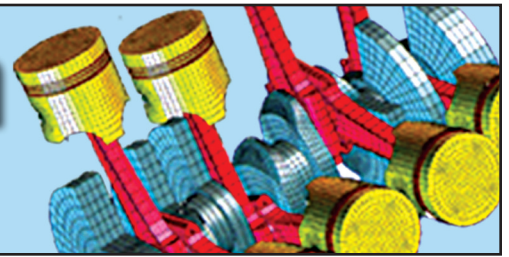


Internal Combustion Engine



FALL 2011

From the Editor's Desk **Suri Rajan, Editor**

This summer 2011 Internal Combustion Engine Division Newsletter features an interesting article on Oil Imports in addition to encouraging reports by our current and past chairs. It contains a Call for Papers for the fascinating Turino Conference in 2012 while providing inviting details of the upcoming Morgantown Fall Conference. Also meet our new Executive Committee member Bradley Zigler. Hope you enjoy the Summer 2011 ICED Newsletter. ▶



Chair's Message **Stuart Neill**

Did you know that the Internal Combustion Engine Division of

ASME has been promoting the art and science of mechanical engineering of engines for mobile, marine, rail, generation and stationary applications since 1921? I am truly honoured and humbled to serve as ICE Division Chair in this our 90th anniversary year!

Over the past year, the ASME Board of Governors has identified three critical areas for the organization to play a leadership role in matters of global impact. They are energy, engineering workforce development and global impact. So what is the ICE Division doing to support this vision?

As we all know, the ICE Division focuses heavily on improving the energy efficiency of the internal combustion engine. This is of critical importance since the transportation sector currently accounts for 25% of world energy demand and consumes almost 2/3 of the

petroleum used each year. We are also at the forefront of finding alternative fuels to reduce our dependence on petroleum. Our Fall Conference in Morgantown, WV will feature a keynote address by Dr. Nigel Clark (West Virginia University), entitled "The Internal Combustion Engine in an Era of Social Pressure." We have also invited a number of experts to discuss the future for alternative fuels such as algae-derived biofuels, ethanol, natural gas and hydrogen in a special panel session. In this newsletter, you will also find an interesting article regarding oil exports from the ASME Energy Committee.

I am happy to report that your Executive Committee has taken several important steps to improve our impact in the area of engineering workforce development. We have drastically reduced our registration fees to attract more graduate students to our conferences. We have also implemented a highly successful, fast-track procedure for rapid publication of high-quality conference papers in the ASME Journal of Engineering for Gas Turbines and Power, which helps graduate students and young professors to widely publicize their research results in a timely manner.

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This Fall, we will have the opportunity to hear about the work of the three inaugural winners of our undergraduate student competition and participate in a West Virginia University workshop on "Advances in Tailpipe Sensors: Research and Development."

The third area, global impact, is perhaps the most challenging for the ICE Division, given that we have a relatively small group of volunteers. I would be remiss if I did not start off by stating that many of our members work for companies that develop and sell products for global markets. Although we hold conferences outside of North America every three years and routinely have participants from 20 or more countries, our conferences are not accessible to many engineers working in our field. My perception is that perhaps we could do a little more to meet the ASME challenge, which is to improve the quality of life throughout the world. The Executive Committee would like to hear your ideas on this important subject.

Some of you may be familiar with ASME's *Engineering for Change* (E4C)

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Chair's Message

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initiative. E4C is a dynamic and growing community of engineers, technologists, social scientists, non-governmental organizations, local governments, and community advocates whose mission is to improve people's lives around the world. E4C features a user-friendly online platform (www.engineeringforchange.org) that facilitates collaboration and knowledge exchange for the development of appropriate solutions to issues such as sanitation, access to clean water, energy, transportation, food, education and housing. Perhaps the Division or some of our members could offer their expertise to this worthy initiative.

At this stage, I would like to thank my colleagues on the Executive Committee for their hard work during the past year. In particular, I would like to recognize our past Chair, Dr. Frank Aboujaoude (Fairbanks Morse Engine), for his astute leadership of the Division. One of Frank's main contributions was to work with Tim Callahan (Southwest Research Institute) to establish a new CIMAC USA National Member Association (NMA). This new arrangement with CIMAC will result in significant cost savings for the ICE Division, provide benefits to all our members and will energize our large bore engine community. I would also like to thank Dr. Victor Wong (MIT) for his many years of service as Division Treasurer. Thanks to Victor, the Division's finances continue to be in great shape!

I would also like to recognize the

efforts of our many volunteers. On the technical side, I would like to thank the Track Chairs, Session Organizers, Authors, and Reviewers who work so hard to put together excellent technical programs. We also have fantastic support on the administrative side to put together our newsletters, Division website, and our Honors and Awards Banquet. Please visit the Division website for a fairly comprehensive list of our volunteer leaders. I would like to thank Dr. Tom Ryan III (T. Ryan Consultants) again for his keynote address at our San Antonio conference, which is available for viewing at www.ebmcdn.net/asme/asx/KandC/ASME-desktop.asx. Lastly, I must thank the hard-working staff at ASME, especially Mr. Vince Dilworth and Ms. LaShion Pettiford, for their continuing support of the ICE Division.

Unfortunately, I must report that we have lost a couple of our colleagues in the past year. Mr. Malcolm Payne (Engine Systems Development Centre) passed away in February 2011. He was a very active contributor to the Division in the area of locomotive fuels and emissions. We also lost Mr. Paul Danyluk who passed away in October 2010. Paul was very active in the ICE Division and was a former ICE Division Chair in 1994.

Looking to the future, I would like to welcome Dr. Brad Zigler (National Renewable Energy Laboratory), our incoming member to the Executive Committee. Brad joins a dedicated team of volunteers on our Executive Committee who are excited to be able to serve the internal combustion engine community.

Dr. Frank Aboujaoude is our new Treasurer.

On behalf of the Executive Committee, I would like to thank the membership for the trust you place in us to carry the torch for the ICE Division. Like many of you, we are extremely proud to be a part of the ASME organization. We are looking forward to putting together two excellent conferences for the Division in the upcoming year: Morgantown, WV, USA (fall 2011) and Turin, Italy (spring 2012). We strongly encourage you to participate in these important events and look forward to receiving your feedback, both positive and constructive, so we can better serve the needs of our members in the future. Alternatively, you may also reach us by phone or email (see http://divisions.asme.org/ICE/Executive_Committee.cfm for contact information).

In closing, we should all be extremely confident and optimistic about the future of the internal combustion engine industry. Why you might ask? The main reason is that we have a critical number of brilliant, dedicated engineers from around the world that meet on a regular basis to present their ingenious solutions to adapt the internal combustion engine to meet the future needs of society. Take advantage of the unique opportunities that our conferences offer to learn more about energy, further develop your technical expertise, meet (and perhaps hire) an outstanding young engineer, exhibit your innovative products and engage in intellectually-stimulating conversations with your colleagues. ▶

Past Chair's Message

Frank Aboujaoude



It has been an honor to serve as your Division Chair for the past year and I look forward to the upcoming year to serve as the Past Chair. The year has

come and gone quickly. The six years that I have served on the Executive Committee have also passed swiftly. It seems only a short time ago that I attended my first ICE conference in 1989 hosted by Wayne State University in Dearborn, Michigan. Three things I remember the most from my first conference. I was introduced to many people who took the time to talk to me even though there was an experience difference. I was very impressed with the technical presentations, and the proceedings

had very good papers for a "young" engineer. I watched the earthquake live on television while watching the World Series game between the Oakland Athletics and the San Francisco Giants with other conference attendees during one of many social events. I left the conference with a very good impression about this new group of people that I had just met and decided that I wanted to attend another conference. After several conferences, I was asked to perform peer reviews

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Past Chair's Message

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of technical papers. Then, I joined the Board of Associates, started chairing sessions, and began taking an active role in the division's activities. Eventually, I was asked to join the Executive Committee.

This year, the accomplishments of the ICE Executive Committee and the Board of associates have included some significant events. The 2011 Fall Technical Conference, hosted by Southwest Research Institute and held in San Antonio, Texas, was one of the most successful conferences. The conference had an excellent speaker in Dr. Thomas W. Ryan III, T Ryan Consultants, LLC, who discussed a timely subject, "Sustainable Energy - Economic and Environmental Benefit of Efficiency Improvement" and a strong technical program consisting of 96 technical papers. The conference was also very well attended with 182 registrants. The ICE Division retained its strong ties to CIMAC by establishing a

new CIMAC USA National Member Association (NMA) thanks to Tim Callahan from Southwest Research Institute. This new association will provide benefits to the large bore engine group and a better venue for their involvement as well as a cost savings in annual membership fees to the ICE Division. The Long Range Planning continues to be a strong ongoing effort by analyzing conference attendance data, using feedback from the Associates at the Board meetings which are held on Tuesdays at every conference and are open to all conference attendees, and applying lessons learned from previous conferences. Holding a conference every three years outside North America has remained a goal of the Executive Committee to serve a broader membership. The next conference is being planned in Torino, Italy in the spring of 2012.

As outgoing Chair, there is no greater honor than to work with a fine group of engine professionals. I am continuing my involvement with the Internal Com-

bustion Engine Division by serving as the Division Treasurer. I am taking over for Dr. Victor Wong, Massachusetts Institute of Technology, who in addition to being a past Division Chair, has served as the Treasurer for many years and kept the Division finances in excellent shape. I would like to thank my employer Fairbanks Morse Engine for their support for ICE conference attendance and allowance to serve you as an ICE Division Executive Committee member.

A year ago, in my message as incoming chair, I urged you to increase your participation in the ICE Division by attending our conferences, volunteering for numerous divisional activities and/or hosting a conference. My message today remains the same. Our Division is strong; but to continue thriving, it requires more participation from its new and future engineering talent, which will provide the innovation to sustain, improve and propel the ICE Division to even greater heights. ▶

Prepare to Attend the 2011 Fall Technical Conference in Morgantown, West Virginia

J. Hedrick, T. Jacobs

The Internal Combustion Engine Division of the ASME is pleased to announce the details of its upcoming **2011 Fall Technical Conference to be held October 2 – 5, 2011 in Morgantown, West Virginia** and hosted by West Virginia University. The venue for this year's conference is the comfortable and scenic Waterplace Hotel located on the Monongahela River in Morgantown, West Virginia. A river walk accessible from the hotel awaits tired and worn conference participants for refreshing strolls after long and rigorous days of technical interactions and discussions. The technical program includes the following: (1) Around 100 technical papers presented by leading researchers in the field, (2) Keynote address by Professor Nigel Clark (West Virginia University) discussing the development of internal combustion engines in the face of societal pressures, (3) A free workshop (to

registered conference participants) conducted by the Center for Alternative Fuels Engines and Emission of West Virginia University on Advances in Tailpipe Sensors, (4) A panel composed of leading alternative fuel researchers discussing the future directions of alternative fuels and their impact on internal combustion engines, (5) Presentations delivered by three undergraduate student engine enthusiasts who competed through an international competition to attend and participate in the conference for free, and (6) Technical tours of West Virginia University's Center for Alternative Fuels Engines and Emission Laboratories.

In addition to the technically rich environment, the conference offers a small but collegial atmosphere for networking, vibrant discussions, and enthusiastic collaborations to advance the science and art of the internal combustion engine. Reduced registration fees for

students offer employers a unique opportunity to recruit next-generation experts to their organizations.

The Honors and Awards Banquet, which will be held at the Waterfront Place Hotel on Monday, October 3, 2011, is a special annual event to recognize the outstanding achievements and dedicated efforts of Internal Combustion Engine Division colleagues. The Honors and Awards Banquet will start with a cash bar at 6:00 p.m., followed by a delicious dinner and the awards ceremony. The evening will conclude after the awards ceremony with a performance by a String Quartet associated with West Virginia University.

The spouses tour will be a shopping trip to the Tanger Outlets located in Washington, Pennsylvania. Information about the Tanger Outlets can be found at <http://www.tanger-outlet.com/washington>. The bus will depart the hotel at

8:30 a.m. and return at 3:00 p.m. The bus will stop for lunch on the return trip to Morgantown. Attendees are responsible for covering their own lunch.

Registration is now open with early-bird registration rates available until September 1, 2011 and can be made through the 2011 Fall Technical Conference

website: <https://www.asme.conferences.org/ICEF2011/>

SAVE THE DATES

**ASME IC Engine
2012 Spring Technical Conference**
Hosted by Polytechnic University
of Torino
Torino, Italy
May 6 – 9, 2012

**ASME IC Engine
2012 Fall Technical Conference**
Hosted by Westport Innovations, Inc.
Vancouver, British Columbia, Canada
September 23 – 26, 2012

For more information, please contact:

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Energy Committee – Energy Talking Points (ETP) Series

ETP 1: Three Signs the End of Oil Exports is Coming

Issue: The first sign of the end of oil exports has already happened. The second is expected in about six years and the third in twenty years, by which time the price of oil will have dramatically increased and world wide oil exports will have effectively ceased. Broad systemic change involving new technologies has historically taken longer than twenty years to reach maturity. We must respond to this energy challenge now.

THE FIRST SIGN

The first sign of the end of oil exports occurred in 2002-2004. Great Britain had been a net oil exporter due to its North Sea fields. Over time, North Sea

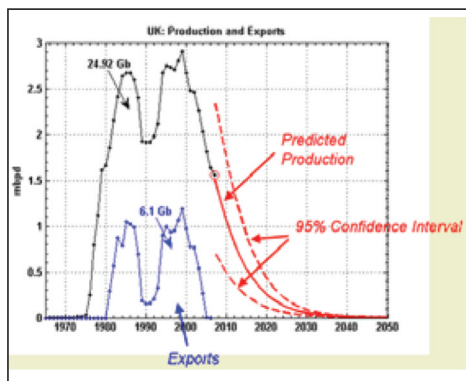


Figure 1. Great Britain's Oil Exports²

oil production passed the peak of the Hubbert curve¹ and began to decline (Fig. 1). (The "Hubbert curve" provides a statistical approximation of production rate over time.)

Domestic consumption greatly increased after 1980 as the UK embraced automobiles and a suburban lifestyle. By the close of 2003, oil exports ceased entirely and Britain again became a net importer of oil.² When internal consumption rises above internal produc-

tion, a country will stop exporting and, on balance, become an oil importer.

THE SECOND SIGN

The second sign was reported by Scientific American (SA) in a Special Issue in September, 2010.³ According to their calculation, they forecast the expected peak of the Hubbert curve in 2014. World production is expected to sharply decline after the peak, falling from 100 ± 10 million barrels per day (MBPD), to about 10 MBPD by 2060. According to the article, this prediction is unique in the sense that the model accounts for multiple waves of technological advances.

We expect the world will react once the decline in global production has been confirmed several years after the peak. For this reason, we deem the second sign will have occurred when the decline in oil production is generally accepted in the years 2016 to 2020.⁴ During this period, it is expected the price of oil will rise more rapidly.⁵

THE THIRD SIGN

Considering the world's top 5 oil exporters (Saudi Arabia, Russia, United Arab Emirates, Iran, and Norway) and estimating their internal production and

consumption, we can determine the point where the consumption curve crosses the production curve as shown in Fig. 2. At this point, oil exports would effectively cease.⁶

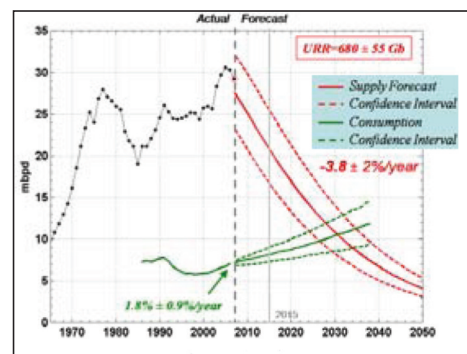


Figure 2. Top 5 Exporters – Production and Consumption⁷

Figures 2 and 3 show three estimated production curves, for maximum, minimum and expected cases, and the same for consumption. The intersections of these lines bounds a window for the appearance of the third sign over a range of years. With the sole exception of Saudi Arabia, all the other large oil exporting countries will cease exports between 2025 and 2030. If present trends continue, Saudi Arabia itself would effectively cease

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Energy Talking Point

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all exports in the time range around 2025 to 2038. (Fig. 3). During this period, we expect dramatically higher oil prices⁵.

By the time this third sign is observed and understood, about 2035, the first sign (the British example) will be over thirty years past, and, the Hubbert curve for world oil production should clearly show decline from its peak around twenty years earlier, 2014.

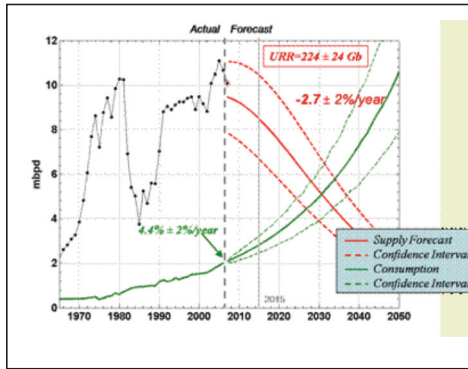


Figure 3. Saudi Arabian Estimated Production and Consumption²

SUMMARY

Study of *the first sign* shows that oil-exporting nations will cease exports when their entire oil production is absorbed by satisfying their internal consumption. *The second sign*, in 2014-2016, will be the confirmation that the global Hubbert Curve will have peaked and that worldwide oil production will be well into a decline. *The third sign*, around 2025-2035, will be when exports from the traditionally largest oil-exporting nations effectively cease. This will place an enormous strain on those countries that are highly dependent upon oil imports, such as the USA, India, and China. The number of people wanting cars continues to increase rapidly, especially in China and India. These two countries are among the largest, and most dynamic, fast-growing economies on Earth, not just in the developing world. Fueling the growth of these economies drives increased global competition for a vital but limited basic resource, thus we can expect the price of oil to rise sharply.

All this is expected to happen within the next twenty years. Fundamental

technological shifts, such as are called for in energy, historically have taken longer than twenty years to mature.⁸ There is an urgent need to prepare today for our future energy needs by formulating and implementing a national plan for energy security that is based on sound science, engineering, and economics.

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⁷ Matthew Simmons, *Twilight in the Desert*, (Wiley, New York: 2005)

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Energy Talking Point (ETP) papers are produced and reviewed by the ASME Energy Committee to address fundamental questions that should be asked regarding the future of energy.

ASME, the American Society of Mechanical Engineers, is a nonprofit, worldwide educational and technical society that enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines. Founded in 1880 by a small group of leading industrialists, ASME has grown through the decades to include more than 120,000 members in over 140 countries. It conducts one of the world's largest technical publishing operations, holds more than 30 technical conferences and 200 professional development courses each year, and sets some 600 industrial and manufacturing standards, some of which have become de facto global technical standards.

The Energy Committee of ASME's Technical Communities comprises 40 members from 17 Divisions of ASME, representing approximately 40,000 of ASME's members.

This public statement represents the views of the Energy Committee of ASME's Knowledge and Community Sector. It does not necessarily represent the views of ASME as a whole. ▶



Dr. Bradley T. Zigler has joined the ASME Internal Combustion Engine Division – Executive Committee as Incoming Member for Technical Programs, effective July 1st. Zigler has been active in the division since 2007, organizing conference sessions and the technical track for the Advanced Combustion Technical Committee. Since 2008, he has led the Advanced Combustion and Fuels research task at the National Renewable Energy Laboratory. Previously, he was an engine and transmission design engineer at Ford Motor Company. His Ph.D. research in mechanical engineering at the University of Michigan included low-temperature combustion, ignition kinetics, and combustion diagnostics development. ▶

Report on ASME ICE 2010 Fall Technical Conference

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The 2011 Fall Technical Conference of the ASME Internal Combustion Engine Division was held on September 12-15, 2010 at the Hilton Palacio del Rio in San Antonio, Texas. It was hosted by Southwest Research Institute. There were 183 registered attendees and 99 presentations.

The conference started with a Keynote Address by Dr. Thomas Ryan III of Ryan Consultants LLC. He discussed potential technologies for improving the fuel efficiency of light- and heavy-duty vehicles. A number of engine technologies that could potentially be incorporated into light-duty engines could provide customer savings of around 7,000 Euros over an assumed 10 year vehicle lifetime while meeting a 130 g/km CO₂ limit. For on-road heavy-duty applications, vehicle technologies such as measures to reduce aerodynamic drag and rolling resistance are more effective than just engine measures alone. A 20% reduction in CO₂ was estimated to be possible by 2030 from line-haul trucks. Even short ownership periods from 2-5 years offer potential savings for truck owners from some of these measures.

Large Bore Engines

The large bore engine papers covered a range of topics focused mainly on medium speed diesel engines for locomotive applications and stationary gas engines.

With the EPA Tier 4 locomotive implementation date coming into effect in 2015, development and engineering work is well under way to meet its challenging limits. During a lunch time presentation, Mr. Michael Iden of Union

Pacific Railroad presented a railway's perspective of considerations that should be taken into account for the design of these locomotives. Some of the issues he brought forward included:

- The major outside dimensions of a locomotive have to be maintained at current values. Locomotives are shared across the U.S., Canada and Mexico so they need to be compatible with the current infrastructure. They also have to fit inside the AAR Plate-L clearance dimensions to ensure coal deliveries to electric power plants can be maintained. Double stack container cars are occasionally pointed to as evidence that locomotive height can be increased. However, these cars are strictly limited to certain routes where bridge/tunnel clearances are sufficient.
- Placing aftertreatment systems high on the locomotive will make maintenance work more difficult because of the need for fall prevention safety measures to protect maintenance workers.
- Additional piping, joints etc. will have to be designed to ensure exhaust leaks in the car body of the locomotive do not occur.
- The fuel capacity of the locomotive needs to be sufficient to ensure current operating ranges between scheduled fuel stops can be maintained. An additional urea tank located next to the fuel tank can necessitate the use of a smaller fuel tank.
- Engine maintainability needs to be ensured. Removal of power cylinder assemblies often required the use of over-head cranes and aftertreatment

placed immediately above the engine can interfere with this operation.

Joint studies by GE Transportation and Southwest Research Institute covered several pertinent issues. One study carried out with the added participation of Da Vinci Emissions Services, Ltd. identified the cylinder liner design as the most important factor influencing oil consumption (and therefore the lube oil derived portion of PM emissions) for cylinder rebuild kits intended to allow existing locomotives to meet EPA Tier 0+ emission standards. Piston ring design also had a significant but smaller effect [ICEF2010-35199]. Another study looking at the influence of biodiesel blends on emissions from a Tier 2 locomotive found that PM was consistently reduced and volumetric fuel consumption increased with blends as low as B2 but that NO_x emission increases did not exceed test-to-test variability until the blend level exceeded B20 [ICEF2010-35024].

Another study by GE Transportation examined the influence of Miller cycle valve timing, turbocompounding and a combination of the two on fuel consumption in a medium speed diesel engine. Combining the two technologies seems to have little benefit over turbocompounding alone because the decrease in effective compression ratio resulting from the Miller cycle leads to lower pre-turbine exhaust availability that decreases the potential benefit of turbocompounding [ICEF2010-35085].

The presentations on stationary gas engines focused largely on achieving lower emissions from new and existing

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engines while maintaining or improving thermal efficiency. An important mitigation measure to reduce NO_x emissions from lean burn gas engines is to extend engine operation to leaner air fuel ratios. Waukesha discussed their low NO_x 275GL series gas engine that uses a reduced pre-chamber volume to achieve a leaner air fuel ratio. Closed loop control of AFR uses a NO_x sensor instead of the more conventional oxygen sensor in order to maintain NO_x at low levels over the life of the engine, for varying humidity and for varying fuel compositions. A reduction in peak firing pressure also allowed for increases in BMEP and a DOC is required to limit formaldehyde emissions [ICEF2010-35030] [ICEF2010-35038].

Other means of extending the lean limit to achieve NO_x reductions in gas engines that were discussed included:

- A micro pilot injection of diesel fuel [ICEF2010-35052, Niigata Power Systems]
- Supplying the pre-chamber with synthesis gas from a natural gas reformer rather than natural gas alone [ICEF2010-35162, Colorado State, Rolls-Royce Fuel Cells]
- Laser ignition [ICEF2010-35058, Colorado State, Caterpillar]

Cummins presented a combustion modeling tool that can be used for the development of engines to meet the U.S. Department of Energy's Advanced Reciprocating Engine Systems (ARES) program goals for advanced large gas engines of 50% thermal efficiency, 0.1 g/bhp-hr NO_x, 10% lower operating cost and increased fuel flexibility [ICEF2010-35061]. They then went on to use it to investigate the effect of stroke-to-bore ratio in a lean burn gas engine that had same bore size as their QSK engine [ICEF2010-35108].

A joint program involving Caterpillar, Fluent, NETL, Hiltner Combustion Systems on the development of a simulation tool that can predict the onset of engine knock was also presented. The re-

duction in end-gas knock potential will result in the ability to run the engine at increased power densities (>2 MPa) while keeping NO_x emissions fixed [ICEF2010-35109].

A growing interest in using landfill gas to power distributed generation and combined heat and power systems has led to technological developments unique to these engines. The Gas Technology Institute and North Carolina State University provided an update on a gas composition sensor that can be used to compensate for wide variations in gas composition to avoid engine shut-down or damage [ICEF2010-35124]. Infineum presented a new engine oil formulation that provides the potential for extended drain intervals and reduced oil consumption from these engines by improving the acid neutralization capability and reducing the tendency of landfill gas contaminants and engine oil detergents to form in-cylinder deposits [ICEF2010-35189].

Large engine manufacturers are constantly looking for solutions that can reduce maintenance costs and reduce the number of scheduled shut-downs that are required for maintenance. Several papers discussed new materials that could increase the durability of large engines to achieve these objectives. Markisches Werk, GmbH discussed the development of multi-phase metal-mineral coatings that can reduce the effects of hot gas corrosion and increase the service life of exhaust valves and piston crowns in large engines burning heavy-fuel oil [ICEF2010-35068]. Miba Gleitlager, GmbH presented developments in bearing materials for large 2-stroke engines for marine and stationary engines based on babbitt materials that use new production techniques that allow alloy compositions with enhanced mechanical properties [ICEF2010-35139].

Advanced Technologies

Many papers focused on relatively new technologies for light- and heavy-duty engines for mobile applications. The areas covered by these presentations included: fuel efficiency improvement measures, low temperature combustion (LTC), combustion control, aftertreatment and sensors.

Fuel Efficiency - With the major reductions in emissions from new light- and heavy-duty on-road mobile applications that have been achieved in the past decade, the focus of technological developments is moving away from emissions reductions towards fuel efficiency improvements and CO₂ reductions. This shift was apparent in many of the presentations.

One potential source of efficiency improvement is through the recovery of additional work from waste heat in the exhaust. Michigan Technological University reviewed waste heat recovery using two emerging technologies: organic Rankine cycle (ORC); and thermoelectric devices. They identified a number of factors that need to be considered for the successful application of these technologies to transportation applications. The application of ORC to heavy-duty applications seems to be the most attractive application of waste heat recovery with thermal efficiency improvements of about 18% possible [ICEF2010-35142].

The application of ORC to light-duty applications, however, offers more modest thermal efficiency improvements of 2-3% due to driving cycle differences according to researchers at Oak Ridge National Laboratory. An important technical barrier is the need to manage the limited thermal energy in the exhaust gases so that NO_x aftertreatment catalysts continue to have sufficiently high temperature to operate effectively [ICEF2010-35120].

Another design trend for achieving fuel efficiency gains is engine downsizing. A joint program between the Conservatoire national des arts et metiers (Cnam), Honeywell, Peugeot and Renault discussed the need to characterize turbocharger performance at low speeds such as might be experienced in urban driving [ICEF2010-35071]. Downsized engines will also experience higher bearing loads and may need improved bearing materials such as Federal Mogul's IROX bearing technology to ensure downsized engines do not suffer from premature bearing failure [ICEF2010-35114]. Higher power densities in

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downsized engines can increase coolant temperatures and according to Seals Eastern, Inc., some of the current elastomer materials used for cooling system seals may not be compatible [ICEF2010-35074]. Higher temperature cooling systems can utilize the higher heat transfer coefficient available from nucleate boiling to improve cooling system efficiency and reduce engine warm-up times but must contend with a more difficult control problem. Researchers at the Michigan Technological University suggested that a pressure based control method can avoid performance variability and overheating [ICEF2010-35118].

Low Temperature Combustion - Low temperature combustion continued to receive significant attention with numerous aspects covered. Papers on fuels for LTC included work by the National Research Council of Canada with CRC designed FACE fuels in a heavy-duty engine [ICEF2010-35194] and work by Argonne National Laboratory on low octane gasoline in a light-duty diesel engine [ICEF2010-35056]. Fuel injection topics included the effect of injection pressure on cylinder-to-cylinder and cycle-to-cycle variations in a light-duty diesel engine [ICEF2010-35021] and work by Argonne on end-of-injection phenomena that could potentially be a source of unburned fuel [ICEF2010-35032]. The University of Wisconsin Madison investigated the roles of flame propagation, turbulent mixing and volumetric heat release in conventional diesel and LTC combustion [ICEF2010-35135] while Texas A&M University examined the contributors to efficiency loss in late phased LTC combustion [ICEF2010-35070]. The University of Michigan investigated the potential for increasing the upper load limit in HCCI combustion [ICEF2010-35122] as well as the ability of several different relationships to accurately predict exhaust soot concentration from Filter Smoke Number (FSN) measurements [ICEF2010-35117].

Combustion Control - Controlling and

monitoring the combustion processes in modern diesel engines can be a critical factor to ensure engines maintain long term emissions performance and compliance with OBD requirements. While high quality, piezoelectric cylinder mounted pressure sensors are the conventional approach to combustion monitoring in a laboratory setting, such an approach would be too expensive for most production engine applications and lower cost options that provide a high level of precision and accuracy are needed. Several of these approaches are being developed including:

- A fiber-optic based pressure sensors mounted in the cylinder head gasket [ICEF2010-35076, Optrand, Federal Mogul]
- A high precision torque sensor that can be used to estimate cylinder pressure and extract combustion timing information [ICEF2010-35101, SAAB, Lund University]
- Processing techniques that use engine speed measurements from the toothed wheel already present in most engines to estimate combustion phasing [ICEF2010-35166, University of Bologna, Magneti Marelli]
- In-cylinder ion current sensors [ICEF 2010-35123, Wayne State University]

Other combustion control papers covered topics such as hardware and software techniques to improve real-time heat release calculations to control cycle-to-cycle variations [ICEF2010-35100, Scania, Lund University], estimating individual cylinder indicated efficiency using the cylinder pressure for active fuel consumption optimization [ICEF2010-35113, Lund University] and a review of next-cycle and same-cycle control techniques for enhancing production engine control and aiding engine calibration. [ICEF2010-35119, Drivven, Argonne National Laboratory]

Particulate Matter Sensors - Sensors that can provide real-time soot data are of great interest for both laboratory work and on-board diagnostic (OBD) applications. Two papers were presented that discussed two different technologies.

The University of Texas at Austin has been developing a PM sensor for on-board applications including OBD that utilizes two high voltage electrodes and a charge amplifier to separate and detect naturally charged exhaust particles [ICEF2010-35055]. It is sensitive primarily to the carbonaceous fraction of diesel PM. In real time on-vehicle tests, the sensor readings correlated well with opacity measurements from a vehicle with very high PM emissions. The sensor is to be commercialized by EmiSense.

An update was presented by researchers from the Royal Military College of Canada on the development of a spark discharge PM sensor for use in a measuring instrument rather than on-board applications [ICEF2010-35141]. Through changes to the design and the calculation algorithm, the measuring range and repeatability was improved (Filter Smoke Number up to 3.5) and the response time was decreased (to under 2 seconds). The experimental work was conducted under controlled conditions; practical applications would require compensation for temperature and other cross-sensitivities.

Emissions Control - Several papers were related to issues in diesel and natural gas emissions aftertreatment. Investigators at PNNL studied the inhibition of SCR reactions by water and hydrocarbons and intend to use the results to develop an SCR catalyst model using the competitive adsorption kinetics of H₂O, hydrocarbons, NO₂ and NH₃ [ICEF2010-35054].

Researchers from the University of New South Wales, Australia presented images of cylinder wall wetting by fuel during post-injections such as would be used for DPF regeneration [ICEF2010-35075]. No significant wall impingement was seen with early post injections while significant impingement was observed with post-injections starting about 80 degrees aTDC with all fuels investigated. More severe wall wetting occurred with fuels containing biodiesel. Oil dilution was not quantified in the study.

A cooperative study by Emitec and FEV examined the placement of an

aftertreatment system—including a DOC and a flow-through filter (FTF)—in a pre-turbo position [ICEF2010-35086]. This work targeted large non-road engines (above 30 L displacement) in applications with little transient operation. Due to the higher gas density, the pre-turbo position allows for a volume reduction of the DOC+FTF system by up to 64%. The main disadvantage (which prevented commercialization of pre-turbo catalysts in highway engine applications) is the negative impact on the transient response of the turbocharger. No emission data was

presented at this stage of the study.

West Virginia University reported on an emission aftertreatment system for pre-2007 heavy-duty natural gas engines such as the Cummins Westport C8.3G+ (2000 MY) [ICEF2010-35131]. While PM emissions from these engines are considerably lower than from diesels, PN emissions tend to be higher. The system—designed to reduce emissions of toxic air contaminants (TAC), PM and PN (particle numbers)—included a Pt-coated, passively regenerated SiC wall-flow particulate filter followed by a Pt/Pd oxidation catalyst. The somewhat unusual location of the catalyst was chosen to control PM emissions and prevent PN nucleation from heavy, lube oil-de-

rived hydrocarbons that passed through the particulate filter. The system, installed and tested on a transit bus, not only showed significant reductions in PM, PN, HC and CO but NO_x as well. NO_x reductions were attributed to increased back pressure as well as conversion to NH₃.

Technical Tours

Two technical tours were organized on the third day of the conference. The tours were hosted by Southwest Research Institute, one of the oldest and largest independent research organizations in the United States, and the San Antonio Toyota Tundra plant.



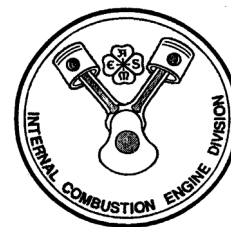
Call For Papers

Internal Combustion Engine Division ASME International

Invites Papers for the 2012 Spring Technical Conference

May 6–9, 2012 • Torino, Piemonte, Italy

Hosted by Politecnico di Torino



Papers of high technical quality related to the development, advancement, and improved understanding of the **internal combustion engine** are sought for the ASME Internal Combustion Engine Division's 2012 Spring Technical Conference to be held May 6–9, 2012 in Torino, Italy and hosted by Politecnico di Torino. In addition to two-days of technical presentation of accepted papers, the conference highlights networking activities among members of industry, government, and academia, keynote speakers, industrial tours, a banquet, and an overall collegial atmosphere to advance the state of the art of the internal combustion engine.

All offers relating to the internal combustion engine, or interfaces with internal combustion engines, are accepted for rigorous review by experts in the field. Specifically, accepted papers are generally grouped into one of the following technical tracks (with corresponding track chairs listed for contact):

Track 1: Large Bore Engines (Mr. Dick Dunteman, nrdun@aol.com)

Track 2: Fuels (Professor Scott Miers, samiers@mtu.edu)

Track 3: Advanced Combustion (Dr. Brad Zigler, brad.zigler@nrel.gov)

Track 4: Emissions Control Systems (Mr. Steve Fritz, sfritz@swri.org)

Track 5: Instrumentation, Controls, and Hybrids

(Mr. David Gardiner, dgardiner@nexumresearch.com)

Track 6: Numerical Simulation (Professor Song-Charng Kong, kong@iastate.edu)

Track 7: Engine Design, Lubrication, and Applications

(Mr. Ronald Duda, rduda@unlimiteddesigneng.com)

Accepted papers that are presented at the conference will be archived on the conference proceedings CD and by Scopus. Presentation of

papers at the conference requires payment of the registration fee (papers not presented at the conference are excluded from both the conference proceedings CD and Scopus). Accepted papers must transfer copyright to ASME, with certain exceptions noted. The ASME ICE Division's Presentation Policy and the ASME Copyright Policy are available at <https://www.asmeconferences.org/ICES2012/PubPolicy.cfm> and <https://www.asmeconferences.org/ICEF2012/PubForms.cfm>, respectively.

Offerors may submit papers of two types: 1) archival-type research articles and 2) engineering application articles (with strict policy of no commercialization). Accepted archival-type research articles of highest quality and with potential for long-lasting technical contribution will be approved for fast-track publication in ASME's Journal of Engineering for Gas Turbines and Power. Those research articles not selected for fast-track publication may be submitted to ASME's Journal of Engineering for Gas Turbines and Power after presentation at the conference, where standard review process will occur.

Please submit your 400-word or less paper offer / abstract by **Friday, September 2, 2011** at the conference website:

www.asmeconferences.org/ICES2012

For additional information or questions, please contact the technical program chair:

Stephen A. Ciatti, Argonne National Laboratory, sciatti@anl.gov

Important Dates

September 2, 2011	400-word paper offer / abstract due
November 4, 2011	Draft manuscript due for review
February 3, 2012	Final manuscript, copyright, and author registration due