Gas Machinery Conference

October 4-6, 2010
Phoenix, AZ

One registration fee includes:

Short courses

Technical papers

Technology updates

Exhibit of new products and services

A year-long subscription to the *GM Journal*, a quarterly publication dedicated to bringing you the latest news and industry information.

Information:
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GMRC
RESEARCH • TRAINING • TECHNOLOGY

The GMRC Gas Machinery Conference is for all design and facility engineers and technicians responsible for the performance, efficiency, safety, and reliability of gas compression machinery. A combination of short courses and technical paper presentations gives you the opportunity to learn new technology and discuss your company's experiences. An exhibit of the newest in compressors, engines, and related technology will provide you ample opportunity to visit with suppliers in a relaxed and informal atmosphere.

SUNDAY, OCTOBER 3

3:00 – 6:00 p.m. **Registration**

5:30 – 7:30 p.m. **Welcome to PHOENIX!** (Sheraton Hotel)
Sponsored by Siemens

MONDAY, OCTOBER 4

Coffee breaks today sponsored by Caterpillar Inc.

7:00 a.m.-5:00 p.m. **Registration**

8:00 –10:00 a.m. **Spouse Breakfast** (Sheraton Hotel)

8:30 a.m. – 5:00 p.m. **GMRC Board of Directors Meeting**
Open to all GMRC Official Company Representatives

8:00 – 11:00 a.m. **SHORT COURSES** (select one)

Field Demonstration Test of Integrated ERLE Technologies

Matthias Huschenbett – Hoerbiger Services America, Inc.; Greg Beshouri – Advanced Engine Technologies Corporation

As the culminating project in the PRCI Emissions Reduction for Legacy Engines (ERLE) multi-year program, PRCI sponsored field testing of integrated ERLE hardware on two pipeline engines. Starting with typical pipeline engines operating at RACT or higher levels, the team layered ERLE (and pre-ERLE) technologies to cost effectively reduce emissions and maintain that performance under challenging engine operating conditions. The test also demonstrated how the same technologies could improve efficiency, reliability, and operational flexibility. The paper reports on the results of those field tests comparing pre-conversion and post conversion performance, quantifying the benefits in each category.

Developing an Effective Approach for Sizing Reciprocating Compressors

Dwayne A. Hickman - ACI Services; Bruce Howerton & Noah Dixon - Williams Gas Pipeline; Scott Schubring - El Paso Pipeline Group; Jeff Dowdell - Dominion Resources; Bret Grier - Kinder Morgan; Travis Sixel - GE Oil & Gas; Joe Fernandez - Ariel Corporation; Jack Smith – Exterran

Since reciprocating compressors are capable of handling a wide range of operating conditions, they are often considered for a wide variety of compression needs. To assist with appropriate unit selection, most reciprocating compressor OEMs provide useful sizing software. Understanding the overall sizing problem, effectively using sizing methodologies, allowing for appropriate system variances, and successfully incorporating goals and constraints from all parties involved can be an engineering challenge. This short course will provide attendees with a better understanding of what criteria is important when sizing reciprocating compressors; a general overview of how reciprocating compressors are sized; communication goals between end users, packagers, and OEMs; consideration of the effects of unloading options on unit sizing; effects of pulsation and pressure drop on unit sizing; real world examples of problems and how they were solved, and the importance of integrating flexibility into the compressor sizing process.

Understanding Cast Iron & Repairing Damaged Castings Permanently

Gary J. Reed - LOCK-N-STITCH Inc.

This short course will include a detailed explanation of why cast iron cannot be welded the way other metals can, specific explanation of how cast iron responds to heat, how cast iron can be successfully welded, how metal stitching works and when to choose between welding and metal stitching, and discovering, understanding and solving the cause of damage to prevent future failures. Case studies are also included.

MONDAY, OCTOBER 4 - *continued*

Resolving Common Vibration Problems on Reciprocating Compressors

Bill Eckert, Kelly Eberle & Rich Bennekemper – Beta Machinery Analysis

Drawing on field troubleshooting cases from around the world, this training session discusses vibration problems and methods to resolve them. This session will be valuable to those engineers and technicians involved in designing new compressors, field testing, maintenance or operations. The course agenda will cover these topics: overview of vibration terms, root-cause issues that create vibration problems on compressor packages, case studies illustrating the most common vibration problems, tips for assessing vibration problems in the field including a checklist for addressing mechanical vibration problems, and suggested approach when designing new installations or retrofitting existing sites.

11:15 a.m.-12:45 p.m. **LUNCH and OPENING GENERAL SESSION**

Pledge of Allegiance & Welcome
Rainer Kurz, Solar Turbines Inc. – GMC2010 Chairman
GMRC Singing Pipes Vocal Group

SPECIAL PRESENTATION: **Developing a Comic Vision**

Tim Gard is a recognized and leading authority in stress reduction through humor. Traveling over 150,000 miles annually, he speaks at over 100 events each year from Texas to Tasmania.

1:00 – 2:00 p.m. **TECHNOLOGY UPDATE**
(10 minute overviews of new technology in the industry)

New Variable Speed Drive for Compressor Package Cooling Fans
Roland Hoet - Voith Turbo, Inc.

Deactivating & Step-less Control of Reciprocating Compressor Cylinder Ends
Lauren D. Sperry, PE & W. Norman Shade, PE - ACI Services, Inc.

ABB Turbocharging: Newest Solutions for Gas Engines
Dr. Mirko Lepel - ABB Turbo Systems

The BCD Packing Ring: A New High Performance Design
Tino Lindner-Silwester - Hoerbiger

Dresser-Rand – Revitalizing America's Compressors
Charles G. Ely, PE – Dresser-Rand Midstream

High Speed Technology – HOFIM®
Matthias Grapow - MAN Turbo Switzerland

2:15 – 3:00 p.m. **TECHNICAL PAPERS** (running concurrently)

Physics-Based Characterization of NSCR Operation-Part 1

Mohamed Toema & Dr. Kirby S. Chapman – Kansas State University National Gas Machinery Laboratory

This paper presents the work done to date on a modeling study of the Non-Selective Catalytic Reduction (NSCR) system. Several recent experimental studies indicate that the voltage signal from the heated exhaust gas oxygen sensor commonly used to control these emission reduction systems may not be interpreted correctly because of the physical nature in the way the sensor senses the exhaust gas concentration. While the current signal interpretation may be satisfactory for modest NOx and CO reduction, an improved understanding of the signal is necessary to achieve consistently low NOx and CO emission levels. This model simulates the output from a planar switch type lambda sensor. The model consists of three modules. The first module models the multi-component mass transport through the sensor protective layer. A one-dimensional mass conservation equation is used for each exhaust gas species. Diffusion fluxes are calculated using Maxwell-Stefan equation. The second module includes all the surface catalytic reactions taking place on the sensor platinum electrodes. All kinetic reactions are modeled based on

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Langmuir-Hinshelwood kinetic mechanism. The third module is responsible for simulating the reactions occurred on the electrolyte material and determining the sensor output voltage. The details of these three modules as well as a parametric study that investigates sensitivity of the output voltage signal to various exhaust gas parameters is provided in the paper.

Do It! Do It Right! Do It Right Now! And Don't Quit! Maintenance!

Randy Anderson – CECO Training & Technical Services

One of the most common problems in our industry today is maintenance management. How to manage maintenance? Systems software, or hardware are in place to help companies reduce emissions, facilitate better staff management, reduce cost, manage risk, perform ROI analysis and optimize systems or facilities. This paper will address three basic topics: broad systems problems with examples of failures in the recent past; existing maintenance philosophies (not so merry-go-round maintenance, ostrich maintenance, personality maintenance, eclectic maintenance, run to failure maintenance, tools, techniques, processes, policies and procedures driven maintenance); practical and proven solutions (leadership, big hairy audacious goals, confronting the facts, keeping it simple stupid and discipline).

Connecting Rod Bearing Impact Vibrations in High Speed Industrial Gas Engines Using Acceleration vs. Crank-Angle, Non-Phased Vibration Time Waveforms & FFT Spectral Analysis

Warren Laible - Windrock, Inc.

Connecting rod bearing impact analysis can identify the early stages of crankshaft bearing failure before substantial damage occurs. Unfortunately, almost all beginning and most experienced equipment analysts are unwilling to make bearing condition calls. Portable reciprocating engine analyzers can provide vibration vs. crank-angle displays that show impacting of the bearing shell and crank throw in relation to normal engine events including top dead center (TDC) and bottom dead center (BDC) piston reversals. The use of non-phased high-density acceleration time waveforms and FFT plots will be explained to add confidence in the bearing failure diagnosis. Trending of overall acceleration levels will be examined to aid in determining the rate of change in the developing bearing failure. Typical engine types covered by this procedure include 300 to 8000 horsepower, high speed, spark-ignited gas engines. A brief discussion of the required instrumentation, setup and data acquisition process is included in the body of the paper. A complete description of the procedure used is presented with examples of real data and photos that show a damaged bearing identified by this method.

Gas Turbine Packaging Options & Features for Pipeline Applications

Dr. Klaus Brun - Southwest Research Institute; Dr. Rainer Kurz & Bernhard Winkelman - Solar Turbines, Inc.

Industrial gas turbines require a significant number of on-skid and off-skid (aka, ancillary and auxiliary) equipment such as lube oil systems, controls and instrumentation, fire-detection and suppression systems, fuel forwarding and filtration systems, starter and crank motors, and inlet/exhaust systems for their safe and efficient operation. Given a specific application, an optimal set of ancillary and auxiliary equipment options must be selected. This selection is not just based on the type of application and utilities available at the site, but the operator's requirements for operating profile, reliability and/or availability, and the environmental conditions at the site must also be considered. This paper will describe standard ancillary/auxiliary equipment options for gas turbine driven compressor systems and their relative advantages and disadvantages in pipeline applications. API 616 and 617 requirements for these equipments will also be discussed.

3:15 – 4:00 p.m. **TECHNICAL PAPERS** (running concurrently)

Characterization of Exhaust Pollutant Emissions for Design, Implementation & Validation of After-Treatment System Effectiveness

Jacob J. McFarland, Dr. Diana K. Grauer & Dr. Kirby S. Chapman – Kansas State University National Gas Machinery Laboratory

This paper reports on the development of a quasi-dimensional model for quantifying the formation of carbon monoxide (CO) and total unburned hydrocarbons (HC) within the cylinder of a reciprocating internal combustion engine. The proposed methodology is presented in two parts: 1) equilibrium combustion formation and in-cylinder storage, and 2) kinetic formation and oxidation during exhaust removal. On March 5, 2009, the EPA proposed modifications to the current National Emission Standards for Hazardous Air Pollutants (NESHAP) for existing stationary reciprocating internal combustion engines (RICE). The proposed 2009 NESHAP implements new carbon monoxide (CO) limits for all RICE as a surrogate for HAP, with the exception of a formaldehyde (CH2O) limit for 4SRB engines. This rule not only requires a significant reduction in HAP but moves completely away from the previous rule which included limits for NOx, CO and VOCs. This future promulgation has created the need for a comprehensive algorithm to characterize pollutant emission formation regardless of engine design and regulatory focus. The purpose of this work is to evaluate in-cylinder kinetic CO and THC formation in order to evaluate the effectiveness of current and future after-treatment technologies. The simplified CO and THC scheme has been tuned and validated with exhaust concentration data collected on a variety of two- and four-stroke cycle engines and directly relates to the impact of operating conditions and in-cylinder geometry.

Design Challenges for Reciprocating Compressors in Specialty Gas Services

Kelly Eberle & Mike Cyca - Beta Machinery Analysis

Many different software tools are used to simulate compressor performance and pressure pulsations in piping systems. A challenge for designers of reciprocating equipment is the accurate simulation of gas properties and pressure pulsations for specialty gases to reflect the real operation of the compressor. The authors use two case studies to outline the root causes behind inaccurate performance and pulsation predictions and the consequences to the compressor operation. The first case study is a reciprocating compressor used to ethylene in a polyethylene facility; the second case study is a reciprocating compressor used for ethane at a midstream gas company. This paper outlines a number of design tips and "lessons learned" that will be helpful to engineers involved in all reciprocating compressor applications.

Threads & Such

Michael Sereda-Mohr, EIT, Pavel Mayzus, MSc, PEng, Paul Alves, MSc, PEng & Mario Forcinito, PhD PEng - AP Dynamics, Inc.

Bolted connections are one of the most ubiquitous forms of connection between engineered components. However, these connections present a degree of complexity that is most often lost in the everyday practice of twisting wrenches. An analytical model was created and programmed using visual basic and was validated with MSC Nastran. This model explores some of these interesting quirks in the science of bolting, such as the use of very diverse material pairs for the internal and external threaded components. Important observations are made with respect to the load distribution of the engaged threads and the effect of varying the engaged (threaded) length or stiffness ration between external and internal threaded components. Different bolt loading situations are analyzed with either a simple pulling action or with preload clamping requirements. Some of the more well known "tricks" utilized in shifting the load distribution of the engaged threads are also discussed.

Identifying & Mitigating Flow-Induced Vibration in Recycle Loop Gas Piping at a Centrifugal Compressor Station

Eugene (Buddy) L. Broerman, III, Jason T. Gatewood & James T. O'Grady – Southwest Research Institute; Russell F. Troy, PE – Spectra Energy; Charles L. Rand, Jr., PE & Gary T. Stroud, PE – RSH Engineering

Centrifugal compressors are often used in pipeline compression applications where high flow rates are required. Under certain operating conditions, high flow rates past branched connections in the piping system can result in vortex shedding at the strouhal frequency. Significant excitation energy is generated if the strouhal frequency matches the acoustic resonance frequency of the piping side branch. This excitation energy can lead to undesirable piping vibration. Further coupling of the excitation energy with a mechanical natural frequency of the piping system will lead to increasingly undesirable vibration. During the commissioning of the Southeast Supply Header's Lucedale Compressor Station, unsafe vibration levels were observed in the recycle gas piping near the

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surge control valves during certain operating conditions. An on-site analysis was conducted to measure the amplitude and frequency of the compressor piping vibration over a range of operating conditions. The on-site analysis provided evidence of flow-induced vibration in the recycle gas piping. An acoustic and mechanical response analysis of the piping system was conducted to verify the conclusions of the on-site analysis and determine the necessary piping modification needed to eliminate the flow-induced vibration. The acoustic analysis determined that vortex shedding frequencies were coincident with acoustic resonance frequencies of the fast stop valve side branch. The acoustic excitation was eliminated by modifying the branch connection length and flow path through the connecting tee. The mechanical response analysis was conducted to ensure that piping modifications were implemented in a manner that resulted in a acceptably supported piping system. Piping modifications were implemented and the flow-induced vibration was eliminated allowing safe operation throughout the desired operating range. The lessons learned from this study were applied to other centrifugal compressor stations that were in the design phase. This paper will discuss the background of the station installation, field study (including data), acoustic and mechanical analyses (including data), implementation of the recommendations and lessons learned.

4:15 – 5:00 p.m. **TECHNICAL PAPERS** (running concurrently)

Combining Technologies for Extending the Operating Range of Reciprocating Compression Assets

Steve Hawley - Dresser Rand Enginuity; Curt Pedersen – TransCanada

Several new technologies have emerged over the last few years which are designed to bring the aged large-bore reciprocating horsepower base of the gas compression industry into compliance with continuously tighter emissions requirements. High energy ignition systems, enhanced mixing technologies and advanced air delivery systems have emerged as the de facto standard in retrofits to reduce exhaust emissions in non-attainment areas to meet these requirements. When combined with advanced control strategies, these technologies have proven reliable and effective in achieving and maintaining compliance to permitted emissions limits. These technologies offer significant improvements in combustion stability, at exceptionally lean levels of air fuel ratio. Since the focus of these technologies has been to reduce the harmful exhaust emissions, the systems have typically been configured for ultra-burn, low NOx operation. The pipeline operations requirements have been changing as well. The demands for flexibility in operating compression assets have often been de-emphasized when these compression assets are being considered for emissions retrofit or replacement. The ever changing needs of gas control require that compression assets must become more flexible to handle the increasing demands to maintain flow set points with fewer units and fewer personnel to run them. This paper presents an approach to the integration and tuning of several of these newer technologies, including high pressure fuel injection, pre-chamber ignition systems, enhanced monitoring, and automatic balancing, to evaluate and document the operability of compression assets when the systems are tuned for expanded operation. Testing was completed to evaluate the flexibility of the compression asset for increased and decreased load and speed conditions. The typical operational guarantee allows for speed and load ranges of 75 to 100% of the OEM rated operating conditions. Testing was done to evaluate how well the operating range of the compression asset could be expanded by taking advantage of the capabilities of the new technology hardware and by configuring the control systems for extending the operating conditions to lighter loaded conditions. The load and speed of the asset were increased as well to take advantage of some of the design margins that were originally defined for handling the inconsistent combustion that were considered normal operation when the units were originally designed.

Improving Reciprocating Compressor Reliability at Suncor Commerce City

Wes Darnell – Suncor Energy; Mark Snyder, PE & L. John Kitchens, PE – GE Energy Services

Periodic condition monitoring systems for reciprocating compressors have successfully provided cylinder pressure and other measurements on reciprocating compressors for many years. Cylinder pressure measurements alone enable diagnostic tools such as pressure versus volume (PV) curves to derive the condition of the sealing elements inside the cylinder. Reciprocating compressor continuous monitoring systems with acceleration and cylinder pressure measurement capabilities have gained commercial acceptance for improving compressor reliability. These systems consist of a variety of transducers, electronic protection/data collection hardware and data analysis and trending software. The transducers are permanently attached to the compressor and the data collection hardware installed at the compressor. Combining the cylinder pressure, rod load and crosshead pin, piston rod to crosshead connection, and piston to piston rod as well as cylinder condition. Suncor Energy required such a system on critical reciprocating compressors to improve their compressor valve monitoring and maintenance and reliability practices. This paper presents a short tutorial of the systems installed at Suncor Energy in Commerce City, Colorado and case histories that demonstrate the benefits experienced by Suncor. Suncor Energy was able to 1) detect a valve design flaw and correct it, 2) move from typical preventative maintenance practices to more reliability center predictive maintenance practices, and 3) detect valve failures early and avoid excessive downtown that cost upwards of $1M/day.

Reciprocating Compressor Station Consolidation Study

Jeffrey Essel-Ampah – Detechtion Technologies

This paper will discuss the process for selecting reciprocating compressor candidates for consolidation projects as well as quantifying the gains and benefits of consolidated a compressor station. This consolidation study is completed using Enalysis™, a web-based compressor optimization tool and Envision™, a compressor simulation and curve building tool. The consolidation method involves looking at a given field's operating conditions and quantifying the horsepower and cylinder utilization of all the compression on site. A summary of the associated operational costs and emissions at the current conditions is tabulated. Then a consolidation study is performed to determine if any compressors can be shut down while still maintaining the site's original flow rates and pressures. A summary for the site is then constructed showing the reductions in costs and emissions after the consolidation. The summary highlights the before and after values for the following key points: horsepower utilization, cylinder utilization, operating conditions, fuel gas or electricity used, operating/maintenance costs, and emissions of CO2, NOx and SO2.

Centrifugal Compressor Vibrations Case Study

Bill Eckert – Beta Machinery Analysis

In 2008, three centrifugal compressors at this compressor station were retrofitted with higher head impellers. For the next two years, the owner experienced continual vibration problems that caused failures with RTDs, transmitter and position switches. Most of the failures were on the discharge side, but failures did occur on the suction side as well. The cause of the failures was assumed to be flow induced pulsations (also referred to as vortex shedding). Many attempts were made to modify the thermowells and RTDs, but they were not successful in reducing the failures. In early 2010, Beta Machinery Analysis traveled to the site and conducted a vibration and pulsation analysis. After assessing the situation, it was determined that shell mode piping vibration excited by blade pass pulsation was responsible for the problems and not flow induced pulsations as originally assumed. This case study outlines the factors that contributed to the vibration problem and recommended solutions; it predicts interferences between the compressor and sell mode piping natural frequencies and potential excitation sources such as flow induced and/or blade passing pulsations; and it also highlights why a centrifugal vibration study may be good practice during the initial design (or retrofit) as it is much easier and less costly to make adjustments at the design stage compared to searching for, and solving, the problem in the field.

5:30 – 7:30 p.m. **RECEPTION -** *Sponsored by Ariel Corporation*

7:30 – 10:30 p.m. **MONDAY NIGHT FOOTBALL PARTY**
Sponsored by Dresser-Rand (Sheraton Hotel)

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TUESDAY, OCTOBER 5

Coffee breaks today sponsored by Mueller Environmental Designs, Inc.

7:00 a.m. – 5:00 p.m. **REGISTRATION**

6:45 – 8:00 a.m. **BREAKFAST**
Sponsored by Hoerbiger Compression Technology

8:00 – 9:00 a.m. **Spouse Breakfast** (Sheraton Hotel)
Spouse tour will leave from the Sheraton Hotel at 9:00 a.m.

8:00 – 11:00 a.m. **SHORT COURSES** (select one)

Principles of Business Ethics for The Gas Compression Industry

William A. Couch, PE – El Paso Pipeline Group; W. Norm Shade, PE – ACI Services, Inc.

Adherence to sound Business Ethics principles is an important cornerstone of most successful companies and individuals in the Gas Compression Industry. Many companies have statements and policies that establish ethical practices and conduct for their employees, yet formal training in business ethics tends to be very limited and often non-existent. As a result, companies and individuals alike may have widely divergent opinions of what constitutes acceptable ethical practices and behaviors. Accordingly, many states have made ethics training a continuing education requirement for the renewal of PE licenses. This course will present an overview of sound business ethics principles and conduct, especially as pertinent to the Gas Compression Industry from upstream through midstream. Presented by experienced industry business leaders, the training will include numerous case studies and real experiences that reinforce the subject matter. A short test will be administered at the conclusion of the course to help each participant validate their grasp of the principles and their application.

Data Collection & Analysis Techniques for Emissions Mapping

Hans Mathews – Hoerbiger Engineering Services; Greg Beshouri – Advanced Engine Technologies Corp.

This short course focuses on defining the data used for mapping emissions, how to collect that data, verify its integrity and how to use the data for predicting and controlling future engine performance. Trapped Equivalence Ratio is broadly accepted as the primary method for mapping and predicting engine emissions, fuel efficiency and combustion performance. The first section of this short course will define Trapped Equivalence Ratio (TER) and teach the attendee how TER can be used to evaluate current and predict future performance. The attendee will learn how to either directly identify or determine the parameters necessary for TER analysis and gain an understanding of why the technique is so robust and useful. The second section of the course will focus on the collection of the on-engine field data necessary to build a TER model. A complete test plan will be developed that supports the data collection efforts. In addition to the data collection requirements, the attendee will learn how to verify the integrity of their data. The final section of the course will focus on analysis of the collected data and what it means to predicting and controlling performance. The control potential of TER will be reviewed in detail and an Air Fuel Ratio (AFR) control scheme for controlling engine emissions will be presented. At the conclusion of the course, the attendee should have a good grasp of what TER is, how to collect data so that it can be used in a TER analysis and why TER is a preferred method predicting and controlling emissions.

Selection, Installation & Operation of Gas Turbine Inlet Air Filtration Systems

Melissa Wilcox - Southwest Research Institute; Dr. Rainer Kurz - Solar Turbines, Inc.; Jan-Peter Nilsson - Camfil Farr Power Systems AB

The inlet filtration system of the gas turbine is important for protecting the gas turbine from airborne contamination which could lead to erosion, fouling, or corrosion. In order to minimize the gas turbine degradation due to inlet air quality, many considerations must be taken when selecting, installing,

and operating this system. First, the type of contaminants the gas turbine will experience must be defined. This can be determined from the operating environment, local and temporary contaminants sources, and weather patterns. Once the contaminants are know, the inlet filtration can be selected. The majority of modern systems are comprised of multiple stages of filtration. In these systems, there are different types of filters which are used for removal of water, large objects, coarse particles, and fine particles. The filters are selected based on the type and amount of contaminants they must remove. After the filter system is selected and installed, there are several measures that must be taken to maintain the filtration system. For instance, filtration efficiency is maintained by periodically checking the condition of the filters and also replacing or cleaning filters once they are fully loaded. In order to provide operators with a comprehensive approach to selecting, installing, operating, and maintaining a filter system, GMRC developed a guideline for gas turbine inlet air filtration. This short course reviews the key topic areas outlined in the recently published GMRC Gas Turbine Inlet Air Filtration Guideline.

Vibration Control in Reciprocating Compressor Systems

Benjamin A. White, PE, Richard M. Baldwin, PE, & Jason T. Gatewood – Southwest Research Institute; Christine M. Scrivner – El Paso Pipeline Group

Reciprocating compressors inherently generate pulsations in the compressor cylinders and attached piping system. The reciprocating motion of such compressors, along with the pulsations they generate, result in mechanical vibrations. Pulsations and vibrations can adversely affect the compressor performance, increase maintenance costs, and ultimately result in unavailability of equipment. For systems with unacceptable pulsations and/or vibrations, design modifications should be considered to reduce the risk of failures and improve reliability by reducing the pulsation and vibration to acceptable levels. This short course will discuss the fundamentals associated with pulsation and vibration problems in reciprocating compressor piping systems. The course will cover areas of good general practice to control vibration and will illustrate several recent problems encountered in the field where good design practice was not used. Field case studies and troubleshooting will be discussed. Topics from the GMRC "Systems Mounting Guidelines for Separable Reciprocating Compressors in Pipeline Service" document and guidelines for compressor foundation design will also be discussed. This short course will improve the attendee's ability to identify potential problems in new designs and to have a better understanding of existing vibration problems.

11:00 a.m. – 1:00 p.m. **EXHIBITS OPEN**
Lunch served in the exhibit hall for all Conference registrants

1:15 – 2:00 p.m. TECHNICAL PAPERS (running concurrently)

Field Demonstration of Advanced NSCR Control Using Integrated Technologies

Greg Beshouri–Advanced Engine Technologies Corp.; Matthias Huschenbett – Hoerbiger Services America Inc.

Prior work by AETC and Kansas State University has demonstrated that currently available air-to-fuel ratio controllers (AFRC) for NSCR systems have difficulty maintaining compliance over extended periods of time. This problem exists not only at BACT permit levels but even at less stringent NSPS levels. Those results point to the need for better system integration and fuller use of lambda sensor outputs by more comprehensive algorithms. Consequently, under the ERLE program the PRCI sponsored a field demonstration test of more advanced NSCR strategies which fully integrate sensors, control algorithms and diagnostics. This paper reports on the results of the long term field test for two different systems.

High BTU Fuel Gas from the Marcellus Shale & How It Affects Emissions & Peak Firing Pressures

Keith Schafer – Columbia Gas Transmission a Nisource Company

The recent discovery of the Marcellus Shale Gas Reserve has brought some new challenges for our operations. The heating value of the Marcellus Shale gas is much higher than what we have had in the past and is very inconsistent when it mixes with our other pipeline gas. Our pipeline has gas mixtures

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that range from very low BTU coal bed methane to normal transmission gas (about 1040 BTU) to very high BTU Marcellus Shale gas. We are experiencing BTU heating values changing from 980 to 1350 and Ethane levels changing from 1% to 16% in very short periods of time. This paper will show some of the BTU swings and how they affect our peak firing pressures, exhaust emissions, exhaust temperatures, and fuel rates. It also addresses what is being done to stay in emission compliance and to protect the equipment when these high BTU swings happen.

Carbon Monetization & Management Strategies for the Natural Gas Industry: Preparing for the Impact of a Carbon Constrained Energy Market
Brian Kromer – Infleksion

A growing global movement internationally and sub-nationally has created both mandatory and voluntary markets focused on reducing greenhouse gas (GHG) emissions through the monetization of "carbon" or carbon dioxide equivalent (CO2e) criteria emissions. This process, independent of a comprehensive national cap and trade program targeting GHGs has imposed the constraints and added costs on traditional fossil fuel industries at a sub-national and international level. And while a national program may be off the 2010 political agenda, the EPA is exercising its granted authority to monitor and manage GHGs. The international aspirations for a post 2012 replacement to the Kyoto Protocol and the duration of the current Executive Branch of Government in the United States both align with a three-year window when both Kyoto and the current administration's terms end on December 31, 2012. This window of opportunity will be critical in determining the mandatory regulation and outcome on an international, national and sub-national basis. Therefore, despite the status of national legislation centered on GHGs, sub-national and international activity will continue to influence national GHG policy over the course of the next three years. Yet, despite the outcome of legislation, it is apparent that global competition for fossil fuels, the emerging focus and funding on "greener" energy technologies and the establishment of voluntary carbon markets, will in and of themselves impact traditional energy markets. Carbon monetization is in process and GHGs are an environmental commodity. Therefore, carbon management strategies must consider the financial impact of compliance in terms of mitigation and opportunity that may exist in the early stages, prior to an imposed scarcity of a national or global cap and trade program.

Rewheeling Centrifugal Compressors: Design Considerations & Field Application
William Parry, Nate Milliman & Y.P. Tang – Dresser Rand

Centrifugal compressors are commonly used for high flow pipeline applications with well defined operating conditions. Centrifugal impellers are selected based on their ability to meet a variety of expected operating conditions. As market and pipeline conditions change over time, these compressors may operate at poor efficiencies (near surge or stonewall conditions). To better meet current and future operating conditions, the compressor performance can be modified and improved by selecting and installing a better matched impeller wheel. This technical paper and case study discuss two issues related to "rewheeling" a centrifugal compressor. The first part of the paper will discuss the criteria that users should consider when determining whether or not a compressor "rewheel" is merited and justified. This section will also include a discussion about upgrades and enhancements that are commonly selected (acoustical arrays, dry gas seals, modern surge control, etc.). The second part of the paper discusses field application and installation considerations that should be considered when upgrading an existing centrifugal compressor (including a case study). This technical paper is co-authored and presented by OEM and pipeline company personnel to provide a well-rounded approach and discussion of considerations and factors that are important to the overall success of a compressor "rewheel."

2:15 – 3:00 p.m. **TECHNICAL PAPERS** (running concurrently)

Improving Engine Reliability & Fuel Economy Through Medium Pressure Fuel Injection & Ion Sense Balancing: A Case Study
Patrick W. Jacobs, PE – Williams Gas Pipeline; Ronnie Walker – Hoerbiger Engineering Services

The balancing of slow speed integral engines has been an important part of maintaining the reliability of slow speed engines in the natural gas industry. Over the past few years, the industry has been involved with several new balancing technologies. This case study will look at advanced balancing techniques using the common engine spark plug and comparing a manual balance to ion sense balance. Ion sense is a technology that utilizes an electronic signal from the standard spark plug after it fires to determine the air-fuel ratio in the cylinder and uses that signal to adjust the fuel input. The TLA6 engine is retrofitted with medium pressure fuel and the case study will also look at the results of running this type system with the ion sense balancing system. We will look at the reliability improvements (based on COV), fuel savings at full load, skip fire and potential emissions benefits (including greenhouse gas) of an ion based system with medium pressure fuel. The results will be published in the case study.

Alternate Approach to Tackle Turbocharger Upgrades for Low Emissions Retrofit on a Legacy Large Bore, Slow Speed Engine
Grant Broughton, PE, ME & Earl Glover – Dresser-Rand Enginuity; Rodney Goehring – PG&E

Operators of natural gas fired internal combustion engines continue to face increasingly stringent federal and state air regulations while striving to maintain engine operability and performance. Revitalization of existing horsepower often remains the most attractive approach technically and financially to meet both the air quality demands and operating flexibility in moving gas to meet market demands. Such conditions present the challenge to approach engineered solutions in alternate manners than OEMs often offer to meet lower emission levels and improved engine performance. This case study addresses the specific challenge of the required air specification based on engine type, location and state regulations. Pacific Gas & Electric faced reducing air emissions on a Cooper-Bessemer GMWC-10 engine at the Hinkley, California, compressor station in 2007-2008. The need to achieve low NOx and CO levels presented a challenge to apply coordinated emissions reduction technologies backed by ensuring the air delivery to the engine could be met across operating range of speed, load and in an environment of very high ambient temperatures.

Engine Cooling Performance Optimization
Clint E. Kendrick & Dr. Kirby S. Chapman – Kansas State University National Gas Machinery Laboratory

This paper presents an investigation into the optimization of cooling systems in large bore two-stroke cycle engines. Even though common operating knowledge suggests that cooling capacity will increase with an increase in the water flow rate, there are documented cases where engine cooling can be increased by adjusting the cooling water flow to something less than the maximum flow rate. As such, a need existed to explore the heat transfer mechanisms from the combusting gases to the cooling water and then from the cooling water to the environs. PRCI funded a project at the K-State National Gas Machinery Laboratory to collect OEM cooling system operating specifications, determine if there was, in fact, an optimal operating "condition" of the cooling system and to then explore the claims that the higher flow rate does not always lead to improved cooling. This paper reports on the latter portion of the study where an engineering model was developed to quantify the heat transfer rate from the combusting gases through the cylinder walls and then to the cooling water flowing through the engine block and head. The cooling system engineering model is physics-based and relies on the plethora of information in public-domain literature.

Human Error Reduction: Traps, Consequences & Tools
Brad Grieves – Panhandle Energy

Nearly all companies that perform high risk and potentially dangerous activities have implemented a safety program. While some companies have better safety records than others, all still experience events that lead to equipment damage and serious personal injury. With today's operating environment of fewer resources and an ever-increasing workload, no company can afford accidents and the associated costs. Safety meetings are a great way to share

continued next page

experiences and talk about implementing new safety techniques and tactics, but as time passes, the impact of a meeting tends to fade. To supplement these efforts, tools are needed that an individual can utilize as the last line of defense to prevent human errors and thereby protect equipment and keep personnel safe. Drawing from his experience in the nuclear and natural gas industries, the author explores the three types of human errors and explains why these errors can lead to and ultimately cause accidents, even though an organization has a good safety program. Specific tools that can be applied to prevent human errors will be presented, as well as how they can be used to circumvent each of the top ten error traps. This presentation is intended not only for employees of natural gas pipeline companies but also anyone who services the industry. This message can save lives.

3:15 – 4:30 p.m. **TECHNOLOGY UPDATE**
(10 minute overviews of new technology in the industry)

Extending the Life of Your TEG Dehydration System
Lee Ann Wolfe – Dow Oil & Gas

Enhanced Field Performance & Reliability Using Caterpillar G3508 Engine Upgrade
Sreenivas Ramanujam – Caterpillar Inc.; Luis Carrillo – ConocoPhillips, Inc.

Addressing the Single Point of Failure in NSCR
Geoff Ashton & Mark Richter – Advanced Engine Technologies Corp.

Reciprocating Gas Engine: The Clean & Reliable Workhorse
Johan Boij – Wartsila Finland

Put Pipeline Equipment & Diagnostics Data on Every Desktop in Your Organization Using the PI Infrastructure from OSIsoft
Heathcliff Howland – OSIsoft, Inc.

Centrifugal Compressor Surge Modeling
Augusto Garcia-Hernandez – Southwest Research Institute

The Next Generation Clean Burn Package for Cooper Bessemer Engines
Dustin Malicke – Cameron Compression Systems

4:45 – 6:30 p.m. **EXHIBITS OPEN**
Reception in the exhibit hall for all conference registrants and spouses.

WEDNESDAY, OCTOBER 6

Coffee breaks today sponsored by Caterpillar Inc.

7:00 a.m. – 5:00 p.m. **REGISTRATION**

8:00 – 10:00 a.m. **Spouse Breakfast**

8:00 – 8:45 a.m. **TECHNICAL PAPERS** (run concurrently)

Performance Testing of a Switching Control Strategy on Four Stroke Natural Gas Fueled Stoichiometric Engine Equipped with a NSCR Catalyst

Aaron Zimenoff – Woodward Governor Company

This paper relates Woodward Governor's experience performance testing a closed loop switching Air Fuel Ratio (AFR) control strategy on an unattended stoichiometric four stroke natural gas engine. The emissions post-catalyst were monitored semi-continuously for a period of 500 hours of runtime to characterize the ability of the strategy to consistently and reliably maintain commissioned emissions without operator intervention during normal operation. The catalyst out monitoring involved measurements of CO, NOx and O2 for 15 minutes out of every one hour using a portable CEMS analyzer. Engine related parameters were also recorded at the same time during the corresponding sampling events. The presentation will present the emissions performance data obtained during the test and the correlation between the measured engine parameters and catalyst out emissions.

Knowing Peak Pressure without Pressure Sensor

Henry Lam & Mark Richter – Advanced Engine Technologies Corp.

Today many industrial engines operate on a blend of fuels with inconsistent gas quality and the affect on combustion performance and emissions levels

are affected. This is a case study focusing on two Caterpillar 3516 Generator Engines rated 1000VA, at 1200 rpm, lean burn gas and turbocharged, running on a renewable energy source supplementing power to a waste water treatment facility in California. The engines operate on a wide range of fuel mixture including landfill, digester gas and air blended natural gas over a heating value range from 350-650 BTU. Further the facility does not have any storage tank for homogenizing fuel blend. This study relates to our industry's future concern of variable value fuels entering the piping via the LNG market and emerging non-gas patch fields.

Case Study of Capacity & Power Compression Usage Optimization in a Pipeline System

Augusto Garcia-Hernandez – Southwest Research Institute

Nowadays, machines' efficiencies are looked at closely to avoid misusage of compression capacity and save energy costs. However, a compression-transport system would include more than one machine and station working together at different conditions. Therefore, a detailed analysis of the entire compression system should be conducted to obtain a real power usage optimization. This case study is focused on analyzing natural gas transport system flow maximization while optimizing the usage of the available compression power. Various operating scenarios and machine spare philosophies are considered to identify the most suitable conditions for an optimum operation of the entire system.

Case Study of Large Medium Speed Reciprocating Horsepower in Pipeline Applications

Mark Bounds – Energy Transfer; Jeremy Valero – Caterpillar Global Petroleum

This paper is a report to the North American natural gas pipeline market on one company's experience with the GCM34 engine in mainline transmission. These are the first GCM34 engines commissioned in pipeline service representing a trend in North America for the next generation of reciprocating HP in this application. Discussed are reasons a unique skid mounted design was chosen. Energy Transfer will discuss the factors that influenced their decision to replace centrifugal HP with reciprocating HP on existing pipelines. Key drivers for compression decisions include low emissions, high fuel efficiency, availability and durability. This paper presents a case study of a midstream and interstate pipeline company's experience showing actual engine and compressor performance.

9:00 – 9:45 a.m. **TECHNICAL PAPERS** (run concurrently)

Operating Company Experience with Electronic Pre-Combustion Chamber Check Valves: A Case Study

Marlan Jarzombek, PE & David Link – Atmos Energy Corp.; James J. McCoy, Jr., PE – Hoerbiger Engineering Services

Since pre-combustion chambers have been offered with large-bore gas engines, operators have had problems with check valves that tend to malfunction, mainly on start-up after the engine has been shut down for whatever reason. This sticking causes the pre-combustion chamber to either be over- or under-fueled, leading to poor combustion or no combustion in the pre-chamber and thus in the main chamber. This has led to onerous maintenance practices, such as changing all check valves prior to every start. This problem has been solved with an electronic pre-combustion chamber check valve, and this paper gives one company's experience with this new technology. Large-bore gas internal combustion engines utilized in the gas pipeline industry have a long history of reliable service. Starting in the 1970s, engine manufacturers began to offer engines that produced lower levels of undesirable emission, mainly NOx and unburned hydrocarbons. In order to accomplish this goal, larger turbochargers were employed to produce air in excess of the air needed for combustion. The excess air served as a heat sink to keep combustion temperatures down, thus lowering NOx. However, this excess air led to unstable combustion and in order to restore stable combustion, pre-combustion chambers were employed.

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A New Technology Electronic Ignition Which Eliminates the Limitations of Traditional Ignition Systems

Joseph Lepley, Keith Brooks & David Bell – Altronic, LLC

Electronic ignition systems remain the standard for internal combustion engines today, in spite of the best efforts of many researchers worldwide to find alternatives. The allocation of so much R&D effort to find a replacement for the electronic ignition system is in part driven by a number of limitations in the current electronic ignitions systems which have been seen as difficult, if not impossible, to overcome and limitation in combustion stability (misfire). A new approach to electronic ignition will be described and its ability to overcome the various ignition limitations of the past described and demonstrated. The intention of this presentation is to show that in terms of electronic ignition systems, "The best is yet to come."

Driver Options for Pipeline Compressors: Gas Turbine, IC Engine & Electric Motor

Dr. Klaus Brun, Marybeth Nored & Dr. Timothy Callahan - Southwest Research Institute; Dr. Rainer Kurz - Solar Turbines Inc.

Most compressors in pipeline service utilize gas turbines, electric motors, or reciprocating engines as their mechanical drivers. The selection of which of these drivers is the most appropriate for a given application depends on the operating/performance profile requirements, the available utilities, the initial cost and operating budgets, the site conditions and the type of compressor. This technical paper will discuss each of the driver options for typical pipeline applications, their principal components, functions, features, operating characteristics, as well as their advantages and disadvantages for a given application. Hardware options and failure modes will also be discussed. Example pipeline case studies will be presented for each driver type, specifically outlining the operator's decision-making criteria for the selection of the driver given the application. Standard API and ISO specifications for each will also be discussed.

A Comparative Validation of Simulated Compressor Valve Performance with Closed Loop Compressor Test Data

John Person, PEng & Soraya Bailey – Klaus Enterprises Ltd.; Terry L. Baker & W. Norm Shade, PE – ACI Services, Inc.

Simulation and testing of compressor elements is a critical step in new product development and component failure evaluation. In an effort to enhance the accuracy of characterizing compressor performance, especially various types of high-speed compressor valves, a closed loop compressor test facility was developed. This paper outlines a collaborative project with the purpose of validating results from a new valve simulation program using high-speed compressor test data from the closed loop facility. A custom valve was designed for this test application using computational fluid dynamics (CFD) and proprietary valve dynamics simulation software. This valve and original compressor valves were tested in a nitrogen flow loop at speeds ranging from 600 to 1200 rpm, over a wide range of suction and discharge pressures. A Windrock 6310 Portable Compressor Analyzer was used to record dynamic crank angle speed and position, temperatures, HE and CE cylinder pressures, and suction and discharge line pressures. PT cards from the dynamic analysis were compared at several pressure-speed combinations to determine correlation between simulation predictions and measured performance data. Results of the study show that the simulations correlate well with the measured data, which supports the validity of both the test stand measurements techniques and valve design methodology. The resulting analysis validates both the test stand and valve simulation software as sound tools for future compressor performance studies.

10:00 – 10:45 a.m. TECHNICAL PAPERS (run concurrently)

Preparation for Fugitive Emissions Rulings 2011: Strategies for Compliance

Mark Sproull - OGE Enogex

This paper provides insight into possible "regulator" targeted emitters and their compliance and possible "regulatory" monitoring, surveillance or auditing of fugitive emissions. Examples will be provided of a range of strategies to meet new fugitive emissions rulings that may be applied in 2011 including:

WEDNESDAY, OCTOBER 6 - *continued*

wait and see with no capital out lay, no solutions and high exposure; low capital out lay, few solutions, lower exposure and some return; higher capital out lay, solutions, minimized exposure, and higher return on investment. Information on STAR, LDAR, and SMART LDAR programs will be discussed. An example of a thermography program will be given, a description of methods used to find gas vents or losses, a description of methods used to quantify losses, a description of equipment and methods used to compile the data, analyze the costs and pay-out, and describes the program's part of a team effort to reduce fugitive emissions. This paper shows how a thermography program can add to the bottom line by reducing fugitive emissions, add detailed information on a compressor fleet, add insight into often overlooked compressor fuel efficiency and exhaust emissions and, most importantly, increase compliance. The presentation uses examples of actual leak analysis reports with videos of fugitive gas emissions.

Parametric Emission Monitoring System of Dry-Low NOx Natural Gas Fired Turbines

Mohamed Toema & Dr. Kirby S. Chapman – K-State National Gas Machinery Laboratory

The strict emission regulations of gas turbines require not only reduction of the emissions level but also continuous monitoring of the in-stack exhaust emissions. This on-line monitoring system ensures continuous compliance with the regulatory limits. Over the past years, the traditional Continuous Emission Monitoring System (CEMS) has been used to directly measure the exhaust emissions. Due to the cost and complexity of the CEMS, the Parametric Emission Monitoring System (PEMS) arises as a low-cost reliable alternative of the CEMS. PEMS calculates the emissions utilizing simple easily measured operating parameters such as ambient conditions and turbine speed. According to the authors' literature review, generic PEMS which is applicable to all types of gas turbine combustors is not yet available. This paper presents the modeling study of a gas turbine combustor based on first engineering principles to fully characterize the nitrogen oxides (NOx) and carbon monoxide emissions (CO). The model is mainly focused on the emissions from a widely used lean-premixed, dry-low NOx combustor. The combustor is divided into several zones where each zone can be considered as a plug-flow reactor. Each of these zones is assumed to have a uniform pressure, temperature and perfect mixing between combustion spices. The temperature of each zone is calculated using the mass and energy balance along with the heat transfer through the combustor liner. The emissions are calculated using well-known pollutant reaction schemes such as the Zeldovich mechanism in addition to other well-established semi-empirical correlations.

Failure Analysis of 7500HP Induction Motors Driving Reciprocating Compressors with Three Years in Service

Dennis Schmitt, PE - EnCana Corp. & Dr. Robert Hanna, PEng – RPM Engineering, Ltd.

This paper presents the failure analysis and field measurements of five 7500 HP induction motors driving reciprocating compressors for a natural gas compression station. The motors were in service for less than three years when two of them suffered cooling fan failures. Four of the five motors were sent to a motor repair shop to be fitted with a modified cooling fan per the manufacturer's recommendation. It was during one of the fan replacement processes that the repair shop accidentally discovered that many of the magnetic wedges were missing. The end user is not always aware if a motor is provided with magnetic or non-magnetic wedges unless identified in the motor engineering specification. This paper presents the findings from the failure analysis of the cooling fans and magnetic wedges for these motors. This failure analysis examined fan design, vibration, motor operating temperature, compressor loading profile, number of motor starts and ambient temperature. The paper also presents a comparison between direct on line motor starting and soft starting using an adjustable speed drive and the impact on motor performance. The settings and historical data gathered from the microprocessor protection relay for the motors will also be covered and discussed.

Understanding Rod Reversal in Reciprocating Compressors

Hasu N. Gajjar – Hasu Gajjar & Associates, Inc.

Thorough knowledge of the dynamic forces developed during the operation of reciprocating compressors is critical to the efficient and safe function of the

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machinery. Understanding the role that rod reversal plays on the crosshead and crosshead pin assembly can prevent catastrophic failure resulting from seizure of the pin due to inadequate lubrication. The guidelines presented here give insight into the factors leading to rod reversal in both single-acting and double-acting compressors using compressor manufacturers' published information.

11:00 a.m. – 12:45 p.m. **EXHIBITS OPEN**
Lunch served in the exhibit hall for all Conference registrants

1:00 – 4:00 p.m. **SHORT COURSE**

Air Regulatory Update

James McCarthy – Innovative Environmental Solutions

This annual update will focus on new regulations facing the industry in 2010 and beyond.

1:00 – 2:00 p.m. **TECHNICAL PAPERS** (run concurrently)

Low-Loss Pulsation Control: A Case Study of the Pressure Recovery Insert (PRI) Nozzle

Marybeth Nored, Eugene (Buddy) L. Broerman, III & Dr. Klaus Brun – Southwest Research Institute; Gary Bourn – El Paso Western Pipelines

In 2009, El Paso and SwRI investigated changes to the pulsation filter bottles and piping system at the Elk Basin Station utilizing orifice plates, side branch absorbers, and a modified piping system. The original objective of the study was to alleviate high piping vibrations, particularly when single acting the compressor. During this station upgrading effort, the compressor cylinder nozzle orifice plates were replaced with the pressure recovery insert (PRI) nozzle, developed through the GMRC Pulsation Research Program. This paper will report on the benefits of the PRI nozzle compared to conventional orifice plates based on field testing performed after the station modifications (2009-2010). The field tests determined the pressure loss across the first and second stages of compression as well as the reduction in pipe vibrations due to the overall improvement in pulsation levels in the flow stream. The PRI nozzle's ability to control high frequency pulsations due to compressor cylinder nozzle resonance while recovering pressure losses (unlike an orifice plate) makes it a preferred option for efficient operation of reciprocating compressors. The test results will also review the PRI nozzle performance over a range of pressure ratios compared to an orifice plate based on both field testing and laboratory results.

Demystifying Turbocharger Vibration

Eric Figge – National Gas Machinery Laboratory, Kansas State University; Jerry Lewis – El Paso Western Pipelines

There are many aspects involved when investigating a machine's performance and health. This is especially true for something as critical to the industry as an engine's turbocharger. One component of turbocharger health is mechanical vibration. Vibration can be defined as oscillations about an equilibrium point. So, any piece of rotating equipment will exhibit oscillations uniquely its own than can be measured and analyzed by vibration spectrum data. However, there is much more to vibration than just gathering data. This paper will cover the basics of how an electrical signal gets transformed into useful information, and how that information can be used to monitor and diagnose turbocharger health. The material in the paper explains how to properly use a vibration severity chart and use frequency spectra data as a diagnostic tool. The information in the paper will include real-life data from operating turbochargers.

Heavy or Sour Poor Quality Fuel Gas? Maximize Uptime Using Simple Membrane Process for Heavy & Acid Gas Removal from Fuel

Sachin Joshi & Kaaeid Lokhandwala – Membrane Technology & Research Inc.; Sherman Smith – EQT Corp.

In many remote or offshore production locations, only raw, heavy and sour gas is available as fuel for compressor drives and power generation turbines. Heavy or sour gas can damage or foul engine components causing mechanical reliability issues and reduced compressor/engine efficiencies, thereby even leading to engine or turbine shutdown. The immediate impact of this is loss of gas and oil production until the components are replaced or fixed. This paper describes the use of unique heavy hydrocarbons and acid gas-permeable membranes to produce clean fuel gas at these sites. Numerous fuel gas conditioning units have been installed around the world by companies like Exterran, EQT Corp., and Southern Union Gas for reducing the heavy and sour contents from the fuel gas. These systems have no moving parts, are designed for simple, unattended operation and are virtually maintenance free. Practical cases of how these units have helped in resolving issues with problematic fuel gas will be discussed in the paper.

WEDNESDAY, OCTOBER 6 - *continued*

2:00 – 3:00 p.m. **TECHNICAL PAPERS** (run concurrently)

Use of Oil-Flooded Single Screw Compressor for Hydrogen & Other Gases in a 75000 bpd Refinery: Package Designs, Bearing Technology & Practical Experiences

Jose D. Cosa – SCFM Compression Systems, Inc.; Jean Sewell – Lion Oil Co.; Dr. Lars Kahlman – SKF Industrial Division

As part of the work to boost production, enhanced performance and enabled adherence to new environmental standards, the Lion Oil Refinery, together with SCFM, has devised 10 new compressor packages each equipped with an electrically driven single screw oil-flooded screw compressor. These compressors handle, for example, hydrogen-rich process gases as used in the treating of high-sulfur crude oil to ultra-low sulfur gasoline and diesel fuels and in vapor recovery. The single screw compressor design was selected based on its high flexibility in pressure, pressure ratio and flow rates and requirement of simple support and maintenance structures, which made them an attractive choice as compared to conventional installations, e.g. with recips. The general design aspects of these types of single screw compressor packages will be covered. To ensure high reliability and availability of the compressors, the rolling bearing systems were systematically equipped with state-of-the-art bearings for process gas service. Consequently, bearings with rings in a newly introduced high fatigue and corrosion resistant bearing steel, ceramic rolling elements and glass fiber reinforced polymeric PEEK cages were introduced over a time period. A summary will be given that includes the various steps in the implementation of the new bearing systems in the compressors, practical experiences and the significant increases in reliability.

The Influence of High Rotational Speed on the Hydrodynamic Behaviour of Reciprocating Compressor Bearing

Klaus H. Hoff, Dr-Ing – Neuman & Esser

In the gas compression machinery business, reciprocating compressors are generally run with higher rotational speed compared to the API 618 market. This higher speed needs to be carefully introduced in the hydrodynamic design of the plain bearings. One thing is the higher frictional heat introduced in the bearing by the higher speed. The oil consumption must be checked for this heat in order to remove it by the oil flow. Another thing is the hydrodynamic load capacity increase by the higher speed. The paper will demonstrate this effect on the basis of the theory and example calculations. The crosshead pin bearing design is more critical than main and crank pin bearing design since this bearing must be checked for a minimum rod load reversal. The rod load reversal demand will be explained on the basis of a new design tool the author has developed. One of the critical design parameters concerning this effect is the rotational speed. Unfortunately, higher speeds need more absolute rod load reversal angle than lower speeds. This fact can be demonstrated with simple formulas and animated hydrodynamics.

Do You Want to Retire? A Brief Retirement Planning Discussion

Manny Angulo – CECO Training & Technical Services

While many of us talk about how great it would be to retire, few of us actually spend any time planning for it. This paper presents a brief discussion of a couple of basic topics that should be considered when developing a plan. Throughout the discussion, the paper will discuss the author's personal experiences along with examples that he used in planning for his retirement.

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WEDNESDAY, OCTOBER 6 - *continued*

4:15 – 5:15 p.m. **GMRC Annual Membership Meeting**
An overview of the GMRC Research Program and review of the year's activities. Open to all members and potential members. Voting members are encouraged to participate in determining the direction of the Council.

5:30 p.m. **RECEPTION**

6:00 p.m. **CLOSING DINNER & AWARDS PRESENTATIONS**
For all Conference registrants and spouses.

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Individual **HOSPITALITY SUITES** and outside social functions (including golf) are not allowed during scheduled Conference activities.

FLYERS and other promotional materials may not be distributed outside individual company exhibit booths.

HOW TO REGISTER

MAIL the registration form to

GMRC
3030 LBJ Freeway, Suite 1300
Dallas, TX 75234
ATTN: Marsha Short

FAX the form to 972-620-1613

PHONE Marsha Short at 972-620-4024

EMAIL to mshort@gmrc.org

Be sure to indicate which one of the short courses you'll attend during each time period. There's no extra charge for the short courses, but space is limited and you must pre-register to ensure a spot.

If you register before September 10, you will receive the pre-Conference mailing including a preliminary attendance roster, updated schedule and information on other Conference activities.

REGISTRATION FEE

Your registration fee of $525 for GMRC members ($625 for non-members) covers

- Papers presented at GMC2010 plus a CD of the Proceedings mailed after the Conference
- All short courses and technical sessions
- Admission to the exhibit hall
- Lunch in the exhibit hall on Tuesday and Wednesday
- Opening lunch Monday and Conference dinner on Wednesday *(for you and your spouse)*

PROFESSIONAL DEVELOPMENT HOURS

A certificate indicating Professional Development Hours (PDHs) will be sent to attendees after the Conference. By turning in a signed evaluation card in each session you attend, you earn PDHs for that session (3 hours for each short course, .5 hours for each technical paper).

EXHIBIT INFORMATION

If you are interested in exhibiting and did not receive exhibit information, please contact Marsha Short in the GMRC office, 972-620-4024 or mshort@gmrc.org

SPOUSE INFORMATION

Monday through Wednesday the spouses will meet in the Sheraton Hotel for breakfast and conversation and to make plans for the day. On Tuesday, a special tour is planned: The Wright Stuff.

In the late 1930s, Frank Lloyd Wright dreamed of, and created, TALIESIN WEST "out of the desert." Wright and his apprentices gathered rocks from the desert floor and sand from the washes to build this desert masterpiece. Taliesin literally means "shining brow" in Welsh, the nationality of Wright's ancestors. Taliesin West is located on a broad mesa with views of the valley stretching beyond. Wright's goal was to make the structure an integral part of nature, evident in the low and sleek design; a momentary intrusion on a level plain before the desert rises again to the mountain behind it. From the beginning, this remarkable set of buildings astounded architectural critics with its beauty and unique form. Situated on 600 acres of rugged Sonoran desert in the foothills of the McDowell Mountains, Taliesin West is now a National Historic Landmark. Visitors to Taliesin West will not see a museum but rather a remarkably vital and active community of architects and students working together to maintain Wright's vision. Today 70 people live, work and study at Taliesin West. Guests will experience firsthand Wright's brilliant ability to integrate indoor and outdoor spaces. The tour will include various rooms at the home as well as an explanation of how the site relates to the natural desert. There will be ample time for shopping in the gift store.

The tour also includes a group lunch in a local restaurant and a narrated city tour on return to the hotel.

The tour leaves from the Sheraton at 9:00 a.m. and returns at about 2:00 p.m. The cost for the Spouse Tour is $100 a person. Space is limited and can be reserved on your registration form. There is no charge for spouses not participating on the tour.

If you would like your spouse to personally receive the information on spouse activities, please list his/her email address or mailing address on the registration form. These addresses will not be published.

HOTEL ACCOMMODATIONS

HEADQUARTERS HOTEL

Sheraton Phoenix downtown Hotel
340 N. Third St.
Phoenix, Arizona 85004
www.sheratonphoenixdowntown.com/

The brand-new Sheraton Phoenix Downtown Hotel is at the heart of Phoenix's development and renewal. Conveniently located in the center of the city, it is adjacent to the Phoenix Convention Center and just five miles from the Sky Harbor International Airport.

Room Rate: $185 for single or double accommodations (includes free internet for GMC attendees)

Reservations: 1-800-325-3535
or go to http://www.starwoodmeeting.com/Book/GMRC2010

Reservations cut-off: September 8, 2010. Reservations after this date will be accepted at the group rate on a space available basis.

ADDITIONAL ACCOMMODATIONS

Wyndham Hotel
50 E. Adams St.
Phoenix, Arizona 85004
www.wyndham.com/hotels/PHXHT/main.wnt

The Wyndham Hotel is in the heart of downtown Phoenix, adjacent to the Phoenix Convention Center and just five miles from the Sky Harbor International Airport.

Room Rate: $165 for single or double accommodations (includes free internet for GMC attendees)

Reservations: 1-800-359-7253
or go to https://resweb.passkey.com/go/GMRC1010

Reservations cut-off: September 8, 2010. Reservations after this date will be accepted at the group rate on a space available basis.

QUESTIONS

If you have questions on GMC2010 call Marsha Short in the GMRC office,
972-620-4024 or mshort@gmrc.org

GMC2010 PLANNING COMMITTEE

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Kansas State University NGML

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GAS MACHINERY CONFERENCE 2010 October 4-6 - Phoenix, Arizona

REGISTRATION FORM *(Duplicate this form as necessary)*

Full Name _____ ❍ **PE?** **Nickname for Badge** _____

Title _____ ❍ **THIS IS MY FIRST GMC!**

Company _____

Address _____

City _____ **State** _____ **Country** _____ **ZIP/Postal Code** _____

Phone _____ **e-mail** _____

Spouse Name *(if attending)* _____ **e-mail** _____
If you would like your spouse to personally receive information on activities, please list his/her e-mail or mailing address.

❍ Please check here if you have a disability and may require accommodation to fully participate.

Please indicate which short courses you plan to attend (technical paper presentations do not require pre-registration):

Monday, October 4 - Choose One
- ❍ Field Demonstration Test of Integrated ERLE Technologies
- ❍ Developing an Effective Approach for Sizing Reciprocating Compressors
- ❍ Understanding Cast Iron & Repairing Damaged Castings Permanently
- ❍ Resolving Common Vibration Problems on Reciprocating Compressors

Tuesday, October 5 – Choose One
- ❍ **Principles of Business Ethics for the Gas Compression Industry**
- ❍ **Data Collection & Analysis Techniques for Emissions Mapping**
- ❍ **Selection, Installation & Operation of Gas Turbine Inlet Air Filtration Systems**
- ❍ **Vibration Control in Reciprocating Compressor Systems**

Wednesday, October 6
- ❍ Air Regulatory Update

Registration fee: $525 GMRC Members /$625 Non-Members

❍ Spouse Tour: $100 (there is no charge for spouses who are not participating in the tour & lunch on Tuesday)

❍ Check Enclosed (Payable in U.S. dollars to "Gas Machinery Research Council")

❍ Please Invoice

❍ Credit Card ❍ American Express ❍ MasterCard ❍ Visa ***Note: Charge will appear on your credit card as "Southern Gas Association"***

Card # _____ Expiration Date _____

Signature _____

To receive the pre-Conference mailing, please send your registration before September 10, 2010 to:

GMRC
ATTN: Marsha Short
3030 LBJ Freeway, Suite 1300
Dallas, TX 75234
Phone: 972-620-4024/Fax: 972-620-1613
e-mail: mshort@gmrc.org