HEAT RATE OPTIMIZATION OF COAL POWER PLANTS

26 – 28 JANUARY 2016, SINGAPORE

Topics Covered

- Calculating Heat Rate
- Benefits of Lowering Heat Rate
- Efficiency of Power Plants and Power Plant Systems
- Areas of a Pulverized Coal Plant where Efficiency Loss Can Occur
- Assessing the Range and applicability of Heat Rate Improvements
- Heat Rate Improvement – Methodologies, Capital and Maintenance Projects
- Heat Rate Improvement – Common Recommendations

Expert Course Faculty Leader

Philip Kiameh

Has more than 30 years of practical engineering experience with Ontario Power Generation and as a Training Manager, has conduct courses and seminars, to more than 4,000 working engineers and professionals who consistently ranked him as "Excellent" or "Very Good". Philip has also wrote 5 books for working engineers from which three have been published by McGraw-Hill, New York.
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Course Overview

This seminar provides detailed description of all the methods used to reduce the heat rate (increase the efficiency) of pulverized coal and circulating fluidized bed coal power plants. All the processes, operational and maintenance activities, capital projects, technical options, potential initiatives and incentives to implement upgrades/repairs for increasing the plant efficiency will be covered in detail. This seminar will also provide in-depth explanation of all the equipment and systems used in coal power plants. This includes, boilers, superheaters, reheaters, turbines, condensers, feedwater heaters, deaerators, pumps, compressors, fans, electric generators, instrumentation and control systems, and governing systems, etc. All the factors which affect the power plant efficiency and emissions will be explained thoroughly. All the methods used to calculate the heat rate of the power plant will be covered in detail. All the areas in pulverized coal and circulating fluidized bed power plants where efficiency loss can occur will be explained. This seminar will also provide up-dated information in respect to the following methods used to improve the power plant heat rate:

- Optimizing the Combustion Process and Sootblowing
- Controlling the Steam Temperature
- Recovering Moisture from Boiler Flue Gas
- Performing Steam Turbine Maintenance
- Lowering Condenser Back Pressure
- Pre-drying High Moisture Coal and Reducing Stack Temperature

Course Learning Outcomes

- Calculating the Heat Rate of Coal Power Plants: Learn all the methods used to calculate the heat rate of coal power plants
- Benefits of Lowering the Heat Rate of Coal Power Plants: Understand all the benefits of lowering the heat rate of coal power plants
- Methods Used to Improve Coal Power Plants Heat Rate: Gain a thorough understanding of all the methods used to improve the heat rate of coal power plants.
- Processes, Operational and Maintenance Activities: Discover all the processes, operational and maintenance activities used to improve the heat rate of coal power plants
- Capital Projects Used to Improve the Heat Rate: Learn about all the capital projects used to improve the heat rate of coal power plants
- Technical Options for Improving the Heat Rate: Understand all the technical options used to improve the heat rate of coal power plants
- Potential Initiatives and Incentives to Implement Upgrades/Repairs for Improving the Heat Rate: Discover all the potential initiatives and incentives to implement upgrades/repairs for improving the heat rate of coal power plants
- Factors Affecting Coal Power Plant Efficiency and Emissions: Learn about all the factors which affect coal power plants efficiency and emissions
- Areas in Pulverized Coal and Circulating Fluidized Bed Power Plants where Efficiency Loss Can Occur: Discover all the areas in pulverized coal and circulating fluidized bed power plants where efficiency loss can occur
- Optimize the Operation of Coal Power Plant Equipment and Systems to Improve the Plant Heat Rate: Understand all the techniques and methods used to optimize the operation of coal power plant equipment and systems to improve the plant heat rate
- Coal Power Plant Equipment and Systems: Learn about various coal power plant equipment and systems including: boilers, superheaters, reheaters, steam turbines, governing systems, deaerators, feedwater heaters, coal-handling equipment, transformers, generators and auxiliaries
Training Methodology

The instructor relies on a highly interactive training method to enhance the learning process. This method ensures that all the delegates gain a complete understanding of all the topics covered. The training environment is highly stimulating, challenging, and effective because the participants will learn by case studies which will allow them to apply the material taught to their own organization.

Who Should Attend

- Engineers of all disciplines
- Managers
- Technicians
- Maintenance personnel
- Other technical individuals

Special Feature

Each delegate will receive a copy of the following materials written by the instructor:
HEAT RATE OPTIMIZATION MANUAL (includes practical information about all the methods used to optimize the heat rate in coal power plants - 300 pages)

Your Expert Faculty

Philip Kiameh, M.A.Sc., B.Eng., D.Eng., P.Eng. (Canada) has been a teacher at University of Toronto and Dalhousie University, Canada for more than 23 years. In addition, Prof Kiameh has taught courses and seminars to more than four thousand working engineers and professionals around the world, specifically Europe and North America. Prof Kiameh has been consistently ranked as "Excellent" or "Very Good" by the delegates who attended his seminars and lectures. Prof. Kiameh performed research on power generation equipment with Atomic Energy of Canada Limited at their Chalk River and Whiteshell Nuclear Research Laboratories. He also has more than 30 years of practical engineering experience with Ontario Power Generation (formerly, Ontario Hydro - the largest electric utility in North America).

While working at Ontario Hydro, Prof. Kiameh acted as a Training Manager, Engineering Supervisor, System Responsible Engineer and Design Engineer. During the period of time that Prof Kiameh worked as a Field Engineer and Design Engineer, he was responsible for the operation, maintenance, diagnostics, and testing of gas turbines, steam turbines, generators, motors, transformers, inverters, valves, pumps, compressors, instrumentation and control systems. Further, his responsibilities included designing, engineering, diagnosing equipment problems and recommending solutions to repair deficiencies and improve system performance, supervising engineers, setting up preventive maintenance programs, writing Operating and Design Manuals, and commissioning new equipment.

Later, Prof Kiameh worked as the manager of a section dedicated to providing training for the staff at the power stations. The training provided by Prof Kiameh covered in detail the various equipment and systems used in power stations.

Professor Philip Kiameh was awarded his Bachelor of Engineering Degree "with distinction" from Dalhousie University, Halifax, Nova Scotia, Canada. He also received a Master of Applied Science in Engineering (M.A.Sc.) from the University of Ottawa, Canada. He is also a member of the Association of Professional Engineers in the province of Ontario, Canada.

Prof Kiameh wrote 5 books for working engineers from which three have been published by McGraw-Hill, New York. Below is a list of the books authored by Prof Kiameh:

5. Industrial Equipment (600 pages), Custom Publishing, University of Toronto, University of Toronto, University of Toronto Custom Publishing (1999).
# 3 Day Course Outline

### Day 1 – Steam Power Plants, Steam Generators, Steam Turbines, Steam Turbine Auxiliaries
- Review of Thermodynamics Principles
- Steam Power Plants
- Steam Generators
- Steam Turbines
- Reheaters
- Condensers
- Feedwater Heaters
- Efficiency and Heat Rate
- Supercritical Plants
- The Fire-Tube Boiler
- The Water-Tube Boiler
- The Steam Drum
- Superheaters and Reheaters
- Once-Through Boilers
- Economizers
- Fans
- The Stack
- Steam Generator Control
- Feedwater and Drum-Level Control
- Steam-Pressure Control
- Steam-Temperature Control
- Mechanisms of Energy Conversion in a Steam Turbine
- Turbine components
- Rotating and Stationary blades
- Thrust bearings
- Labyrinth seals
- Turbine controls
- Testing of Turbine blades
- Quality Assurance of Turbine Generator Components
- Assembly and testing of turbine components
- Turbine Types
- Compound Turbines
- Turbine Control Systems
- Steam Turbine Maintenance
- Steam Generators, Heat Exchangers, and Condensers

### Day 2 – Coal Fired Power Plants Systems and Equipment, Factors Influencing Power Plant Efficiency and Emissions, Efficiency Standards and Monitoring, International Energy Agency (IEA) Recommendations for Improving the Heat Rate in Coal Power Plants
- Major Components of Pulverized Coal and Circulating Fluidized Bed Power Plants
- Pulverized Coal Fired Power Plant Performance
- Circulating Fluidized Bed Power Plant Performance
- Net Power Generation Capacity
- Steam Cycle Heat Rate
- Design Parameters that Affect the Steam Cycle Heat Rate
- Boiler (Steam Generator) Efficiency
- Coal Composition
- Ultimate Analysis
- Flue Gas Exit Temperature
- Energy Content or Heating Value
- Penalty for Stack Gas Reheat
- Flue Gas Desulfurization (FGD) Systems
- Power Consumption of the Auxiliary Equipment (Allowance for Auxiliaries)
- Power Plant Availability
- Average Load Factor
- Annual Coal Consumption
- Annual Ash and SO2 Generation
- Coal Transportation, Unloading and Storage
- Coal Storage and Reclamation
- Environmental Issues Related with Coal Based Energy Conversion
### HEAT RATE OPTIMIZATION OF COAL POWER PLANTS

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<th>Day 3 – Calculating Heat Rate, Benefits of Lowering Heat Rate, Heat Rate Improvement – Methodologies, Capital and Maintenance Projects, Steam Turbine Steam Path Modifications; Processes, Operational and Maintenance Activities Used to Increase the Plant Efficiency</th>
</tr>
</thead>
<tbody>
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<td>• Heat Rate Improvement – Methodologies, Capital and Maintenance Projects</td>
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<tr>
<td>• Heat Rate Improvement – Common Recommendations</td>
</tr>
<tr>
<td>• Plant Specific Recommendations</td>
</tr>
<tr>
<td>• Potential Heat Rate Improvements</td>
</tr>
</tbody>
</table>

| • Quantified Benefits of Implementation of Recommendations |
| • Fuel Savings and CO2 Benefits |
| • Heat Rate Improvement – Fleetwide Assessment Case Study |
| • Heat Rate Improvements – Issues and Perspectives |
| • Flexible Operation, Cycle Alignment, Remote Monitoring Centers |
| • Steam Turbine Steam Path Modifications |
| • Heat Rate Improvement Program Guidelines |
| • Realized and Projected Heat Rate Improvements |
| • Efficiency Improvements to Reduce Greenhouse Gases (GHG) |
| • Existing Coal-Fired Plants Efficiency Improvements |
| • Key Technical Opportunities to Increase Thermal Efficiency |
| • Processes for Increasing the Plant Efficiency |
| • Operational and Maintenance Activities Used to Increase the Plant Efficiency |
| • Capital Projects Used to Increase the Plant Efficiency |
| • Framework for Measuring and Sustaining Improvements |
| • Technical Options to Increase Plant Efficiency |
| • Accurate Definition and Standard for Measuring Efficiency in Real Time |
| • Potential Initiatives for Increasing Plant Efficiency |
| • Incentives for Existing Fleet to Implement Upgrades/Repairs for Increasing Plant Efficiency |
| • Improve the Heat Rate by Optimizing the Combustion Process and Sootblowing |
| • Improve the Heat Rate by Controlling the Steam Temperature |
| • Improve the Heat Rate by Recovering Moisture from Boiler Flue Gas |
| • Improve the Heat Rate by Performing Steam Turbine Maintenance |
| • Improve the Heat Rate by Lowering Condenser Back Pressure |
| • Improve the Heat Rate by Pre-drying High Moisture Coal and Reducing Stack Temperature |

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| Energy Institute |
| Approved Training Provider |
HEAT RATE OPTIMIZATION OF COAL POWER PLANTS
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OTHER AVAILABLE COURSES

- 4 Pillars of Transformer Condition
- Advanced Project Finance for Power
- Advanced Technical Report Writing & Presentation Skills
- Advanced Turnaround Shutdown & Outage Management
- Ancillary Services in Competitive Electricity
- Asset Management for the Power Industry
- Best Practice Renewable Energy Capital & Project Management
- Biomass Power Generation
- CFB Combustion for Boiler Operations
- Clean Development Mechanism and Carbon Markets
- Coal Contracts
- Combined Cycle Power Plants Operation
- Combined Heat & Power (CHP) and Co-Generation Plant Operations
- Competency Management System for the Power Industry
- Design & Operations of Circulating Fluidized Bed Boiler
- Developing & Structuring Public-Private Partnership (PPP) for Infrastructure
- Effective Tender Process Management for Power & Utilities
- Electrical Hazop (eHazop) Studies for the Power Industry
- Electricity Demand-Side Management
- Electricity Industry Design
- Electricity Network Planning
- Electricity Retail Contracts
- Electricity Theft
- Electricity Trading Essentials
- Energy Efficiency
- EPC Contract Management for Power & Utilities
- Essentials of Coal Markets and Trading
- Essentials of Power Trading
- Excitation Systems
- Feed-In Tariffs for PV Systems
- Finance for Non-Finance Professionals in Power & Utilities
- Financial Modelling for Project Finance in Power & Utilities
- Fitness-For-Service AP1 579 & High Energy Piping Life Management
- Fundamentals of Geothermal Energy
- Fundamentals of Power Generation
- Gas & LNG Contract Negotiation
- Gas Turbine Generator Selection, Operation & Maintenance
- Gas Turbine Hot Gas Paths, Rotors & Failure Analysis
- Gas Turbine Major Inspection & Overhaul
- GE Gas Turbine Operations Simulation Based
- HRSG Design, Operations & Understanding, Controlling of HRSG Damage
- HV Substation Design & Construction
- IEC for Utilities
- Integration of Distributed Generation
- Introduction to Carbon Capture & Storage
- Introduction to Clean Coal Technology
- Introduction to Power Systems
- Keeping Electrical Switchgear Safe
- Leadership & Team Dynamics for Power & Utilities
- LNG Fundamentals
- LNG Markets & SPOT Trading
- Maintenance Planning & Scheduling
- Making IPP & Renewable Energy Projects Contract Frameworks Bankable
- Managing Complex Projects for Power and Utilities Professionals
- Medium Voltage & High Voltage Switchgear
- Metallurgy for Engineers
- Mechanical Engineering for Non-Mechanical Engineers
- Mini Hydro Project Analysis
- MKV Speedtronic Control System
- MK VI Speedtronic Control System
- Nuclear Energy Project Planning & Economics
- Nuclear Power
- Offshore Platforms Electrical Systems Design & Illustrations
- Operations of Coal Fired Power Plants
- Power Generation Commissioning, Operations & Maintenance
- Power Generation Operation, Protection & Excitation Control
- Power Plant Chemistry for Chemist & Chemical Engineers
- Power Purchase Agreements
- Process Control Methods
- Programmatic CDM
- Project Management for Power and Utilities
- Relay Protection in Power Systems
- Reliability Centered Maintenance Masterclass
- Reliability Engineering
- Renewable Energy Development & Investment
- Renewable Energy Integration
- Risk Based Inspection
- Risk Management in Power Markets
- Root Cause Analysis
- Rotating Equipment Maintenance & Reliability Excellence
- SCADA & Power Systems
- Smart Grid
- Solar Energy & Photovoltaic Power
- Spare Parts Optimisation
- Supercritical and Ultra-Supercritical Coal-Fired Power Plant
- Technical Report Writing & Presentation Skills for Power & Utilities Professionals
- Ultra Low NOx Gas Turbine Combustion
- Uninterruptible Power Supply
- Vibration Analysis & Condition Monitoring
- Waste to Energy Plant Operations
- Water Treatment and Corrosion Control for Steam Generation and Power Production
- Writing Effective Standard Operating Procedures (SOP) for Power & Utilities Professionals & Engineers

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### Frequently Asked Questions (FAQs)

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Does PowerEdge have other programmes than those listed?</td>
<td>We have more than 200 programmes that we are capable of running. All we need is for you to contact us and request for the preferred programme and we will able to develop it.</td>
</tr>
<tr>
<td>2.</td>
<td>Where is PowerEdge based?</td>
<td>PowerEDGE is headquartered in Singapore but we run our training programmes in different venues around Asia.</td>
</tr>
<tr>
<td>3.</td>
<td>What does PowerEdge do?</td>
<td>We are a Power &amp; Utilities Training Specialist.</td>
</tr>
<tr>
<td>4.</td>
<td>Can this course be done in our city?</td>
<td>It absolutely can. Get in touch with us to request for a training programme to be carried out in your city.</td>
</tr>
<tr>
<td>5.</td>
<td>Can you reduce the price of our preferred course?</td>
<td>While our price has been reduced before it is even launched, we are always happy to help you with further discounts.</td>
</tr>
<tr>
<td>6.</td>
<td>Can you change the dates of the course?</td>
<td>If you have a special requested date, let us know and we will arrange another session for you.</td>
</tr>
<tr>
<td>7.</td>
<td>Who are the companies that will be participating?</td>
<td>This varies from a diversity of Power Operators, Regulators, Financiers, to Vendors in the Power &amp; Utilities industry.</td>
</tr>
<tr>
<td>8.</td>
<td>Where is the venue for the course?</td>
<td>We usually engage a 4 to 5 star hotel meeting room to ensure the comfort of our participants.</td>
</tr>
<tr>
<td>9.</td>
<td>How many delegates should we expect for each course?</td>
<td>This varies from 15 to 20 participants. Class sizes are kept small to allow trainers to focus better on each participant.</td>
</tr>
<tr>
<td>10.</td>
<td>What are the different payment modes?</td>
<td>We accept Visa/MasterCard, cheques, bank transfers and cash on site.</td>
</tr>
<tr>
<td>11.</td>
<td>Is accommodation included when I sign up for a course?</td>
<td>Accommodation is not included in the course fee but we are always happy to advise on available accommodations.</td>
</tr>
<tr>
<td>12.</td>
<td>Can I get a cheaper accommodation through PowerEdge?</td>
<td>We will be pleased to help you negotiate a better rate with hotels.</td>
</tr>
<tr>
<td>13.</td>
<td>Is lunch provided during the course?</td>
<td>We provide lunch and 2 tea breaks every day during our training programmes.</td>
</tr>
<tr>
<td>14.</td>
<td>Are the training materials included once I have signed up for a course?</td>
<td>Yes, training and course materials are included in the course fee.</td>
</tr>
<tr>
<td>15.</td>
<td>Will there be a certificate for the course?</td>
<td>Yes, there will be a certificate of participation upon completion of a course.</td>
</tr>
<tr>
<td>16.</td>
<td>Who are PowerEdge trainers?</td>
<td>They are expert consultants and practitioners with many years of experience in the subject matter that they deliver on.</td>
</tr>
<tr>
<td>17.</td>
<td>Are PowerEdge trainers competent?</td>
<td>We have received numerous favourable feedbacks on our trainers from past participants.</td>
</tr>
<tr>
<td>18.</td>
<td>Can PowerEdge assist with Visa travel applications?</td>
<td>We can assist in advising you on the relevant procedure(s) and embassies/consulates that provide Visa for travel purposes.</td>
</tr>
<tr>
<td>19.</td>
<td>Can we purchase training materials without attending a course?</td>
<td>Unfortunately this option is not available as training materials are specially developed for courses.</td>
</tr>
<tr>
<td>20.</td>
<td>Can course content be tweaked to cater to our needs?</td>
<td>Of course! Just let us know your request and we will get the trainer to assist in carrying it out.</td>
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</tbody>
</table>
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<table>
<thead>
<tr>
<th>3 Day Programme</th>
<th>NORMAL PRICE</th>
<th>EARLY BIRD ENDS 30 Nov 2015</th>
<th>GROUP OF 3 or More</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SGD 2,900 Per Participant</td>
<td>SGD 2,700 Per Participant</td>
<td>SGD 2,500 Per Participant</td>
</tr>
<tr>
<td></td>
<td>*SGD 3,103 Per Participant (GST Inclusive)</td>
<td>*SGD 2,889 Per Participant (GST Inclusive)</td>
<td>*SGD 2,675 Per Participant (GST Inclusive)</td>
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</tbody>
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*GST FOR SINGAPORE REGISTERED COMPANIES

ATTENDEE DETAILS

Name ................................................................. Job title .................................................................
Tel ...................................... Department ................................................................. Email .................................................................

Name ................................................................. Job title .................................................................
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Name ................................................................. Job title .................................................................
Tel ...................................... Department ................................................................. Email .................................................................

COMPANY DETAILS

Organisation name ................................................................. Industry .................................................................
Address .................................................................................................
Postcode ................................................................. Country .................................................................
Tel ................................................................. Fax .................................................................

PAYMENT METHODS
By Cheque/ Bank Draft: Make Payable to PowerEdge Pte Ltd.
By Telegraphic Transfer: Please quote AE 1 with the remittance advise
Account Name: PowerEdge Pte Ltd.
Bank Address: 65 Chulia Street OCBC Centre, Singapore 049513
All bank charges and payment in Singapore dollars (SGD) to be borne by payer. Please ensure that PowerEdge Pte Ltd receive the full invoiced amount.

PAYMENT POLICY
* Payment is due in full at the time of registration. Full payment is mandatory for event attendance. I agree to PowerEdge Pte Ltd. payment terms
* GST- Exclusive price is only applicable for overseas corporate customers subject to qualifying conditions.

CANCELLATIONS & SUBSTITUTIONS
You may substitute delegates at any time. POWEREDGE PTE LTD does not provide refunds for cancellations. For cancellations received in writing more than seven (7) days prior to the training course you will receive a 100% credit to be used at another POWEREDGE PTE LTD training course for up to one year from the date of issuance. For cancellations received seven (7) days or less prior to an event (including day 7), no credits will be issued. In the event that POWEREDGE PTE LTD cancels an event, delegate payments at the date of cancellation will be credited to a future POWEREDGE PTE LTD event. This credit will be available for up to one year from the date of issuance. In the event that POWEREDGE PTE LTD postpones an event, delegate payments at the postponement date will be credited towards the rescheduled date. If the delegate is unable to attend the rescheduled event, the delegate will receive a 100% credit.