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Advanced Energy Systems Division Newsletter

Editor: Srinivas Garimella

Fall 2000

Chair's Message



Salvador Aceves

As the chairman of the Advanced Energy Systems Division, I wish to thank all members of the division for their interest and support. We, the members of the executive committee

are working hard in developing activities that are of interest to our membership and contribute to their professional development.

In my opinion, the most important aspect of being a Division Chairman is to enhance member participation. We have currently about 900 primary members. However, only about 80 of these choose to actively participate in our activities. The purpose of this message is to describe our recent and future activities with the intention of raising interest for active participation among our members.

The future looks promising for energy engineers. Higher oil prices have suddenly reminded everybody of the intrinsic volatility in energy costs and of the dangers of depending on foreign oil. Energy efficiency has also been identified as the least expensive and least difficult method for reducing greenhouse gas emissions, which appear to be altering the global climate. Deregulation of the electric industry may also offer new opportunities for those of us working on energy engineering. Energy systems miniaturization is

also an area of future growth. Recently we have directed our efforts to focus on these areas of growth. During the 1999 IMECE we had panel sessions on High Efficiency and Low Carbon Technologies and Heat Pumps for the 21st Century, and sessions on hydrogen technologies, fuel cells and energy systems miniaturization. Our efforts will continue into the IMECE 2000 with sessions on renewable energy. These sessions are added on to our traditional symposia on power plant and heat pump efficiency and improvements.

We have also made an effort to reach out to members from industry. During the last IMECE, we had the valuable participation of many speakers from industry, including representatives from General Electric, Mitsubishi Heavy Industries, Raytheon Systems, Tokyo Gas, and many more from small companies, for a total of 18 papers from industry.

In addition to our growing industry participation, we have been able to maintain a substantial participation from foreign countries. Typically, over 50% of our papers have foreign authors. Foreign participation gives our sessions a diversity of perspective that could not be obtained otherwise.

With all of this said, I would like to repeat my invitation. There are opportunities for everybody to get involved with the division. We have a variety of technical committees that span a very diverse range of fields for energy engineers. Please contact the respective committee chairman for active participation in the division, or check our web site at

<http://www.asme.org/divisions/aesd/>. We have an exciting list of future activities including the IECEC and the IMECE meetings.

Finally, I would like to thank our outgoing division chairperson Karen den Braven. Over many years Karen has worked hard at improving the division activities and our recent successes are due, in good measure, to her hard work. I also express my gratitude to the executive committee members, who have done a superb job at coordinating the different division activities. Their efforts are deeply appreciated.

Publication Opportunities for AESD Authors

Several opportunities are available for AESD authors to publish their technical articles. These include symposia, the monthly *Mechanical Engineering*, and archival journals. AESD authors are cordially encouraged to give a tangible expression of their ASME affiliation by considering these publication outlets for their work.

Periodically, AESD has a special section in the monthly *Mechanical Engineering*. Special sections are comprised of articles submitted by various AESD technical committees on a rotating basis. Members interested in participating in this activity

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AES Division Participation in IECEC

This year's 35th IECEC is being hosted by AIAA with a theme of "Energy and Power in Transition" at the Riviera Hotel in Las Vegas, Nevada from July 23-27, 2000. The AESD is sponsoring and co-sponsoring several technical sessions on "Engines and Energy End-Uses", "Cogeneration and Thermal Energy Storage" and "Power System Issues" as well as Advanced Heat Pumps and other topics. We will have more work to do next year when the 36th IECEC will be hosted by ASME at Savannah, Georgia, July 29-August 2, 2001. There will be plenty of opportunities for you to volunteer to help in organizing sessions, writing papers, reviewing papers, etc. Please watch the ASME web page (www.asme.org) for more details on this exciting conference in the coming months. The contact information for this conference is as follows:

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<http://www.aiaa.org/calendar/iecec00prog.html>

Sriram Somasundaram

Garimella, Metghalchi Named to Executive Committee



Srinivas Garimella

Dr. Srinivas Garimella is the new Member-at-large for Membership Development. He currently serves as the editor for this newsletter and is also the Chair of the AESD Heat Pump

Technical Committee. Dr. Garimella received his Bachelor of Technology degree from the Indian Institute of Technology Kanpur, India, and M. S. and Ph.D. degrees from the Ohio State University. He is the William and Virginia

Binger Associate Professor of Mechanical Engineering at Iowa State University. Prior to this appointment, he was an Associate Professor at Western Michigan University in Kalamazoo, MI. He has also held research appointments at Battelle Memorial Institute in Columbus, OH, Harrison Division of General Motors Corporation in Lockport, NY and at The Ohio State University. Dr. Garimella directs the Advanced Thermal Systems Laboratory at ISU, and conducts research in the areas of microchannel two-phase flow, absorption and vapor compression heat pumps, and binary fluid heat and mass transfer. His research has resulted in numerous publications, in addition to three patents. In 1999, he received the National Science Foundation's CAREER Award for research on heat and mass transfer in falling-films and droplets. He was also awarded the 1998 New Investigator Award by ASHRAE, and the SAE Ralph E. Teetor Educational Award for Engineering Educators. His teaching has been recognized by ISU through the Miller Faculty Fellowship (1999-2000), and the *Outstanding Service to Students Award* from Western Michigan University in 1996 and 1997.



Mohamad (Hameed) Metghalchi

Dr. Mohamad (Hameed) Metghalchi is the new Member-at-Large for Honors and Awards. He received a B. S. in Mechanical Engineering from the University of Oklahoma, and M. S. and D. Sc. degrees in

Mechanical Engineering from Massachusetts Institute of Technology. He joined department of Mechanical Engineering at Northeastern University in Fall 1979. Prof. Metghalchi has been Associate Chair of Mechanical, Industrial and Manufacturing Engineering Department since 1991.

Professor Metghalchi is an active member of national professional societies such as ASME, ASEE, SAE and the Combustion Institute. He is currently president of the System Analysis Technical Committee of the AES Division of ASME. Professor Metghalchi's research is in the area of Thermofluids and he has numerous publications on combustion, fluid mechanics, thermodynamics, heat transfer and chemical reactions. His research has been funded by National Science Foundation, Department of Energy and companies such as Ford Motor Company, Stone and Webster Corporation, Integrated Genetics and Genzyme Inc. He has supervised five Ph.D. theses and fifteen M.Sc. theses at Northeastern University.

AES Division Awards and Keynote Lecture

The AES Division recognizes the outstanding contributions of its members and researchers and educators in the Advanced Energy Systems area at the annual AESD Luncheon which is held at the IMECE. The contributions of these individuals are truly outstanding and are one of the main reasons for the continued advancement of energy related technology. The Awards Luncheon also offers the opportunity for attendees to hear from a leading expert on issues at the forefront of such research and technology. Last year, Professor Adrian Bejan of Duke University gave a thought provoking and inspiring talk on "*A Role for Exergy Analysis and Optimization in Aircraft Energy System Design*".

The paper entitled "Available Energy: Gibbs Revisited and Extended." by Richard A. Gaggioli, David H. Richardson, Anthony J. Bowman, and David M. Paulus, Jr. of the Department of Mechanical Engineering, Marquette University, Milwaukee, WI, was selected for the *Edward Obert Best Paper Award In Thermodynamics* from the papers presented at the IMECE 1999.

The *Heat Pump Technical Committee Best Paper Award* was given to Alexander Lifson and James W. Bush of the Carlyle Compressor Division, Carrier Corporation, UTC, for their paper entitled "Comprehensive Modeling of Reed Valve Impact Velocity in Scroll Compressors."

Professor Enrico Sciubba, from the University of Rome, was awarded the *Fellow* grade of ASME membership.

The tireless contributions of Mysore Ramalingam, past chair of the Division, and Vince Mei, past chair and founding member of the Heat Pump Technical Committee, were also recognized.

Congratulations and a hearty thanks to all these awardees!



Pictured from left, Karen Den Braven (Past Chair), Enrico Sciubba, and Adrian Bejan

Direct Thermal Power Conversion and Thermal Management

This technical committee promotes R&D in all areas related to direct conversion of heat to electric power without any moving parts or thermal management of energy. Direct thermal energy conversion devices include thermionics, thermoelectrics, AMTEC (alkali metal thermal to electric converter), and TPV (thermophotovoltaics). All areas of thermal management including aircraft and spacecraft, ground vehicles, electric components and power systems, and industrial energy systems are covered. The committee participates in the IECEC, IMECE, and other conferences related to advanced energy systems. Four sessions on direct thermal power conversion and six sessions on thermal management were organized by committee members for the 34th IECEC held in Vancouver, Canada, during August 1999.

Muhammad Rahman

Heat Pumps

The development of heat pumps is undergoing a phase of rapid changes due to the availability of superior technology, renewed concerns about energy efficiency and the environment, and pertinent legislation. This has provided a great impetus to the activities of this committee, which continues to contribute to the advancement of heat pump technology. This committee maintains an active role in disseminating the latest developments in heat pump technology through the organization of several well-attended symposium sessions at the annual IMECE. The committee has been able to sustain a high degree of interest and contributions from academia, industry and government agencies. Six sessions, including a panel discussion with experts on Computational Fluid Dynamics for Compressors and Pumps, are being organized for the IMECE in Orlando. The other sessions in this year's symposium focus on heat actuated heat pumps, heat and mass transfer fundamentals, developments in compressor technology, natural refrigerant heat pumps, and other emerging topics in this area. Over 30 manuscripts from all parts of the globe including China, South Korea, Japan, Singapore, Spain, Germany, Austria, Brazil, Denmark, Israel, South Africa, and the United Kingdom are being reviewed. More in-depth information is provided in the feature article in this newsletter on transcritical cycles for space-conditioning and refrigeration, using an environmentally benign fluid such as carbon dioxide. The HPTC would like to thank all its members, session organizers, and authors for their

effort in making it one of the most active technical committees in the AES Division. We look forward to increased participation in the conference sessions and committee activities.

Srinivas Garimella

Energy Systems Miniaturization

This committee organized a successful two-session technical forum at the 1999 IMECE in Nashville, TN. The two sessions, held in conjunction with other sessions organized by the Heat Transfer Division (sessions entitled Microscale and Mesoscale Energy Systems) showcased a number of research and development activities in the miniature and microscale energy systems area. To lead off the sessions, Dr. William Warren of DARPA provided an overview of activities of interest to his agency. This was an interesting and entertaining look at some of the forefront work now taking place in the field of miniaturizing energy systems such as refrigerators, heat pumps, and thermal engines. It was the consensus of the individuals attending the sessions and the brief committee meeting that the interest areas for the committee should be as broad as possible within the overall subject of energy systems miniaturization. This area can thus be described as energy systems smaller than traditional devices (e.g. the size of a sugar cube or smaller) and/or having a reliance on microscale structures for operation. The term "energy systems" can be very inclusive, but should involve the concept of energy generation, use, distribution, and/or conversion from one form to another. These miniature energy systems are expected to provide a number of important uses where a premium is placed on either mobility, compactness, or point application of the function.

The committee will focus on providing a forum for individuals working in the area of energy systems miniaturization and to promote the area where appropriate. It will also be a source of information and expertise that other institutions and agencies can interact with. The next full meeting of the committee will be at the 2000 IMECE in Orlando, FL, November 5-10. Anyone interested in additional information on the committee, or in participating in its activities is welcome to attend.

Richard B. Peterson

Superconductivity

This committee provides a forum for presenting the most recent progress in the field of applied superconductivity. The committee continues its efforts in sponsoring paper sessions including those co-sponsored in conjunction with other ASME committees. New members

are sought to bring in new ideas and to help coordinate future activities.

Ming-C. Chyu

System Analysis

During the previous year, the Committee organized its fifteenth symposium on "Thermodynamics and Design, Analysis and Improvement of Energy System," at the 1999 IMECE. The symposium included 54 papers, which were organized in 12 sessions. These papers originated from sixteen different countries, which showed a strong international participation. Industrial participation was also high, with 10 papers authored by industry. The Committee is also a co-sponsor of the yearly international ECOS (*Efficiency, Costs, Optimization, Simulation and Environmental Aspects of Energy Systems*), which will be held in Holland in summer 2000.

Michael von Spakovsky is the organizer of the 2000 IMECE symposium. He has received 53 papers, which are currently under review. These papers have originated from Canada, China, Denmark, Germany, Italy, Japan, Korea, Kuwait, Mexico, New Zealand, Poland, South Africa, Spain, Sweden, Taiwan, Ukraine and United States. The symposium will consist of 11 technical sessions with one panel discussion on Energy Conversion Technology in the 21st Century. The committee held its yearly meeting at the 1999 IMECE. Interested members are invited to attend the next committee meeting at the IMECE in Orlando.

Hameed Metghalchi

Hydrogen Technologies

This committee provides a forum for presenting the most recent progress in the field of hydrogen technologies for energy, including hydrogen utilization, storage, production, systems analysis, and safety. The committee is attempting to increase its membership by attracting attendees from hydrogen forums such as the National Hydrogen Association, the DOE hydrogen program, and similar programs in foreign countries. We are currently making plans for conducting a hydrogen session at the IMECE 2001 in New York. Those wishing to participate by contributing papers or helping to organize the session can contact Joel Martinez-Frias (contact information at the end of the Newsletter).

Joel Martinez-Frias

Fuel Cells

Activities of this committee include support of the ongoing efforts of the ASME PTC-50 fuel cell test code committee. This effort was initiated by the Fuel Cell power systems commit-

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Transcritical Carbon Dioxide Cycle Technology

Eckhard Groll and Srinivas Garimella

In today's world, refrigeration has become essential to ensure the availability of safe food supplies. In addition, the health field has experienced a rapid increase in using refrigeration techniques for medical procedures and tissue, organ, and specimen preservation. Our culture also depends on air-conditioning to support indoor comfort and high living standards. In health care facilities, HVAC systems provide a sterile indoor air environment conducive to patient recovery. The global economy also depends on refrigeration and air conditioning technologies that are crucial to manufacturing processes in the electronics and chemical industries.

The dependence of modern society on these technologies has, however, come at a significant price, most importantly the problems of ozone depletion and global warming. Both of these concerns are serious enough to have resulted in landmark governmental and intergovernmental legislation. This legislation prohibits the use of chlorofluorocarbons (CFCs) as refrigerants by industrialized nations, and requires the phase-out of the more benign hydrochlorofluorocarbons (HCFCs) as refrigerants in the near future. These regulations, created to protect the ozone layer, have thus eliminated highly efficient and economically viable refrigerants. Therefore, it is necessary to investigate new refrigerants and new refrigeration technologies to replace these fluorocarbon-based vapor compression cycles.

The choice of replacement refrigerants and technologies is complicated by yet another mandate of the global community: the reduction of greenhouse gas emissions. Recent international treaties are driving local legislation that continuously raises the standard for energy efficiency of HVAC&R equipment and systems. To meet these demands, industry has begun to direct significant resources toward fundamental research and development activities. This has also indirectly stimulated increased global competition as companies act on market opportunities whenever new technologies become economically and technically feasible.

One of the alternative refrigeration technologies that has gained increased attention for certain heat pumping, air conditioning, and refrigerating applications is the transcritical carbon dioxide cycle.

The critical point of CO₂ is 30.85°C and 73.53 bar. Thus, many refrigeration and

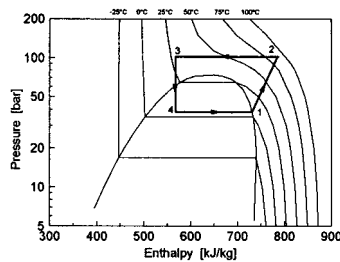


Figure 1: Transcritical CO₂-cycle in a p-h diagram

air-conditioning applications span the critical point in that the evaporator temperature is below and the heat rejection temperature is above the critical temperature. This implies a transcritical cycle in which the evaporator operates as a familiar vapor-liquid two-phase device, but the condenser is replaced by a supercritical heat rejection device called the 'gas cooler'. This can be best visualized by using the cycle state points indicated in a p-h diagram, which is shown in Figure 1. The evaporator portion of the cycle (state 4 to 1) is shown completely within the vapor dome. Line 1 to 2 represents the compression process. The compressor raises the pressure well above the critical pressure. Following thermodynamic laws, the temperature also rises well above the critical temperature. The heat rejection process (state 2 to 3) is shown along a supercritical isobar. This is a feature that is substantially different from the conventional vapor compression cycle. The heat rejection from the fluid will not exhibit a constant temperature segment, but will instead exhibit a continuously varying temperature associated with the thermodynamic properties in the supercritical region. This feature can be exploited in some applications where the temperature glide of the refrigerant provides a better match with the corresponding heat sink fluid than the constant temperature during condensation. The heat rejection device is no longer a condenser since no phase change occurs, but rather a gas cooler where the supercritical fluid continuously changes its density and other relevant properties. Following the gas cooler, the expansion process (state 3 to 4) occurs, which is very similar to the expansion process of the vapor compression cycle.

The cycle shown in Figure 1 illustrates the basic transcritical cycle technology. To get a satisfactory fit to the near-logarithmic temperature curve of the heat sink fluid, the discharge pressure should be on the order of 90-100 bar or higher. This means that when the evaporation temperature is, for instance 0°C, the discharge temperature in single-stage compression with dry saturated suction vapor will be about 70-80°C. This temperature can be adjusted by varying the discharge pres-

sure and suction vapor state using a suction-to-liquid line heat exchanger or, possibly, some liquid injection. A suction-to-liquid line heat exchanger as used quite commonly in refrigeration and air-conditioning equipment may also result in 5-10% increase in cycle efficiency (Robinson and Groll 1998a; Lorentzen and Pettersen 1993).

Several advanced cycle designs that show promise well beyond the basic cycle could also be considered. The compression process may be optimized by utilizing technologies such as multiple-effect (Voorhees 1905) and two-stage compression (Hall 1889) that were already available for CO₂ vapor-compression cycles at the beginning of this century. In addition, these technologies can be applied to increase the overall temperature lift between the lowest heat source temperature and the highest heat sink temperature, resulting in a major expansion of possible applications.

Further improvement in the basic transcritical cycle can be obtained by decreasing the relatively high throttling losses for CO₂. This can be amended by a number of well-known methods (Lorentzen 1983). One possible solution is to recover the expansion work directly by using an expansion machine, since the properties of CO₂ make this feasible. With a conventional refrigerant such as R-12, most of the theoretical expansion work comes from the flash gas and the p-V diagram becomes very thin with a low mean pressure. For CO₂ the situation is quite different, with most of the work in the liquid phase, a high mean pressure, and small volume requirement (Lorentzen 1994). An expansion aggregate may result in 14-17% increase in cycle efficiency (Robinson and Groll 1998a) and therefore, may become a cost-effective element.

The compression process of the transcritical cycle using CO₂ involves a compression ratio, which is greatly reduced compared to that of other refrigerants, resulting in the potential of much better compressor efficiencies. On the other hand, the absolute pressures are much higher than those encountered in traditional refrigeration technology. R-12 and R-22 exhibit high-end pressures of up to 20 bar, based on the application. Depending on the cycle configuration, the high-end pressure in a transcritical cycle using CO₂ might be as high as 140 bar. This high pressure is tolerable since it can be confined on the inside of small diameter tubes, which form the spine of the heat exchanger. Due to the fact that the volumetric heat capacity of CO₂ is five to eight times higher than that of R-12 or R-22, the mass flow rate is much smaller for the same capacity, and pipe diameters in the refrigeration piping and the heat

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Transcritical Carbon Dioxide Cycle Technology

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exchangers can be decreased drastically (Robinson and Groll 1999b). Because of the small area over which the pressure acts in a small diameter tube, this geometry is ideal for high-pressure systems. In particular, microchannel heat exchangers are being investigated as the design of choice for carbon dioxide. Thus, the high pressures are not expected to be a problem in the heat exchanger components. The compressor for the transcritical CO₂ cycle requires thicker walls to contain the high pressure, but since the volumetric capacity of the fluid is large, the compressor itself will actually be smaller than a current refrigeration compressor for the same capacity.

In summary, the transcritical cycle using CO₂ offers the potential for efficient refrigeration and air-conditioning in several applications, without the ozone-depletion and global warming problems associated with conventional refrigerants. The practical feasibility of the basic cycle, and the additional features that enhance the performance of the basic cycle must be investigated to demonstrate this potential. Ongoing research on the overall system performance, heat exchange component innovations, and compressor development, to name a few, will help demonstrate the suitability of this technology as a viable substitute for current vapor-compression technology that uses conventional refrigerants. In addition to technical innovations, tradeoffs between operating and capital costs, and evolving legislation in the global economy will govern the widespread implementation of transcritical carbon dioxide cycle technology.

Further information about this technology can be obtained from Eckhard Groll of Purdue University at groll@ecn.purdue.edu or from Srinivas Garimella of Iowa State University at garimell@iastate.edu

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Fuel Cells

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tee and is nearing the end of completion of a first draft of what will ultimately be an ASME code for evaluating the performance of fuel cell power systems. Beyond the PTC-50 work, the committee has typically been meeting at the biannual fuel cell seminar, although this was not held last year. The next meeting of the committee will be at the 2000 Fuel Cell Seminar, will be held Oct 30 to Nov 2 in Portland, OR.

Tony Leo

Stirling Engines

Activity of the ASME Stirling Liaison has been limited to support of the annual gathering at IECEC and the biennial International Stirling Conference (most recently in South Africa). Our technology has entered a quiescent period since the end of the major energy conservation efforts of the 80's. There are two active arenas dependent on Stirlings now: cryocoolers and dish-engine solar power generation. In the first, many thousands of units are built and sold by defense contractors like Raytheon and Hymatic (UK), for night vision service. Many expect cryocooler technology to expand in the coming years, with the advent of high-temperature superconductors. At least three companies worldwide are actively pursuing development of solar power via Stirling engines: SES/Boeing, SBP (Germany), and SAIC. In each of these applications, the unique characteristics of Stirling cycle machines (external heat source, small scale, high efficiency) make the Stirling cycle the preferred approach. Meanwhile, recent advances in acoustic-Stirling hybrids (at Los Alamos National Lab) have received attention and promise to simplify the mechanism required to implement Stirling physics in working hardware for some applications.

John Corey

Publication Opportunities for AESD Authors

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should contact the AESD chair and/or their technical committee chairs.

Opportunities for publishing technical papers are provided by the symposium volumes of papers presented at the IMECE AESD technical sessions. Normally one or more such volumes are prepared annually. Such papers may be eligible for consideration for the prestigious E. F. Obert Award.

Symposium volumes are available for purchase at IMECE and also may be ordered directly from ASME technical publications. Abstracts are generally due in January for papers to be presented at the following IMECE. Authors wanting to participate at IMECE should check the calls for papers in the monthly meetings calendar of *Mechanical Engineering*.

Many AESD authors participate in the annual IECEC held during the summer. Nearly every summer for several years AESD also has participated in symposia held outside the United States at various memorable sites. The 2000 event, ECOS 2000 (*Efficiency, Costs, Optimization, Simulation and Environmental Aspects of Energy Systems*) was held in Enschede, The Netherlands in July 2000. ECOS 2001 will be held in Turkey.

Papers for all such conferences are reviewed according to ASME standards and the symposium volumes are published variously by ASME or commercial publishing houses. For information concerning upcoming conferences, authors should consult the meetings calendar in *Mechanical Engineering*.

Additional outlets for technical articles by AESD authors are provided by the archival journals, *Journal of Engineering for Gas Turbines and Power*, *Journal of Turbomachinery*, and *Journal of Energy Resources Technology*, and the monthly, *Mechanical Engineering*. Owing to peer review requirements and some queuing of accepted papers before publication, a year to 18 months can elapse between paper submission and publication. Still, archival journals are the appropriate forum for articles of enduring value. Prospective authors should see current issues of the journals for instructions concerning the submission of articles.

For answers concerning your questions about AESD publishing opportunities contact M.J. Moran (contact information elsewhere in this newsletter.)

M.J. Moran

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Systems Analysis

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AES Division Extremely Active at IMECE Orlando (November 5-10, 2000)!

Mark your Calendars!

The AES Division has planned a very stimulating technical program at this year's IMECE in Orlando, Florida. A total of 19 sessions (one session co-sponsored with the Technology & Society Division under the Engineering & Technology Management Group) including two panel sessions on current topics will be held. The 80 papers scheduled in these sessions include an impressive 50 from outside the US and 12 from industry, demonstrating the wide-ranging and global appeal of the technical topics being addressed by the AES Division. A list of session titles is provided below. Please be sure to participate in these informative sessions and add your valuable input wherever possible, especially during the discussion period at the end of each paper or panel presentation. We hope to see you there.

Systems Analysis Symposium Sessions

- Fundamentals of Thermodynamics
- Fuel Cell Technology (2 sessions)
- Panel Session on Sustainability of Energy Conversion Technologies in the 21st Century
- Thermodynamics and Energy Systems
- Energy Systems and the Environment
- Energy System Analysis and Design (5 sessions)

Heat Pump Symposium Sessions

- Heat Actuated Sorption and Desiccant Heat Pumps
- Natural Refrigerant/Environmentally Benign Heat Pumps
- Compressors & Pumps - Do they Pose Enough Challenge to CFD?
- Fluid Mechanics and Heat Transfer in Positive Displacement Compressors
- Emerging and New Technologies for Heat Pump and Refrigeration Cycles
- Heat and Mass Transfer in Heat Pumps

Technology & Society Division Session (co-sponsored with AESD)

- New Paradigm for the Energy & Environment in the 2000s

Join the ASME Advanced Energy Systems Division Today!

To join the Division and/or ASME, fill out and mail the following form to ASME Headquarters at the following address or connect to <http://www.asme.org>.

To: ASME International, 3 Park Avenue, New York, NY 10016-5990

From: _____ Date: _____

Affiliation: _____ Phone: _____ E-mail: _____

Address: _____

City: _____ State: _____ Zip: _____

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I wish to become a member of the ASME Advanced Energy Systems Division

I am an ASME member I wish to join the ASME; please send me a membership application

I would like to be active in the Advanced Energy Systems Division. Please contact me.

Technical Interests and Comments: _____

36th Intersociety Energy Conversion Engineering Conference

"Energy Technologies Beyond Traditional Boundaries"

July 29 - August 2, 2001

Westin Hotel

Savannah, Georgia

Call for Papers

*Abstract Deadline: 30 November 2000

The American Society of Mechanical Engineers announces the 36th Intersociety Energy Conversion Engineering Conference (IECEC). The IECEC provides a forum to present and discuss engineering aspects of energy conversion, advanced energy and power systems and devices, and energy policy implications for research, development and utilization of technologies. Papers on all engineering aspects and disciplines of terrestrial and aerospace power, as well as advanced energy systems that fall into the topical areas, are welcome.

The IECEC series is sponsored jointly by six participating societies. In addition to ASME, the sponsors are the American Institute of Aeronautics and Astronautics (AIAA), the Institute of Electrical and Electronic Engineers (IEEE), the American Institute of Chemical Engineers (AIChE), the American Nuclear Society (ANS), and the Society of Automotive Engineers (SAE) International.

TOPICAL AREAS INCLUDE:

Aerospace Power Systems and Technologies	Conversion Technologies
Electrochemical Technologies	Environmental Impact
Energy Systems	Policy Impact on Energy
Renewable Energy Sources	Thermal Management

SUBMISSION OF ABSTRACTS:

An electronic version of abstracts should be submitted for review by **30 November 2000** to: Dr. Sriram Somasundaram, technical program chair. Abstracts should be approximately 500 words in length (but not longer than 1,000 words) presenting facts that are new and significant and should indicate the results achieved. Submissions dealing with any topic within the scope of the IECEC topical areas will be considered. Include the following items on the first page of the abstract: (1) the name, address, telephone and fax numbers, and e-mail address of the author to whom correspondence should be addressed and (2) the topical area(s) you believe to be the most appropriate for your paper. Authors will be notified of acceptance and will receive instructions for manuscript preparation in **February 2001**. Completed camera-ready manuscripts will be due to ASME by **30 April 2001**. Only accepted papers published in the 2001 IECEC proceedings will be presented at the conference.

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