobile Power Generation

The new Siemens SGT-A45 TR mobile gas turbine unit addresses the growing market for fast power. With an electrical generating capacity of up to 44 MWe, this aeroderivative gas turbine is packaged for rapid deployment and can be installed in less than two weeks. Its design features high power density, fuel efficiency and operational flexibility for customers with urgent power needs or in regions with less developed infrastructures. The compact SGT-A45 TR gas turbine core utilizes components from the Siemens Industrial Trent 60 that have been adapted to a proven free power turbine.

SGT-A45 TR unit at the manufacturing plant in Montréal

Transport of the gas turbine is facilitated by its compact design and relatively low weight, and the unit can be flown as air cargo to its installation site. The SGT-A45 TR unit can run on gas or liquid fuels, and transition smoothly between both fuel types while in operation. Low NOx emissions can be achieved with optional water injection, which also boosts the unit's power output particularly in warm climates. The aeroderivative gas turbine can generate full power in less than 9 minutes from start without need for auxiliary systems to maintain the unit in an operationally ready standby mode. In the event of a shutdown, the unit can be restarted at any time to restore power quickly, as it has no "hot lockout" restrictions.



Siemens SGT-800 and SGT-400 Gas Turbines

First Canadian Orders for Siemens SGT-800 Units

Siemens Canada has been given an order for two SGT-800 (54 MW ISO) gas turbine packages for Inter Pipeline for its Heartland Petrochemical Complex near Fort Saskatchewan, Alberta. The gas turbine generator sets produced in Finspong, Sweden will be supplying power and steam to the propane dehydrogenation and polypropylene facilities within the Heartland Complex in late 2021.

Siemens will provide the first Canadian application of the SGT-750 (40 MW ISO) gas turbine driving two Dresser-Rand DATUM compressors combined with waste heat recovery for process heat for Encana's Pipestone Gas Processing Facility in Grand Prairie, Alberta. A second train will consist of a Siemens electric motor-driven compressor for refrigeration compression with variable frequency drive.

The amalgamated Siemens company also produces a line of smaller gas turbines in England, from the 5 MWe SGT100 to the 15 MW SGT400, several of which have been installed across Canada since 1993. High efficiency and pre-mix combustion technology ensure that the gas turbines minimize fuel burn and NOx/CO emissions over the operating range to satisfy applicable environmental legislation. The common technology philosophy extends across the power ranges, sharing many common features and parts.

Last year a Siemens SGT400 was added to the cogeneration facility at the Ingredion Canada processing plant in Cardinal, Ontario. CHA Canada designed the plant for Ingredion's corn starch product manufacturing facility to supply reliable electricity and steam. The electrical load management system allows the plant to continue to operate in islanded mode to supply Ingredion with power and steam during a utility power outage.

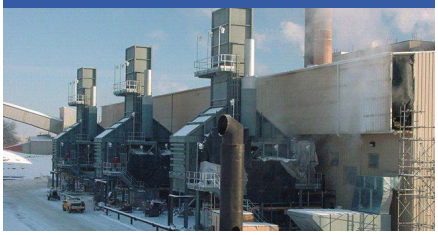
TransCanada Napanee

Power Projects: Combined Cycle Repowering in Saskatchewan

A unique example of utility repowering has been developed at the SaskPower Queen Elizabeth Power Station in Saskatoon. The project involved converting a 200 MWe boiler steam turbine plant (originally using coal, then natural gas in 1975). In replacing boilers in 2005, six Hitachi H-25 gas turbines were installed with IST Once Through Steam Generators (OTSGs) for combined cycle operation with existing steam turbines, totalling 430 MWe. In the 2014-16 period six additional 35 MWe H25 turbines were added with OTSGs, one new steam turbine, and two step-up transformers for an upgrade increasing the plant capacity to 635 MWe.

The QEPS facility now contains 12 gas turbines, 12 heat recovery steam generators and 2 steam turbines (most GT units of any power plant in Canada). The project represents a significant advancement in OTSG technology with nickel alloy metallurgy, offering the highest dry-run temperature (>600°C) ever sold by IST, formerly in Cambridge, Ontario.

Three OTSGs at the Queen Elizabeth Power Station



Other recent large power projects include:

ENMAX Shepard Energy: This 800 MWe plant in Calgary was completed in 2015, also based on two MHI 501G gas turbine combined cycle systems designed for fast start flexibility. It also provides a research opportunity for industry and institutions to collaborate on innovative carbon-conversion technologies at an industrial scale.

TC Energy Napanee: TransCanada'a newest combined cycle plant is the 970 MW gas-fueled facility in Napanee Ontario, to provide reliable power in helping to replace former coal-fired capacity. The equipment installed in 2018 includes two MHI 501 GAC gas turbines and a TC2F-40 steam turbine, from Mitsubishi Hitachi Power Systems, and two Vogt 3x pressure HRSGs with duct-firing.

Suncor Cogeneration: Mitsubishi Hitachi Power Systems announced that Suncor Energy will install two large M501 JAC gas turbines with heat recovery steam generators in a cogen facility to power a more carbon-efficient process for bitumen and power production in Canada's oil sands near Fort McMurray, AB.

ENMAX Shepard plant

Projects in Canada by Solar Turbines

Solar has been very active in the Canadian industrial and institutional power generation market. When Canadian universities needed combined heat and power (CHP) with high efficiency and low emissions they came to Solar Turbines. Starting with Queens, York and Calgary, then continuing with recent Solar Turbines projects at McMaster and Carleton universities.

Typical Solar Gas Turbine Cogen Modules

The Ontario manufacturing and food sectors have also recently invested in Solar Turbines for high efficiency onsite power generation with CHP installations using the very reliable and efficient Centaur and Taurus turbine generator models. These companies include Toyota, Campbell's Soup, Windsor Salt, Oxy Vinyls, Invista, and International (IGI) Wax.

In oil and gas, new gas plants in Alberta and British Columbia are often in remote areas such as Montney and utilize Solar gas turbines to power their facilities. In most cases these turbines are installed in CHP applications to maximize the overall plant efficiency. This includes customers such as Keyera, Arc Resources, Seven Generations, Tidewater Midstream, ConocoPhillips, and Meritage Midstream with a range of Taurus 70, Mars 100, and Titan 130 generator sets.

Oil and gas processing facilities continue to expand in Alberta and British Columbia. Solar customers like AltaGas, Keyera and Pembina will utilize gas turbines driving Solar's centrifugal compressors, most often for inlet or sales gas compression. Recent projects included a mix of Taurus 60, Titan 130, and Titan 250 products depending on the design conditions at each site.

Canada has seen steady growth in gas transmission including pipeline expansions in both western and eastern Canada. Gas transmission companies will utilize Solar's highly efficient lineup of pipeline compressors to optimize their pipeline network and add capacity. Recent developments include projects for Enbridge, TransCanada, and Gaz Metro using gas turbines from Centaur 40 through the Titan 250.

Oil Sands Development in Northern Alberta is starting to increase and Solar's customers, such as Imperial Oil, will utilize gas turbines for both power and steam. The steam is utilized for enhanced oil recovery technology such as steam-assisted gravity drainage (SAGD).

Cogeneration in Ontario

Ontario has been a leader in the past in building small and efficient cogen and district energy projects, providing low-carbon thermal energy with both gas turbine and reciprocating engine systems. This continues, and will be essential as the province has moved away from central coal steam plants, and will need additional energy to compensate for nuclear power upgrades and maintenance over the next two decades. As described above, Solar Turbines has collaborated with design companies such a CEM Engineering in St. Catharines to establish several new facilities, examples below:

Sunnybrook Hospital: Sunnybrook Hospital in Toronto plans to implement a cogeneration system to provide both electricity generation and steam heating with an 8 MWe Solar Taurus 70. This onsite generation capacity would add resiliency to the power distribution system and reduce the risk to the hospital associated with power interruptions - such as those of the December 2013 Ice Storm.

Carleton University: As part of its long term energy plan, Carleton University is installing a new co-generation plant at its Ottawa-based campus to satisfy the anticipated heating and cooling needs, and about 1/3 of its onsite power needs. The installation has a 4.6 MWe Solar Centaur 50 with a heat recovery boiler.

Solar Centaur and HRSG Installation at Carleton U. (Nov 2018)

Air Analysis Tools: Camfil CamLab & Air Monitoring

Gas turbines and other turbomachinery are highly sensitive to even the smallest particles and operational savings and availability can be increased considerably by eliminating degradation with efficient filters that have a low pressure drop development. But to achieve low maintenance costs and maximum availability, it is critical for the turbine operator to choose the right filters to fit specific site conditions. With varying characteristics, such as filter media, efficiency, and construction, how can turbine operators choose the right one?

Field tests provide fast answers to performance questions because they are based on real data gathered at the operator's site. The industry-unique CamLab is a mobile laboratory that can be commissioned onsite for a duration of 3-6 months to monitor the performance of up to 4 different filter configurations.

CamLab is typically placed in the immediate vicinity of a plant to analyze the ability of the filters to remove contaminants and handle variations of ambient air quality. By simultaneously testing several filter combinations, it is possible to determine the best type and level of filtration for the turbine. The sophisticated analysis equipment can be controlled by remote access, allowing data to be retrieved from the test site in real-time. The measured parameters include:

- Ambient dust concentration and airflow
- Filter resistance to airflow (pressure drop)
- Filter efficiency by particle count/size
- Temperature and Relative humidity

All data is analyzed and compiled into a report showing actual operating conditions and performance, comparing multiple filter combinations, and life cycle cost analysis. Camfil Power Systems has commissioned over 20 CamLab's in the Americas since it's conception, including use at Canadian locations at TCPL McKay River, TCPL Pembina, Suncor Fort McMurray, and now ENMAX Calgary.

Once the right filter is defined from the CamLab analysis, and the filters are installed on site, filter performance can further be analyzed throughout the year to optimize maintenance decisions and continuously assess performance during different seasons by monitoring pressure drop and ambient conditions. The Air Monitoring tool is permanently installed on site where it measures and transmits measurements wirelessly to a Camfil server. The Camfil Team analyzes performance data to support operators in their maintenance decisions to:

- Identify the cause of a pressure drop trigger
- Help predict future filter replacement requirements
- Suggest optimal solutions (if a CamLab was not previously used)

The CamLab and Air Monitoring service can be used consecutively or independently. In both cases, these tools will ensure that operators achieve maximum availability and reliability.

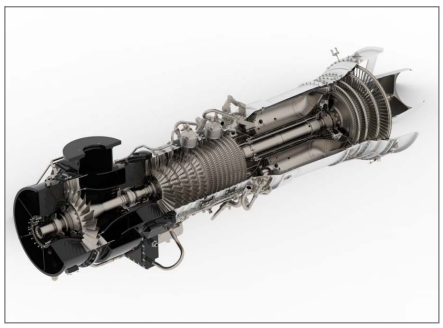
Siemens SGT-A05 KB7HE Gas Turbine

Siemens has improved the aerodynamic technology in the SGT-A05 aeroderivative gas turbine to increase the power and efficiency to provide electrical power output between 3.9 and 5.8 MW. The new SGT-A05 KB-7HE gas turbine leverages the heritage of the former Rolls Royce Industrial 501-K family of products to increase capabilities over the current offering. Through collaboration with Packagers and global Maintenance Repair and Overhaul Centers, the SGT-A05 KB7HE has been operating at our customer's site for the last year to "Lead the Fleet" in operating reliability.

Features Include:

- Increased rated power with potential up to 8000 HP at ISO conditions.
- Increased Engine Thermal Efficiency with potential of 34% depending on operation conditions.
- Operational benefits – the SGT-A05 KB7HE can be installed in existing SGT-A05 KB7S installations, with continued maintenance familiarity.

Siemens Energy Inc. acquired the aero-derivative gas turbine business of Rolls-Royce (Indianapolis) in 2014. Since 1963 they have sold over 1,675 engines. Current active network of packagers include: On-Power for North America, Centrax in European Region, IHI Jet Services and Hitachi Zosen for Japan, and Jereh Group for China.



R&D Project Funding from 'Emissions Reduction Alberta'

In February 2019 Alberta's ERA Industrial Efficiency Challenge committed $70 million towards eleven new projects, two of which would involve gas turbine systems:

Supercritical CO2 Waste Heat Recovery and Utilization Technology

TransCanada Energy will install a demonstration waste heat recovery generation system at one of its Alberta compressor stations. The technology is a first-of-a-kind approach in WHR and uses Supercritical Carbon Dioxide as the working fluid to recover waste heat from a gas turbine and convert it to emissions-free electricity.

Crossfield Energy Centre Hybrid Fuel Project

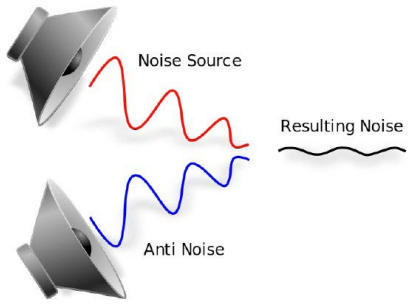
ENMAX Generation will install Canada's first Hybrid Electric Gas Turbine at its Crossfield Energy Centre in Alberta (currently with three GE LM6000 units). This 10 MWe battery storage solution involves the hybridization of one existing gas turbine by adding a lithium-ion battery and control system to provide electricity at near-zero emissions, while supporting the growth of renewables.

Noise Mitigation

In February 2019 Alberta's ERA In-Based on sound data available from gas turbine manufacturers, the component noise sources of a gas turbine engine (combustion air intake, exhaust, ventilation, etc.) produce a significant amount of sound energy in the 20 Hz to 500 Hz frequency range. Active noise control (ANC) systems offer an intriguing solution to significant noise and vibration control problems in gas turbine facilities. The technology presents a significant opportunity for low and mid frequency noise control and is a viable alternative to classic passive measures such as large, costly silencer baffles and enclosures.

Applications that have seen commercial success for industrial engine exhaust stacks, commercial compressors, generators, and large industrial fans. An ANC system comprises of an array of loudspeakers phased to generate a downstream propagating wave that is an inverted mirror image of the offending incident sound wave. The signal to be controlled is sensed by a series of sensors such as microphones that are upstream of the loudspeaker(s). Each anti-noise loudspeaker provides its portion of the overall cancellation signal.

The frequency range of performance expectation from an ANC system is typically restricted to a frequency range of 20 Hz to 500 Hz. Higher frequency ranges are difficult to attenuate as a result of increasing space constraints to address the geometric properties of the sound field. The challenges in the low frequency range are mainly due to physical size, temperature, high mass flow velocities and turbulence. In order to address this constraint, active noise control systems have been designed by Vintec Acoustics.



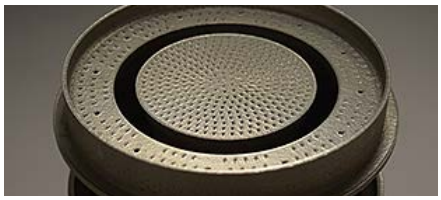
Graphical Depiction of Active Noise Reduction (Wikipedia 2016)

Acoustics include the implementation of passive noise control to achieve broadband noise reduction with exceptional low frequency performance. This approach to noise control can be characterized as a hybrid solution which involves a combination of active and passive noise control elements that can be modelled, refined and integrated on a case by case basis. These systems have little to no backpressure demand in comparison to extensive passive silencer baffle type solutions that often result in a significant system pressure drop directly translating into increased energy costs and system wear and tear.

Properly integrated anti-noise loudspeakers in an ANC system not only can reduce low-frequency noise downstream and/or upstream in a ducted system, but may also improve system efficiency to such an extent that a properly executed hybrid active noise control system can quickly pay for itself through energy savings realized from significantly reduced backpressure demands. Vintec Acoustics staff was involved in the design, build and commissioning of one of world's first and longest standing Outdoor Active Noise Control Systems for the first cogeneration plant that was based on the GE LM6000 aero derivative gas turbine system (1992) resolving an environmental low frequency condensing fan noise problem that was impacting a community in Ottawa, Ontario.

3D-printed Combustion Component for Siemens SGT-A05

There have been a lot of new industry developments in additive manufacturing (AM). Siemens has successfully 3D-printed and engine tested a dry low emission (DLE) pre-mixer for the SGT-A05 aeroderivative gas turbine, a potential for significant reductions in CO emissions. Pictured is a 3D-printed DLE pre-mixer for the SGT-A05 gas turbine developed and tested by Siemens.



The DLE pre-mixer is highly complex with over 20 parts involved in the casting and assembly using traditional manufacturing methods. By utilizing Siemens qualified nickel super alloys as the AM printing material, the 3D-printed component requires only two parts and lead time is reduced by approximately 70 percent. 3D-printing of the DLE pre-mixer allows simplifying the production process, reduce external dependencies in the supply chain, and improves the geometry of the component, thus allowing a better fuel-air mix.

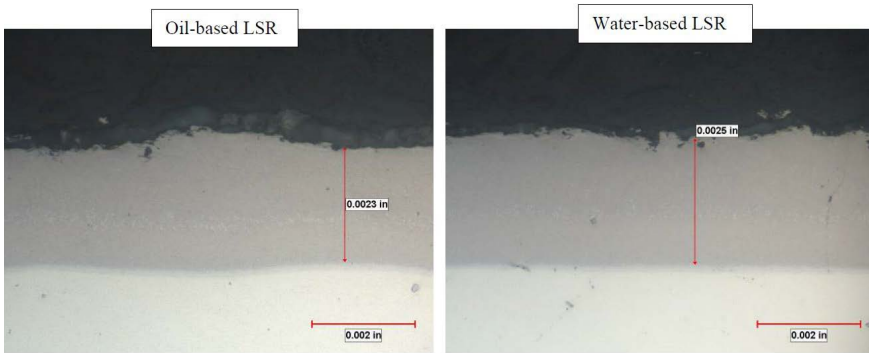
First engine testing of this DLE pre-mixer, which was 3-D printed in Siemens' AM center of competence in Finspong, Sweden, was recently completed with positive results. This DLE solution for the SGT-A05 gas turbine reduces emissions through advanced lean burn combustion technology, eliminating the need for water injection and associated with water treatment. In 2017 Siemens also finished its first full-load engine tests for gas turbine blades completely designed and produced using AM technology, and successful commercial operation for AM burner repairs for SGT-800 burners.

Slurry Aluminide Coatings with Reduced Environmental and Health Impacts

Liburdi Turbine Services (LTS) located in Dundas Ontario has developed a water-based slurry for application of Aluminide oxidation resistant coatings for hot gas-path engine components.

LTS LSR coatings first introduced in 1999 have always been free of carcinogenic hexavalent chromium in the aluminizing slurry, which has been a drawback of other industrially available coatings. Recently Liburdi engineers have transitioned our LSR coating from an oil-based slurry to a water based slurry with no change to the diffused coating. This has improved safety for our staff by eliminating any substances on the US Environmental Protection Agency's Toxic Release Inventory list and eliminating flammability of the slurry. This change has also reduced the environmental impacts of our coating system by eliminating the release of volatile organic compounds and reducing the energy required for drying the coating.

Why does this matter to you? If you operate gas turbines, there are likely components within your engine that receive Aluminide coatings during repair. Now you know you have an environmentally friendlier option for this process. Please visit: https://www.liburdi.com/ for more details on the Liburdi Group of Companies.



Clean, Reliable and Innovative Energy Systems

Many of our environmental and energy initiatives can only be achieved through energy conservation, a variety of renewable energy systems, cleaner fuel choices and innovative power systems for the future. With new low-NOx systems and heat recovery, modern gas turbine cogeneration and district energy plants should be considered part of the solution to reduce both air pollution and greenhouse gas emissions. Waste heat recovery, steam turbines, recip engines, absorption chillers, fuel cells and backup boilers are also part of that diverse portfolio mix.

Although the term 'gas' turbine refers to Gas = Air for its power production, natural gas fuel is often used to heat that clean filtered airflow. Efficient natural gas industry systems can have a 70-80 per cent reduction in GHG emissions versus coal power (with 95 per cent less air pollution), and Canada has been a world leader in the retirement of most existing coal power facilities, and the use of gas turbine compression on gas pipelines, many replacing older recip engines.

Secondly, the resilience of a multi-faceted energy infrastructure can demonstrate the value of a solid and diverse regional energy supply in very cold or hot weather, or other disruptions – an example:

On Sept 21, 2018, some extreme weather near Ottawa, Ont. and Gatineau, Que. shocked both cities, with many homes, electrical and cable services destroyed or damaged. With the remarkable efforts of utility workers, electricity repairs and recovery efforts were effective within two to four days. What was not damaged were the TransCanada and Enbridge natural gas compression and pipeline systems in the area. Those clean, hydrogen-based natural gas services were still available to all those who needed to use it, and liquid fuels from the local Trans-Northern pipeline facilities were intact as well.

On the innovation topic, there has been much general debate in recent years over the future of Canadian oil and gas pipelines. Since the 1960s, the natural gas industry has made many improvements in life-cycle system efficiency, reliability, GHG and air pollutant emissions, and pipeline safety. We have over 100 system-wide examples of significant technology innovations and improvements in gas pipeline applications, including:

- More efficient gas turbines with DLE combustion
- Waste heat recovery
- Methane leakage prevention
- Advanced system controls and reliability
- Automatic pipeline welding and advanced materials
- Electronic pigging and leak detection

The public and media discourse could focus more on those examples and related opportunities. Together with all types of renewable energy and bio-fuels, a diverse array of hydrogen-based natural gas, new LNG export facilities, and gas turbine systems will be continuously improved for providing a critical role in future clean energy for this century.

GTEN™

Gas Turbines for Energy Network™

Our Function

Educational Training for the Energy Market
Providing Resource Awareness
Create Community, Government & Network Forums

Our Focus

Gas Turbine Systems in:
Pipeline Compression
Power Generation
Energy for Buildings
Industrial Solutions
Environmental Solutions

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