ASME International

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PID

Process Industries Division Newsletter

Arun Muley, Editor

Summer 2000

Message from the Chair

Abraham Engeda

In 1999-2000, PID has pursued significant efforts to interact more closely with the Manufacturing Technical Group (MTG) and its other Divisions, to support all of MTG's activities and to work for the overall growth of MTG. *"As they say: more productive work gets accomplished between meetings"* PID has now succeeded in holding three executive meetings in a year with specific and targeted tasks between meetings. Strongly believing that technical committees are the backbone of effective growth and expansion of a division, PID has put in great efforts to strengthen and expand its Technical Committees by recruiting new technical committee members from the PID membership at large. This attempt has been successful and has brought in a balanced technical expertise into the technical committees from government, academia, industry and utility.

PID is trying very hard, in light of the numerous conferences and symposiums world wide, to focus only on the niche concerns the process industry has and on areas that are topically and timely of importance for the process industry. Furthermore PID is actively pursuing to energize its efforts to co-sponsor conferences/symposiums with other organizations. Its efforts include conducting short courses, luncheons , and recognizing achievements and accomplishments of individuals in process industries.

For the International Mechanical Engineering Congress & Exposition (IMECE) 2000 in Orlando, PID is planning one session on Heat Transfer; five sessions on Compressor Applications (including one Highlight/Industry session)

I welcome your participation in the near future, everyone's efforts will make a significant improvement.

Abraham Engeda, PID Chair

Enhanced Tools for Compressor Design and Analysis

The compressor design process has undergone dramatic changes within the past decade, which has led to a substantial reduction in the overall design cycle time and a fundamental improvement in compressor stage performance. These changes were primarily brought about by enhanced compressor design tools, the result of a number of important developments that occurred in the turbomachinery and computer industries. These developments did not occur overnight, rather there has been a gradual but steady evolution as computers have become faster, less expensive, and easier to use.

During the early years of computer use in turbomachinery design, calculations that were previously performed manually were now automated and run on large mainframe computers. The use of these mainframes led to a reduction in design cycle time, since these digital computers were much faster than the manual calculations they replaced, and an increase in modeling accuracy, since large-scale numerical techniques could now be applied to finite element analysis (FEA) and computational fluid dynamic (CFD) analysis.

However, a number of fundamental bottlenecks to accelerating the design cycle and improving the design itself still remained. The design cycle was slowed by the large number of users queuing up to run jobs on each mainframe. The difficulties in data entry and interpretation of results were caused by programs that were run in batch mode with a poor user interface (limited or non-existent graphics), and an engineering department structure which assigned very limited design and analysis responsibilities to separate groups. The engineering department structure slowed the design process due to the time involved in passing the results of one group's work on to the next group in line. For instance, the aerodynamic design group would complete a flowpath design and pass its design to the aerodynamic analysis group, who would evaluate this design and find some flaws. It would send the design back to the design group with suggestions for

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Enhanced Tools

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improvement, and the design group would rework the flowpath based on the analysis group's suggestions. Eventually, the design would make it out of the aerodynamics area, but would then have to run the gauntlet of mechanical design, structural analysis, system integration, and prototype development testing. Clearly, this department structure slows the design process, separates the designer from the final product, and can easily lead to designs that are not fully optimized due to errors in communication and misinterpretation of the design goals.

The turbomachinery design tools that have evolved from these early mainframe programs have encouraged a fundamental transition in the compressor design process and engineering group structure. Today, a single engineer can have an entire compressor design system running on a modern high-speed desktop computer. This design system can include any combination of the following:

- A meanline compressor design program for one-dimensional design, analysis, and data reduction.
- A three-dimensional flowpath and blading design program to create the full aerodynamic flowpath.
- A viscous three-dimensional CFD analysis program with integrated meshing tools for coupled (impeller-diffuser-return channel/volute) viscous flow analysis.
- A three-dimensional FEA program with integrated meshing tools for rapid stress and natural frequency analysis.
- A suite of rotordynamic analysis and bearing design tools for rapid determination of rotor critical speeds and stability.
- A computer aided design (CAD) program to generate manufacturing drawings of the final hardware.

COMPRESSOR DESIGN

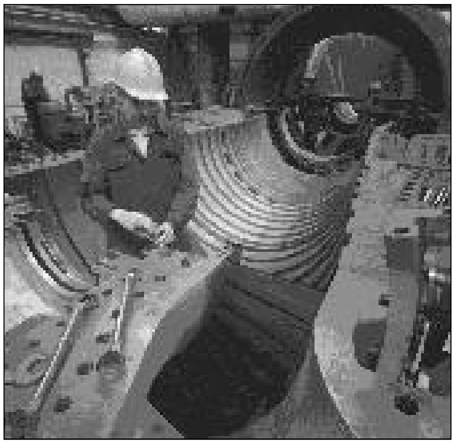
The tools that form this design system have two distinct advantages over their counterparts from even a few years ago:

- The liberal use of graphical user interfaces (GUI) has led to computational tools which are easier to learn, more intuitive to use, and allow more rapid assessment of individual designs because of the immediate visual feedback you get when design changes are made.
- The use of object linking and embedding (OLE) to connect individual programs allows design changes made in one program to be transmitted to all of the other linked programs. As a result, for instance, a single skilled designer with a desktop computer can assess the effect of a change in impeller blade thickness on meanline aerodynamic performance, three-dimensional aerodynamic performance (inviscid and viscous), and impeller stress and natural frequency, with the push of a single button.

An experienced designer, with these tools at his disposal, can markedly accelerate the design process because there is no waiting for a time slot to open up in other groups and little is lost in translation between the aerodynamic, structural, and rotordynamic design phases. This acceleration of the design process results in reduced design cycle time and lower design costs. In addition, the designer will now have a stronger sense of ownership of their design, since they will be the pivotal people at each phase of the design process.

One of the most exciting compressor design system enhancements, now in development, is the linking of numerical optimization techniques to the design codes. The implementation of automatic design optimization should significantly reduce the design cycle time, because the computer can analyze thousands of potential designs in the same amount of time it takes a person to look at one or two alternatives. These optimization techniques should eventually lead to higher performing designs as well, because the computer can find optimized solutions that a designer may never have considered. Take for instance, the fully linked comprehensive design system discussed above, where the meanline design code, 3D flowpath design code, and 3D structural analysis code are all linked together through OLE. To implement an optimization technique within this design system, a comprehensive set of design "rules" such as optimum impeller diffusion characteristics and optimum diffuser area schedules would be added. These rules will likely come from the collective experience of a group of seasoned designers or by carefully examining previous successful (and unsuccessful) designs. These optimization routines would be linked to the entire design system, and would then iterate through a large number of potential design combinations until one or more optimal geometries was identified. The designer would also be able to input his goals in rank order, for instance "sacrifice up to one point in peak efficiency to keep the factor of safety on the peak blade stress above 2.0," or "of primary importance is a flow range greater than 25%, followed by an efficiency of at least 85%, followed by...." Clearly, adding optimization routines to this linked design system will lead to a very powerful design tool, one that will change the entire process of compressor design, as well as the role of the design engineer.

Another important development in compressor design systems is the addition of design for manufacturing and assembly (DFMA) techniques throughout the design process. Where all of the above tools are geared toward higher aerodynamic performance, reduced stress, rotordynamic stability, and shortened design cycle time, DFMA techniques are geared towards minimizing the total cost of a product. To minimize cost, all of the factors that affect product cost, not just design cycle time, need to be considered. A short list of these items includes total parts count, prototype and production manufacturing cost, assembly cost, and the costs of service and support over the lifetime of the final product. To properly integrate DFMA into the design process, it is best to have DFMA as an integral component of the entire design system, and to begin using it with the first design iterations. These DFMA tools can take the form of curves of impeller cost versus diameter, or a summing of total parts count as a function of compressor geometry. While the results of this preliminary analysis of total product cost may not be completely accurate in the early phases of design, the DFMA tools should be able to clearly point in the direction of reduced costs at each point in the overall design process.



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INTERNATIONAL

ME2000

CONGRESS & EXPOSITION

November 5-10, 2000
Walt Disney World Dolphin
Orlando, Florida

Every year the Process Industries Division participates in the IMECE and the different committees of the Division organizes technical sessions for the benefit of its members. This year we have had an overwhelming response both from industry and academia for participation in the technical sessions, and the division in keeping up with the enthusiasm and spirit has worked very hard to accommodate everyone.

The Compressor Applications committee is organizing five technical sessions (including a Highlight/Industry session). The committee has received a total of 21 papers of extraordinary technical merit from highly qualified and well-known people in the field. The details of the topics are given below.

The Heat Exchanger committee is co-sponsoring three technical sessions with the Heat Transfer Division's K-10 committee on Enhanced Heat Transfer. Both K-10 and the Heat Exchanger committee have also received a very healthy response from academia and industry with a total of 18 papers including two keynote lectures.

We expect a packed auditorium for all these sessions and hope to see you at IMECE '00 in Orlando, FL. Please visit the website: http://www.asme.org/conf/congress00/index.htm for the most current information and schedules. See below for details on topics to be covered.

INDUSTRIAL COMPRESSOR SESSIONS

MECHANICAL & FLOW INSTABILITIES

1. Compressor Impeller & Disk Vibration Parameters for Failure Prevention
2. A Numerical Study of Surge and Flow Instabilities in Natural Gas Compression System
3. Operating Experience Obtained with High Speed Compressor provided with Magnetic Bearings
4. Centrifugal Compressor Noise Reduction by using Helmholtz Array

AERODYNAMIC ANALYSIS

1. Effect of Reduced Axial Length on a High Efficiency Process Gas Centrifugal Compressor Stage
2. The Influence of Inlet Flow Distortion on the Performance of the Centrifugal Compressor and the Development of the Improved Inlet Model based on CFD Simulations—I
3. Aerodynamic Analysis of Return Channels of Multi-Stage Centrifugal Compressors
4. Effect of Scalloped Centrifugal Impellers on Aerodynamic and Rotordynamic Performance using CFD Techniques

INDUSTRIAL COMPRESSORS: GOALS AND CHALLENGES IN GAS COMPRESSION, PROCESS AND PIPELINE COMPRESSORS - HIGHLITE/INDUSTRY SESSION

1. Online Assessment and Performance Analysis of Centrifugal Compressors
2. Radial Impeller Design and Optimization by Modern CFD Techniques
3. Add Effectiveness to Your Efficient Aerodynamic Design and Analysis System
4. Decisive Factors in Advanced Compressor Design and Development of Industrial Centrifugal Impellers—Design Philosophies
5. Understanding Stage Matching of a High Efficiency Multistage Centrifugal Gas Compressor

AERODYNAMIC DESIGN AND PERFORMANCE PREDICTION

1. Centrifugal Compressor Design and Testing in the Finnish High Speed Technology
2. Compressor Process Performance Prediction
3. The Redesign of an Industrial Core Compressor Using Multistage CFD Analysis
4. The Influence of Inlet Flow Distortion on the Performance of the Centrifugal Compressor and the Development of the Improved Inlet Model based on CFD Simulations—II

CFD

1. Towards Design Optimization of Diffuser-Volute Configuration Using Hybrid-Unstructured CFD
2. Problem Diagnosis and Aerodynamic Improvement of a Field Pipeline Compressor
3. A Numerical Study of the Flow Structure inside a Centrifugal Compressor Stage
4. The Practical Application of CFD in the Design of Industrial Centrifugal Compressor

ENHANCED HEAT TRANSFER SESSIONS' PAPERS

Enchanced Heat Transfer (EHT)-#1

1. New Frontiers in Enhanced Heat Transfer
2. Resonant Heat Transfer Enhancement by Acoustic Excitation in a Side-heated Enclosure
3. Experimental Study of Heat Transfer Properties of Polycapillary Materials
4. Flow Boiling Heat Transfer with Binary and Ternary Mixtures in Microfin Tubes
5. Influence of Brazing on the Heat Transfer Performance of Fins in Radiators
6. Numerical Solutions for Enhanced Heat Transfer in Laminar Flows of Non-Newtonian Fluids in Corrugated Plate Channels

Enchanced Heat Transfer (EHT)-#2

7. Advances in Air Cooled Heat Exchanger Technology
8. Heat Transfer Enhancement by Turbulent Impinging Jets
9. Calculation of the Optimum Dimensions of Annular-Finned Tube Arrays Using Experimental Forced Convection Coefficients
10. Effect of Promoter Orientation on Enhancement of Heat Transfer from Vertical Fins
11. Numerical Study of Turbulent Boundary Layer Flow over a Flat Wall with a Single Dimple
12. Turbulent Flow Characteristics in Closely-Pitched Internally Enhanced Tubes

Enchanced Heat Transfer (EHT)-#3

13. Plate-fin Surface Optimization using Direct-sizing
14. Heat Transfer Investigation of an Offset Strip Fin using Liquid Crystals
15. Theoretical Modeling of Ice Formation during Direct Contact Heat Exchange
16. Effect of Electric Field on Flow Pattern in Flow Boiling of R-134a—A Visualization Study
17. Heat Transfer Enhancement for Finned-Tube Heat Exchangers using Oval Tubes and Vortex Generators
18. Experimental Investigation of Natural Convection Heat Transfer from Horizontal Helicoidal Pipe

Upcoming Events

PID is planning to participate in the following conferences. Please visit our website to learn more information (www.asme.org):

- (NHTC 2001) National Heat Transfer Conference 2001
- (IMECE 2001) International Mechanical Engineering Congress & Expo 2001
- (IJPGC 2001) International Joint Power Generation Conference 2001

Enhanced Tools

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A key component of these modern design tools is the constant improvement of the modeling through continual validation and calibration of the embedded correlations. Whenever a computational tool is developed to model nature, certain simplifying assumptions must be made to make the problem tractable. These simplifying assumptions, plus the addition of empirical models based on limited or design-specific test results, can lead to prediction errors as the design envelope expands beyond the range of typical or standard machines. It is important, therefore, that the results from these compressor design tools are continually compared to careful laboratory measurements, and the models updated or enhanced when new data becomes available. To this end, it is important that meanline design and analysis tools have a data reduction mode so one-dimensional modeling assumptions can be verified, and that advanced CFD results be compared to experimental data (both overall and internal measurements) to confirm that the basic flowfield parameters are being correctly predicted.

In summary, a number of important developments in the turbomachinery and computer fields has led to advanced compressor design tools that have accelerated the design process and led to a shift in the role of an individual engineer in the design process. The linking of advanced design and analysis tools through OLE, the heavy use of GUI in all phases of the design process, the addition of linked numerical optimization schemes, and the inclusion of DFMA at the early phases of the design process, has resulted in very powerful compressor design tools which have significantly shortened the design cycle time and raised the performance bar another notch.

Short Courses/ Workshops of Interest

ASME PID member, Dr. Michael Ohadi is coordinating a two-day short course/workshop on Thermal System Miniaturization. The course will be offered at the University of Maryland, College Park on September 11 and 12, 2000. The course will focus on fundaments and applications of micro and nano technologies as applied to miniaturization of fluids ad thermal systems. This course was offered in April 2000 and was extremely well received.

High Temperature Heat Exchangers and Microscale Energy Subsystems: Emerging Opportunities and Challenges

Michael M. Ohadi
&
Steven G. Buckley

BACKGROUND

In recent years two important factors have contributed to the growing need for high temperature heat exchangers: (1) The global trend towards more efficient power and propulsion systems that require higher operating temperatures and (2) high temperature thermal pollution control processes (such as thermal oxidation) and heat recovery applications. The recent, growing demand for microscale energy systems for propulsion and energy conversion, pushed by the increasing development of mesoscale and MEMs engineering systems, makes the need for compact combustion and heat exchange devices immediate and urgent. In the following section these needs will be briefly discussed.

THE NEED FOR HIGHER OPERATING TEMPERATURES.

It is well established that the peak operating temperature in a power cycle is the most critical factor contributing to overall plant efficiency, in accordance with the Carnot thermal cycle efficiency. Traditionally, the push for higher temperatures has been most notable in the aerospace and other gas turbine-driven power and propulsion systems, where it is well known that the efficiency of the turbine depends strongly on the Turbine Inlet Temperature (TIT). This value is strongly limited by materials available for the turbine blades. A TIT of 1100 °C and possibly higher temperatures in the future is the actual target value for these applications.

However, in recent years the push for higher efficiencies has resulted in the need for substantially higher operating temperatures in a variety of other industries, including advanced ground and sea transportation, chemical and manufacturing processes, thermal incineration/heat recovery, and electric utility plants. For example higher steam temperatures and pressures in modern coal-fired power generation plants have yielded thermal efficiencies of about 44%. The desire for high efficiency, both to minimize the use of fossil fuels and to minimize the emissions of greenhouse gases, has intensified the push toward higher operating temperatures. High temperature combined cycle plants, in which a gas turbine (fired by natural gas or gasified coal) and a steam turbine are coupled to yield higher efficiencies is one such example. The fossil fuel is first used to drive a gas turbine and then to generate steam. To further increase the turbine inlet temperature (TIT), a high temperature heat exchanger is incorporated between the combustion gas and a possibly inert turbine driving medium, such as helium (Nickel, et al., 1997). Blade materials based on refractory metals, with high steam rupture strength at temperatures around 1100 °C in non-oxidizing environments have been proposed.

THE NEED FOR MICROSCALE COMBUSTION SYSTEMS

As engineering systems are increasingly pushing toward mesoscale and microelectromechanical (MEMs) devices, a great need has emerged for compact, flexible power systems. The uses for these systems may include miniature propulsion systems and efficient, on-demand power and/or heating for small, off-grid systems. There are a number of advantages for compact combustion systems over other means of energy conversion. While battery systems are often used for energy storage and on-demand power, they have a limited lifetime and a low energy density in comparison to typical hydrocarbon fuels. Table 1 compares the energy density of several potential energy storage modes.

TABLE 1: ENERGY DENSITY FOR VARIOUS SYSTEMS.

PHOTOVOLTAICS[A]	PEAK 17% CONVERSION 10 W/KG TYPICAL
BATTERIES (PB-ACID)	≈ 35 WH / KG (1.2×10^5 J/KG)
BATTERIES (ADVANCED LI-ION)[B]	≈ 100 WH / KG (3.6×10^5 J/KG)
HYDROCARBON/ AIR	2.8×10^6 J/KG
HYDROGEN/AIR	3.4×10^6 J/KG
NUCLEAR	9×101^6 J/KG

[A] TYPICAL FIGURES FROM ASTROPOWER, INC. (NEWARK, DE), SEE HTTP://WWW.ASTROPOWER.COMOR FUKUI (1997).

[B] FROM YARDNEY TECHNICAL PRODUCTS, INC., SEE HTTP://SBIR.GSFC.NASA.GOV/SBIR/SUCCESSES/SS/7-015TEXT.HTML

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Microscale Combustion

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Hydrocarbon fuels and hydrogen are surpassed only by the available energy density of nuclear power, and offer approximately an order of magnitude more energy storage per mass than the best battery systems available. In addition, combustion systems are eminently scaleable, and can provide nearly instantaneous power. Other modes of energy storage, including batteries, may be more sensitive to ambient temperature, and due to constraints associated with energy conversion devices, the output may be less scalable than the output from a combustion system.

EXAMPLE APPLICATION AREAS — HIGH TEMPERATURE HEAT EXCHANGERS

Thermal Oxidation.

Thermal oxidation refers to a high temperature air pollution control process in which organic waste gases and organic particulate react with air at high temperatures to form (primarily) carbon dioxide and water vapor. The contaminants are destroyed by exposure of the waste gases to the proper conditions of temperature, time, and turbulence mixing in a reaction/combustion chamber.

Most commonly used bulk oxidation temperatures range from 315 to 980 °C (600-1800 °F), depending on the pollutant and the oxidation method used. In the cases in which a flame is supported, local (peak) temperatures in the flame may be much higher. In many cases inorganic compounds such as hydrogen sulfide, ammonia, and cyanide can also be destroyed by high temperature oxidation, depending on the characteristics of the reaction (peak temperature, residence time, and mixing).

There are two high temperature oxidation methods for eliminating volatile organic compounds (VOCs) in exhaust air / fumes from industrial processes. These are traditional thermal oxidation (combustion) and catalytic oxidation. In traditional thermal oxidation, the VOCs are oxidized at bulk temperatures ranging from 760 °C to 980 °C (1400 - 1800 °F). In the catalytic oxidation, the polluted stream is passed through a catalyst bed at bulk temperatures ranging usually between 315 °C to 540 °C (600-1000 °F) to oxidize the VOCs. Peak temperatures in traditional thermal oxidizers can be as high as 1800 °C, while in catalytic oxidizers the peak temperatures are typically 900 °C at the catalyst surface. While traditional thermal incineration is the proven and predominant state of the technology, for certain applications catalytic oxidation may represent a cost-effective alternative. Catalytic oxidation offers the potential advantage of lower operating temperatures, therefore minimizing material constraints and lowering NO_X emissions.

Commercial technology is available in the U.S. and other countries for self-sustaining thermal oxidation utilizing fixed-bed regenerative heat exchangers to destroy more than 99% of VOCs in exhaust air. The residual organic content can be reduced to levels that meet the most stringent air pollution control regulations. The actual exhaust concentration of residual VOCs depends upon the type of VOCs being destroyed, their initial concentrations, and most importantly the operating temperature of the oxidizer, typically 700 °C (1300 °F) and above. VOC streams with a significant energy content reduce greenhouse gas emissions reducing the need for supplemental fossil fuels, when compared to a conventional oxidizer.

HIGH TEMPERATURE HEAT RECOVERY.

A requirement for efficient operation of high temperature power and propulsion systems is the need to recover as much as possible the significant amount of useful waste heat available. For example, as described above, in thermal or catalytic oxidizers the exhaust gases are at very high temperatures and contain a significant amount of available useful energy that can be recovered. Therefore, efficient heat exchangers are needed to recover heat from the high temperature pollutant-free exhaust air leaving the oxidizer or regenerator. Gas-to-gas heat exchangers, with heat recovery efficiencies up to 80%, depending on the application, are used to transfer heat from the high temperature clean exhaust air to the incoming polluted air for preheating purposes. Some recent designs of advanced power plants involves the recovery of high temperature heat in an Indirectly Fired Gas Turbine (IFGT), where a heat exchanger replaces the combustor. A clean working fluid then flows in a closed and pressurized loop, resulting in some major advantage in gas turbine efficiency, avoided corrosion of the turbine blades, and pollution reduction.

In general, heat recovery using a variety of heat transfer techniques is increasingly playing a major role in the final cost and thermal cycle efficiency of energy systems. In recent years research in this area has intensified and the subject area continues to be at the center of energy system design strategies for “sustainable development” and global competitiveness in the industrialized nations. For example, in the U.S it is believed that 23% of industrial electricity consumption is discharged as waste heat. With recent trends in increased thermal operating cycle temperatures, this figure is estimated to exceed well over 60% for processes with temperatures above 800 °C (1500 °F). Similar opportunities exist in other industrialized countries, e.g. as much as 33% of industrial energy use in France (Dumon, 1987).

The above discussion establishes the need for compact and high performance heat exchangers that can sustain cost effective operation at high temperatures and under harsh environments. As will be discussed later in this paper, in most cases, the heat recovery is through gas-to-gas or gas-to-liquid heat exchangers with a wide variety of heat exchanger design options.

OTHER POWER AND PROPULSION APPLICATIONS.

While traditionally the aerospace industry has been the main user of high temperature heat exchangers, significantly smaller ground, air, and multi-purpose vehicles utilizing engines with much higher fuel consumption efficiency are requiring immediate development of cost-effective high temperature heat exchangers. For example, state-of-the-art recuperated gas turbine engines use metallic heat exchangers (HEs) which are exceedingly heavy and larger in volume than all the engine turbomachinery components combined. While ground vehicles have been able to accommodate these engines, the size, weight, and drag penalties of present day metallic HEs have precluded the use of recuperated gas turbine engines in air vehicles. If HEs can be made small and light enough, air vehicles could make use of the increased fuel efficiency of recuperated engines. This fact is recognized by a joint program announced by German and French companies. MTU (Germany) and SNECMA (France) recently announced a technology development program aimed at reducing long-haul civil transport fuel consumption by more than 20%, which focuses mainly on combining heat exchanger and intercooler technologies.

In ground vehicles, present day recuperated gas turbine engines (e.g. the AGT-1500 in the M1 battle tank) use an open Brayton cycle and utilize exhaust heat to preheat the working fluid (air) between the compressor and the combustor by means of a HE. These HEs are typically exposed to cold side inlet air conditions of approximately 12 atmospheres pressure and 750 F, while the hot side is exposed to just above atmospheric pressure and approximately 1500 F. Significantly smaller and lighter HEs are needed to reduce the weight and volume of open Brayton cycle gas turbine engines. In addition, greater temperature capability is desired. Analytical studies have shown that unconventional (e.g. intercooled/semi-closed) gas turbine engine cycles have many advantages over the currently used open Brayton cycle.

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Microscale Combustion

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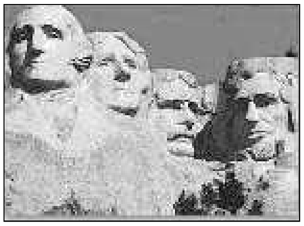
High temperature intercoolers are needed for future high performance diesel engine applications. More efficient diesel engines will require the use of higher pressure ratios, and substantial amounts of turbocharging. Intercooling is used to avoid excessively high inlet charge temperatures. Maximum cold side inlet conditions are approximately ambient pressure and 50 °C (120 °F), while maximum hot side inlet conditions (for a turbocompounded cycle) are approximately 11 atmospheres and 370 °C (700 °F). The size and weight of these intercoolers must be kept small to reduce the overall engine weight and volume.

DID YOU KNOW...

In 1927, the Painted Post facility of Ingersoll-Rand supplied jackhammer drills and portable air compressors that will be used in the construction of the Mt. Rushmore national monument in South Dakota.*



* Reference: http://www.dresser-rand.com/newsroom/history.htm

AWARDS NOMINATIONS

At its March meeting the executive committee approved nomination of Professor Kunio Yoshikawa for the ASME Potter Medal award. Dr. Yoshikawa is a professor of Mechanical Engineering at Tokyo Institute of Technology and is an internationally recognized authority in the field of high temperature air combustion and coal gasification. Professor Yoshikawa will deliver a lecture hosted by PID at a luncheon scheduled for the upcoming ASME International Congress and Exhibition, November 2000.

Process Industries Division Roster 1999-2000

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Editor's Message

It is my privilege to serve as your newsletter editor. I would like to thank all contributors and ASME staff for their hard work in producing this issue. I would also like to express my gratitude to outgoing editor, Mike Ohadi, for putting in significant effort in last year's newsletter. We have developed a PID website: http://www.asme.org/divisions/pid.html. The purpose of this site is to rapidly disseminate division related information to its membership at-large. I encourage you to visit our website regularly to find out the latest PID related news. Finally, I would like to emphasize that your active involvement is critical in keeping our newsletter and website vibrant. If you have suggestions or contributions, please send it to me at Arun Muley, Honeywell International, 2525 W. 190th St., ML 22-2-9305, Torrance, CA 90504 or email at arun.muley@honeywell.com. I look forward to hearing from you.

Arun Muley, Editor