Natural Gas Fired Reciprocating Engines For Power

With new chapters on electrical system optimization and ISO 50001, this edition also covers the latest updates to codes and standards in the energy industry. Also included are chapters on energy economic analysis, energy auditing, waste heat recovery, utility system optimization, HVAC, cogeneration, control systems, energy management, compressed air system optimization and financing energy projects. Additional topics include emerging technologies such as oxy-fuel

combustion, high efficiency burners, enhanced heat exchangers, and ceramic membranes for heat recovery as well as information on how to do an energy analysis of any system; electrical system optimization; state-of-the-art lighting and lighting controls. This reference will guide you step by step in applying the principles of energy engineering and management to the design of electrical, HVAC, utility, process and building systems for both new design and retrofit projects. The text is thoroughly illustrated with tables, graphs, diagrams and sample problems.

Title 40 Protection of Environment - Part 60 (60.1 to 60.499

First published in 2004. Featuring the latest information on the new technology involved in on-site power generation, this book incorporates an overview and further detailed investigations into the issues inherent in the development, use and future of microturbines.
Advanced Natural Gas Reciprocating Engine
ASTM D6522-00 Standard Test Method for Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Concetrations in Emissions from Natural Gas Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers
Electric Power Technologies, Economics and Environmental Impacts

Gas-Turbine Power Generation
State of Colorado Portable Analyzer Monitoring Protocol
Natural Gas Engines

This is a major new handbook that covers hundreds of subjects that cross numerous industry sectors; however, the handbook is heavily slanted to oil and gas environmental management, control and pollution prevention and energy efficient practices. Multi-media pollution technologies are covered : air, water, solid waste, energy. Students, technicians, practicing engineers, environmental engineers, environmental

managers, chemical engineers, petroleum engineers, and environmental attorneys are all professionals who will benefit from this major new reference source. The handbook is organized in three parts. Part A provides an extensive compilation of abbreviations and concise glossary of pollution control and engineering terminology. More than 400 terms are defined. The section is intended to provide a simple look-up guide to confusing terminology used in the regulatory field, as well as industry jargon. Cross referencing between related definitions and acronyms are provided to assist the user. Part B provides

physical properties and chemical safety information. This part is not intended to be exhaustive; however it does provide supplemental information that is useful to a number of the subject entries covered in the main body of the handbook. Part C is the Macropedia of Subjects. The part is organized as alphabetical subject entries for a wide range of pollution controls, technologies, pollution prevention practices and tools, computational methods for preparing emission estimates and emission inventories and much more. More than 100 articles have been prepared by the author, providing a concise

overview of each subject, supplemented by sample calculation methods and examples where appropriate, and references. Subjects included are organized and presented in a macropedia format to assist a user in gaining an overview of the subject, guidance on performing certain calculations or estimates as in cases pertinent to preliminary sizing and selection of pollution controls or in preparing emissions inventories for reporting purposes, and recommended references materials and web sites for more in-depth information, data or computational tools. Each subject entry provides a working

overview of the technology, practice, piece of equipment, regulation, or other relevant issue as it pertains to pollution control and management. Cross referencing between related subjects is included to assist the reader to gain as much of a practical level of knowledge.

A thoroughly updated introduction to the current issues and challenges facing managers and administrators in the investor and publicly owned utility industry, this engaging volume addresses management concerns in five sectors of the utility industry: electric power, natural gas, water,

wastewater systems and public transit. Natural gas provides a natural complement to variable renewable energy sources such as wind and solar power. It is the cleanest fossil fuel, emitting less than half the carbon dioxide and a fraction of the smog-forming pollutants that coal power plants do. Moreover, it can be used in a variety of efficient, flexible, and scalable generating technologies, enabling it to back up wind and solar generation on a range of time and geographic scales. If new supplies can be produced responsibly, natural gas can deliver immediate reductions in carbon emissions from

the power sector. Methane, the main component of natural gas, already is being captured from landfills and other renewable sources, which can contribute a growing share of natural gas supplies in the decades ahead. As renewable energy and natural gas become more economical, their share in global power generation markets is increasing at the expense of coal. Working together, renewable energy and natural gas can facilitate a rapid decarbonization of the power sector and provide the foundation for a low-carbon energy future, starting now. -- from back cover.

2018 CFR Annual Print Title 40 Protection of Environment - Part 60 (60.1 to 60.499
Chemical and Biological Sensors and Analytical Methods : Proceedings of the International Symposium
The Once and Future Roles of Renewable Energy and Natural Gas
Integrated System to Reduce Emissions from a Natural Gas-fired Reciprocating Engine
REX East Project
Essentials of Natural Gas Microturbines

Natural gas has traditionally been used as a feedstock for the chemical industry, and as a fuel for process and space heating.

Recent advances in exploration, drilling techniques and hydraulic fracturing have made it possible for natural gas to become available in abundance (as of 2012). As natural gas displaces traditional petroleum use in various sectors, a certain amount of disruption is likely. In such a changing landscape, this book tries to chronicle the state-of-the-art in various aspects of natural gas: exploration, drilling, gas processing, storage, distribution, end use and finally the impact on financial markets. Review articles as well as research papers contributed by leading authorities around the world comprise individual chapters of this book. Modeling approaches, as well as, recent advances in specific natural gas technologies are covered in detail.

The new edition of Power Generation Technologies is a concise and readable guide that provides an introduction to the full spectrum of currently available power generation options, from traditional fossil fuels and the better established alternatives such as wind and solar power, to emerging renewables such as biomass and geothermal energy. Technology solutions such as combined heat and power and distributed generation are also explored. However, this book is more than just an account of the technologies – for each method the author explores the economic and environmental costs and risk factors. Each technology is covered using the same basic criteria so that comparisons between technologies can be made more easily. Those involved in planning and

delivering energy – including engineers, managers and policy makers – will find in this book a guide through the minefield of maintaining a reliable power supply, meeting targets on greenhouse gas emissions, and addressing economic and social objectives. Provides a unique comparison of a wide range of power generation technologies from oil, coal, nuclear and natural gas, to geothermal, wind, solar, and bioenergy Hundreds of diagrams demystify how each technology functions in practice Evaluates the economic and environmental viability of each power generation system covered New chapters covering fast-advancing renewable and alternative power sources such as municipal waste and concentrating solar plants Fresh focus the evolution of

traditional technologies such as natural gas and "clean coal" Expanded coverage of distributed power generation and CHP (combined heat and power) technologies

The book covers chapters ranging from introduction to recent technological challenges, case studies of energy-efficient buildings with policy and awareness issues, fundamentals and present status along with research updates and future aspects on topics focusing on energy-efficient construction, materials.

Natural Gas Fired Reciprocating Engines for Power Generation: Concerns and Recent Advances

Assessment of Combined Heat and Power Premium Power Applications in California

Advanced Reciprocating Engine Systems (ARES) Research at

Argonne National Laboratory - A Report
Chemical Energy from Natural and Synthetic Gas
Technologies & Applications : an Integrated Approach to Energy Resource Optimization
Handbook of Energy Engineering, Sixth Edition

Gas compressors tend to be the largest, most costly, and most critical machines employed in chemical and gas transfer processes. Since they tend to have the greatest effect on the reliability of processes they power, compressors typically receive the most scrutiny of all the machinery among the general population of processing equipment. To prevent unwanted compressor failures from occurring, operators must be taught how their equipment should operate and how each

installation is different from one another. The ultimate purpose of this book is to teach those who work in process settings more about gas compressors, so they can start up and operate them correctly and monitor their condition with more confidence. Some may regard compressor technology as too broad and complex a topic for operating personnel to fully understand, but the author has distilled this vast body of knowledge into some key, easy to understand lessons for the reader to study at his or her own pace. The main goals of this book are to: Explain important theories and concepts about gases and compression processes with a minimum of mathematics Identify key compressor components and explain how they affect reliability Explain how centrifugal

compressors, reciprocating compressors, and screw compressors function. Explain key operating factors that affect reliability Introduce the reader to basic troubleshooting methodologies Introduce operators to proven field inspection techniques

Past research has shown that laser ignition provides a potential means to reduce emissions and improve engine efficiency of gas-fired engines to meet longer-term DOE ARES (Advanced Reciprocating Engine Systems) targets. Despite the potential advantages of laser ignition, the technology is not seeing practical or commercial use. A major impediment in this regard has been the 'open-path' beam delivery used in much of the past research. This mode of delivery is not

considered industrially practical owing to safety factors, as well as susceptibility to vibrations, thermal effects etc. The overall goal of our project has been to develop technologies and approaches for practical laser ignition systems. To this end, we are pursuing fiber optically coupled laser ignition system and multiplexing methods for multiple cylinder engine operation. This report summarizes our progress in this regard. A partial summary of our progress includes: development of a figure of merit to guide fiber selection, identification of hollow-core fibers as a potential means of fiber delivery, demonstration of bench-top sparking through hollow-core fibers, single-cylinder engine operation with fiber delivered laser ignition, demonstration of bench-top multiplexing, dual-

cylinder engine operation via multiplexed fiber delivered laser ignition, and sparking with fiber lasers. To the best of our knowledge, each of these accomplishments was a first.
Gas-Turbine Power Generation is a concise, up-to-date, and readable guide providing an introduction to gas turbine power generation technology. It includes detailed descriptions of gas fired generation systems, demystifies the functions of gas fired technology, and explores the economic and environmental risk factors Engineers, managers, policymakers and those involved in planning and delivering energy resources will find this reference a valuable guide that will help them establish a reliable power supply as they also account for both social and economic objectives. Provides a concise, up-to-date, and

readable guide on gas turbine power generation technology Focuses on the evolution of gas-fired power generation using gas turbines Evaluates the economic and environmental viability of the system with concise diagrams and accessible explanations

Chemical Sensors VI

Final Report

Locating and estimating air emissions from sources of polycyclic organic matter

For Transportation and Power Generation

Code of Federal Regulations

Evaluation of Reformer Produced Synthesis Gas for Emissions Reductions in Natural Gas Reciprocating Engines

This report analyzes the current economic and environmental performance of combined heat and power (CHP) systems in power interruption intolerant commercial facilities. Through a series of three case studies, key trade-offs are analyzed with regard to the provision of black-out ridethrough capability with the CHP systems and the resutling ability to avoid the need for at least some diesel backup generator capacity located at the case study sites. Each of the selected sites currently have a CHP or combined heating, cooling, and power (CCHP) system in addition to diesel backup generators. In all cases the CHP/CCHP system have a small fraction of the electrical capacity of the diesel

generators. Although none of the selected sites currently have the ability to run the CHP systems as emergency backup power, all could be retrofitted to provide this blackout ride-through capability, and new CHP systems can be installed with this capability. The following three sites/systems were used for this analysis: (1) Sierra Nevada Brewery - Using 1MW of installed Molten Carbonate Fuel Cells operating on a combination of digestor gas (from the beer brewing process) and natural gas, this facility can produce electricty and heat for the brewery and attached bottling plant. The major thermal load on-site is to keep the brewing tanks at appropriate temperatures. (2) NetApp Data Center - Using 1.125 MW

of Hess Microgen natural gas fired reciprocating engine-generators, with exhaust gas and jacket water heat recovery attached to over 300 tons of of adsorption chillers, this combined cooling and power system provides electricity and cooling to a data center with a 1,200 kW peak electrical load. (3) Kaiser Permanente Hayward Hospital - With 180kW of Tecogen natural gas fired reciprocating engine-generators this CHP system generates steam for space heating, and hot water for a city hospital. For all sites, similar assumptions are made about the economic and technological constraints of the power generation system. Using the Distributed Energy Resource Customer Adoption Model (DER-CAM)

developed at the Lawrence Berkeley National Laboratory, we model three representative scenarios and find the optimal operation scheduling, yearly energy cost, and energy technology investments for each scenario below: Scenario 1 - Diesel generators and CHP/CCHP equipment as installed in the current facility. Scenario 1 represents a baseline forced investment in currently installed energy equipment. Scenario 2 - Existing CHP equipment installed with blackout ride-through capability to replace approximately the same capacity of diesel generators. In Scenario 2 the cost of the replaced diesel units is saved, however additional capital cost for the controls and switchgear for blackout ride-through

capability is necessary. Scenario 3 - Fully optimized site analysis, allowing DER-CAM to specify the number of diesel and CHP/CCHP units (with blackout ride-through capability) that should be installed ignoring any constraints on backup generation. Scenario 3 allows DER-CAM to optimize scheduling and number of generation units from the currently available technologies at a particular site. The results of this analysis, using real data to model the optimal schedulding of hypothetical and actual CHP systems for a brewery, data center, and hospital, lead to some interesting conclusions. First, facilities with high heating loads will typically prove to be the most appropriate for CHP installation from a purely

economic standpoint. Second, absorption/adsorption cooling systems may only be economically feasible if the technology for these chillers can increase above current best system efficiency. At a coefficient of performance (COP) of 0.8, for instance, an adsorption chiller paired with a natural gas generator with waste heat recovery at a facility with large cooling loads, like a data center, will cost no less on a yearly basis than purchasing electricity and natural gas directly from a utility. Third, at marginal additional cost, if the reliability of CHP systems proves to be at least as high as diesel generators (which we expect to be the case), the CHP system could replace the diesel generator at little or no additional cost. This is

true if the thermal to electric (relative) load of those facilities was already high enough to economically justify a CHP system. Last, in terms of greenhouse gas emissions, the modeled CHP and CCHP systems provide some degree of decreased emissions relative to systems with less CHP installed. The emission reduction can be up to 10% in the optimized case (Scenario 3) in the application with the highest relative thermal load, in this case the hospital. Although these results should be qualified because they are only based on the three case studies, the general results and lessons learned are expected to be applicable across a broad range of potential and existing CCHP systems.

The goals of these experiments were to determine the potential of employing spectral measurements to deduce combustion metrics such as HRR, combustion temperatures, and equivalence ratios in a natural gas-fired reciprocating engine. A laser-ignited, natural gas-fired single-cylinder research engine was operated at various equivalence ratios between 0.6 and 1.0, while varying the EGR levels between 0% and maximum to thereby ensure steady combustion. Crank angle-resolved spectral signatures were collected over 266-795 nm, encompassing chemiluminescence emissions from OH*, CH*, and predominantly by CO2* species. Further, laser-induced gas breakdown spectra were recorded

under various engine operating conditions.
With new chapters on electrical system optimization and ISO 50001, this edition covers the latest updates to codes and standards in the energy industry. It includes chapters on energy economic analysis, energy auditing, waste heat recovery, utility system optimization, HVAC, cogeneration, control systems, energy management, compressed air system optimization and financing energy projects. This reference will guide you step by step in applying the principles of energy engineering and management to the design of electrical, HVAC, utility, process and building systems for both new design and retrofit projects. The text is thoroughly illustrated with

tables, graphs, diagrams and sample problems.
Fundamental Studies of Ignition Process in Large Natural Gas Engines Using Laser Spark Ignition
Plant Engineers and Managers Guide to Energy Conservation
Old Problems, New Challenges
Sustainability through Energy-Efficient Buildings
Pollution Control Handbook for Oil and Gas Engineering
Guide to Microturbines

The DOE National Energy Technology Laboratory (NETL) prepared this Environmental Assessment (EA) to analyze the potential environmental impacts of providing funding to Norwich Public Utilities

(NPU) for its proposed Norwich Cogeneration Initiative in Norwich, New London County, Connecticut. DOE's proposed action is to provide a financial assistance grant of about $718,000. The total project cost would be about $1.47 million, with NPU providing the balance of the funding. The proposed funding is based on a Congressional earmark. DOE's Office of Energy Efficiency and Renewable Energy believes this project will advance research and development and demonstrate energy efficiency technology. NPU would construct and operate a high-efficiency natural-gas-fired reciprocating engine cogeneration facility on

property leased from and adjoining Atlantic City Linen Supply New England (ACLS). ACLS operates an industrial laundry service at this location. The proposed project would install a natural-gas-fired reciprocating engine to generate 540 kilowatts of electricity and use the thermal energy, in the form of a closed-loop hot water heat exchanger, to produce hot water for ACLS's operations. The electricity generated by the unit would be transmitted to NPU's distribution system and offset electricity purchases, potentially reducing costs to all customers.
Special edition of the Federal Register, containing a codification of documents of general applicability

and future effect ... with ancillaries.

This report presents results of our investigation on parasitic loss control through surface modification in reciprocating engine. In order to achieve the objectives several experimental and corresponding analytical models were designed and developed to corroborate our results. Four different test rigs were designed and developed to simulate the contact between the piston ring and cylinder liner (PRCL) contact. The Reciprocating Piston Test Rig (RPTR) is a novel suspended liner test apparatus which can be used to accurately measure the friction force and side load at the piston-cylinder interface. A mixed

lubrication model for the complete ring-pack and piston skirt was developed to correlate with the experimental measurements. Comparisons between the experimental and analytical results showed good agreement. The results revealed that in the reciprocating engines higher friction occur near TDC and BDC of the stroke due to the extremely low piston speed resulting in boundary lubrication. A Small Engine Dynamometer Test Rig was also designed and developed to enable testing of cylinder liner under motored and fired conditions. Results of this study provide a baseline from which to measure the effect of surface modifications. The Pin on Disk

Test Rig (POD) was used in a flat-on-flat configuration to study the friction effect of CNC machining circular pockets and laser micro-dimples. The results show that large and shallow circular pockets resulted in significant friction reduction. Deep circular pockets did not provide much load support. The Reciprocating Liner Test Rig (RLTR) was designed to simplifying the contact at the PRCL interface. Accurate measurement of friction was obtained using 3-axis piezoelectric force transducer. Two fiber optic sensors were used to measure the film thickness precisely. The results show that the friction force is reduced through the use of modified

surfaces. The Shear Driven Test Rig (SDTR) was designed to simulate the mechanism of the piston ring pass through the liner. Micro PIV system was provided to observing the flow of lubricant in the cavity (pocket). The Vorticity-Stream Function Code was developed to simulate the incompressible fluid flow in the rectangular cavity.

2000-

Texas Gas Fayetteville/Greenville Expansion Project

Combined Heating, Cooling & Power Handbook

Handbook of Distributed Generation

Handbook of Energy Engineering

Evaluation of Low-cost Formaldehyde Measurement

Techniques

This book covers the various advanced reciprocating combustion engine technologies that utilize natural gas and alternative fuels for transportation and power generation applications. It is divided into three major sections consisting of both fundamental and applied technologies to identify (but not limited to) clean, high-efficiency opportunities with natural gas fueling that have been developed through experimental protocols, numerical and high-performance computational simulations, and zero-dimensional, multizone combustion simulations. Particular emphasis is placed on statutes to monitor fine particulate emissions from tailpipe of engines operating on natural gas and alternative fuels.
This book features extensive coverage of all Distributed

Energy Generation technologies, highlighting the technical, environmental and economic aspects of distributed resource integration, such as line loss reduction, protection, control, storage, power electronics, reliability improvement, and voltage profile optimization. It explains how electric power system planners, developers, operators, designers, regulators and policy makers can derive many benefits with increased penetration of distributed generation units into smart distribution networks. It further demonstrates how to best realize these benefits via skillful integration of distributed energy sources, based upon an understanding of the characteristics of loads and network configuration.

This fully updated, comprehensive reference will guide you step-by-step in applying the principles of energy engineering

and management to the design of electrical, HVAC, utility, process and building systems for both new and retrofit projects. You will learn how to do an energy analysis of any system. Detailed presentations cover electrical system optimization, state-of-the-art lighting and lighting controls, thermal storage, cogeneration, HVAC system optimization, HVAC and building controls, and computer technologies. The fifth edition includes a new chapter covering codes, standards and legislation, as well as a new chapter on compressed air systems. You'll also find coverage on use of innovative third party financing mechanisms such as performance contracting to implement energy cost reduction measures. The text is thoroughly illustrated with tables, graphs, diagrams, and sample problems with worked-out

solutions.

Natural Gas

Final Environmental Assessment for the Norwich Cogeneration Initiative, Norwich, Connecticut (DOE/EA-1836)

EPA-450/2

2017 CFR Annual Print Title 40 Protection of Environment - Part 60 (60.1 to 60.499

Characteristics of Formaldehyde Emissions from Natural Gas-fired Reciprocating Internal Combustion Engines in Gas Transmission

Operator's Guide to Process Compressors

Many of the economic road blocks which have previously served to discourage the

implementation of alternative power generation technologies can now be readily overcome through effective energy resource optimization. It is now a fact that solid financial returns can be achieved from combined heating, cooling and power generation projects by integrating energy and cost efficiency goals, and seeking a match between power production and heating/cooling requirements. This book is intended to serve as a road map to those seeking to realize optimum economic returns on such projects. The first

section provides an introduction to basic heat and power thermodynamics, with an overview of heat and power generation technologies and equipment. The second section explores the infrastructure in which the project must be implemented, including environmental considerations, as well as utility rate structures. The third section provides detailed coverage of a broad range of technology types, and discusses how opportunities for their application can be identified and successfully exploited. The final section

takes you through each step of project development, implementation and operation. Numerous examples are provided of actual field applications, with supporting documentation of system layouts and performance. The text is supplemented with more than one thousand graphics, including photos, cutaway drawings, layout schematics, performance curves, and data tables.

Addressing a field which, until now, has not been sufficiently investigated, Essentials of Natural Gas Microturbines

thoroughly examines several natural gas microturbine technologies suitable not only for distributed generation but also for the automotive industry. An invaluable resource for power systems, electrical, and computer science engineers as well as operations researchers, microturbine operators, policy makers, and other industry professionals, the book: Explains the importance of natural gas microturbines and their use in distributed energy resource (DER) systems Discusses the history, development, design, and

operation of gas microturbines Introduces the Evolutionary Algorithm for pollutant emissions and fuel consumption minimization Analyzes the power electronics for grid connection of natural gas microturbines Includes actual power quality measurements—graphical representations and numerical data—from a real system Contains 39 color figures Readers benefit from the clarity and practicality of Essentials of Natural Gas Microturbines, ultimately learning new techniques to increase electrical load

efficiency, keep the environment cleaner, and improve equipment exploitation based on mathematical results.

Commercial development of energy from renewables and nuclear is critical to long-term industry and environmental goals. However, it will take time for them to economically compete with existing fossil fuel energy resources and their infrastructures. Gas fuels play an important role during and beyond this transition away from fossil fuel dominance to a balanced approach to fossil, nuclear,

and renewable energies. Chemical Energy from Natural and Synthetic Gas illustrates this point by examining the many roles of natural and synthetic gas in the energy and fuel industry, addressing it as both a "transition" and "end game" fuel. The book describes various types of gaseous fuels and how are they are recovered, purified, and converted to liquid fuels and electricity generation and used for other static and mobile applications. It emphasizes methane, syngas, and hydrogen as fuels, although other volatile

hydrocarbons are considered. It also covers storage and transportation infrastructure for natural gas and hydrogen and methods and processes for cleaning and reforming synthetic gas. The book also deals applications, such as the use of natural gas in power production in power plants, engines, turbines, and vehicle needs. Presents a unified and collective look at gas in the energy and fuel industry, addressing it as both a "transition" and "end game" fuel. Emphasizes methane, syngas, and hydrogen

as fuels. Covers gas storage and transport infrastructure. Discusses thermal gasification, gas reforming, processing, purification and upgrading. Describes biogas and bio-hydrogen production. Deals with the use of natural gas in power production in power plants, engines, turbines, and vehicle needs.

Power Generation Technologies

Handbook of Energy Engineering, Seventh Edition

Powering the Low-carbon Economy

Phase I Predictive Model for Estimating

Formaldehyde Emissions from 2-stroke Engines
Extraction to End Use
Environmental Impact Statement