

Qualified for 12
PDUs by PEB

CIRCULATING FLUIDIZED BED BOILERS

Selection, Applications, Operation, Maintenance, Performance Monitoring, Diagnostic Testing, Troubleshooting, Refurbishment, Common Problems and Solutions, Life Extension, and Economics

30 – 31 MARCH 2017, SINGAPORE

Topics Covered

Circulating Fluidized Bed Boiler
Advantages

Components and Systems

Applications, Performance and
Economics

Equipment

Maintenance

Environmental Emissions

Instrumentation and Control Systems

Reliability and Testing

Selection and Applications

Reliability, Refurbishment, and Life
Extension Methods

Commissioning

Codes and Standards

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 conducted courses and seminars, to more than 4,000 working engineers and professionals who consistently ranked him as "Excellent" or "Very Good". Philip has also written 5 books for working engineers from which three have been published by McGraw-Hill, New York.



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CIRCULATING FLUIDIZED BED BOILERS

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Course Overview

This seminar will provide a comprehensive understanding of various types of circulating fluidized bed (CFB) boilers. All the components of CFB boilers including furnace, cyclones, economizers, superheaters, reheaters, ammonia injection systems, electrostatic precipitators, polishing dry scrubbers, fuel and sorbent feeding systems, bottom ash handling and extraction systems will be covered in detail. The design, selection considerations, operation, maintenance, diagnostic testing, troubleshooting, refurbishment, pay-back period, and economics as well as, emission limits, reliability, monitoring and control systems of CFB boilers will also be covered thoroughly. This seminar will focus on maximizing the efficiency, common problems and solutions, reliability, and longevity of CFB boilers by providing an understanding of the characteristics, selection criteria, common problems, and repair techniques, preventive and predictive maintenance. All the common problems encountered in CFB Boilers will be discussed in detail. This includes thermally induced failures, anchor system induced failures, water walls tube failures, NMEJ damages, clinker formation, refractory damages, APH tube check-up. Solutions will be presented to each problem.

Several studies have confirmed that CFB boilers are the best method for power generation. This is due to their fuel flexibility, and lowest electricity cost among all types of boilers. This technology is in great demand due to various other advantages such as lower emissions as compared to other types of boilers and has a carbon footprint well below the norms laid down by the World Bank emission requirements. This seminar is a MUST for anyone who is involved in the selection, applications, or maintenance of circulating fluidized bed boilers, because it covers how this equipment operates, the latest maintenance techniques, and provides guidelines and rules that ensure successful operation of CFB boilers. This seminar will also provide up-dated information in respect to all the significant improvements that have been made to this equipment during the last two decades.

Course Learning Outcomes

- **Circulating Fluidized Bed Boiler Advantages:** Gain a thorough understanding of the advantages of circulating fluidized bed boilers.
- **Circulating Fluidized Bed Boilers Components and Systems:** Learn about all components and subsystems of the various types of circulating fluidized bed boilers.
- **Circulating Fluidized Bed Boilers Applications, Performance and Economics:** Examine the applications, performance and economics of Circulating Fluidized Bed Boilers.
- **Circulating Fluidized Bed Boiler Equipment:** Learn about various equipment of circulating fluidized bed boilers including: furnaces, cyclones, economizers, superheaters, reheaters, ammonia injection systems, electrostatic precipitators, polishing dry scrubbers, fuel and sorbent feeding systems, bottom ash handling and extraction systems and materials.
- **Circulating Fluidized Bed Boilers Maintenance:** Learn all the maintenance activities required for circulating fluidized bed boilers, to minimize their operating cost and maximize their efficiency, reliability, and longevity.
- **Circulating Fluidized Bed Boilers Environmental Emissions:** Learn about the monitoring and control of environmental emissions from circulating fluidized boilers.
- **Circulating Fluidized Bed Boilers Instrumentation and Control Systems:** Learn about the latest instrumentation and control systems of circulating fluidized bed boilers.
- **Circulating Fluidized Bed Boilers, Reliability and Testing:** Increase your knowledge of predictive and preventive maintenance, reliability and testing of circulating fluidized bed boilers.
- **Circulating Fluidized Bed Boilers Selection and Applications:** Gain a detailed understanding of the selection considerations and applications of circulating fluidized bed boilers.
- **Circulating Fluidized Bed Boilers Reliability, Refurbishment, and Life Extension Methods:** Learn about the reliability, life cycle cost, profitability, refurbishment, and life extension methods for all types of circulating fluidized bed boilers.
- **Circulating Fluidized Bed Boilers Commissioning:** Understand all the commissioning requirements of circulating fluidized bed boiler.
- **Circulating Fluidized Bed Boilers Codes and Standards:** Learn all the codes and standards applicable for circulating fluidized bed boilers.

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.

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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:

1. *POWER GENERATION HANDBOOK* published by McGraw-Hill in 2012 (800 pages)
2. Practical Circulating Fluidized Bed manual (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:

- 1 Power Generation Handbook: Gas Turbines, Steam Power Plants, Co-generation, and Combined Cycles, second edition, (800 pages), McGraw-Hill, New York, October 2011.
- 2 Electrical Equipment Handbook (600 pages), McGraw-Hill, New York, March 2003.
- 3 Power Plant Equipment Operation and Maintenance Guide (800 pages), McGraw-Hill, New York, January 2012.
- 4 Industrial Instrumentation and Modern Control Systems (400 pages), Custom Publishing, University of Toronto, University of Toronto Custom Publishing (1999).
- 5 Industrial Equipment (600 pages), Custom Publishing, University of Toronto, University of Toronto, University of Toronto Custom Publishing (1999).

CIRCULATING FLUIDIZED BED BOILERS

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DAY 1

Advantages of CFB Boilers, Components of CFB Boilers, Typical Arrangements of CFB Boilers, Hydrodynamics in CFB Boilers, Combustion in CFB Boilers, Heat Transfer in CFB Boilers, Design of CFB Boilers, CFB Boiler Operation, Maintenance of CFB Boilers, CFB Boiler Safety, Control Systems of CFB Boilers, Common Problems and Solutions of CFB Boilers

- Advantages of circulating fluidized bed combustion
- Circulating fluidized bed combustion technology
- Development of circulating fluidized bed boilers
- Components of CFB boilers: wind box and grid nozzle, bottom ash drain, HP blower, cyclone separator, evaporative or superheat wing walls, fuel feeding system, refractory, solid recycle system (loop seal), wall tubes, kick out, limestone and sand system
- Typical arrangements of CFB boilers
- Hydrodynamic in CFB boilers: particle classification, regimes of fluidization, fast fluidization
- Combustion in CFB boilers: coal properties for CFB boiler, stage of combustion, factors affecting combustion efficiency, combustion in CFB, biomass combustion
- Heat transfer in CFB boilers: gas to particle heat transfer, heat transfer in CFB boiler
- Design of CFB boilers: design and required data, combustion calculations, heat and mass balance, furnace design, cyclone separator
- CFB boiler operation: Requirements before starting, grid pressure drop test, cold start procedure, fill boiler procedure, start fan, boiler interlock, purge, start-up burner, drum and DA low level cut off, boiler warm-up, normal operation, normal shutdown, hot shutdown, hot restart,
- Malfunction and emergency: bed pressure, bed temperature, circulation, tube leak, drum level
- Maintenance of CFB boilers: Requirements before maintenance work, overview boiler maintenance, windbox inspection, furnace inspection, kick-out inspection, superheat (wingwalls), superheat (omega tube), roof inspection, inlet separator, steam drum, separator, outlet separator, screen tube, superheat tube, economizer inspection, air heater
- Basic boiler safety: warnings, general safety precaution, equipment entry, operating precautions
- CFB boiler control systems: Basic control, furnace control, main pressure control, main steam pressure control, drum level control, feed tank control, solid fuel control, HP blower control, primary air control, secondary air control, oxygen control, fuel oil control

- Boiler commissioning procedure
- Common problems and solutions of CFB boilers: wear problems in the boiler furnace, wastage in the boiler, thermally induced failures, anchor system induced failures, water wall tube failures (near lignite and subentry area), water wall tube failures at penthouse, main causes of tube failures, remedial actions, NMEJ failures, fitting of dust seal trap, clinker formation, remedial action taken, refractory damage, areas of major refractory damages, refractory damage in cyclones, APH tube chock-up, refractory failures at start-up burner and lignite entry area, chock-up in HP section

DAY 2

Components, Operational Performance, Efficiencies, Availability and Reliability, Operational Flexibility, Fuel flexibility, Environmental Performance, Methods Used to Improve the Heat Rate, Supercritical Once-through Internal Recirculation-Circulating Fluidized-Bed (IR-CFB) Boilers for Power Generation, Ultra Supercritical Fluidized Bed (CFB) Boilers

- Circulating fluidized bed combustion boilers
- Circulating fluidized bed combustion boiler and polishing scrubber
- Circulating fluidized bed combustion boiler combustor
- Circulating fluidized bed combustion boiler solid separation system
- Superheaters
- Economizers
- Reheaters
- Convective backpass
- Internal and external heat exchangers
- Fuel and sorbent feeding systems
- Air feeding and distribution system
- Bottom ash handling and extraction system
- Combustors of circulating fluidized bed boilers
- Cyclones of circulating fluidized bed boilers
- Circulating fluidized bed boiler process flow diagrams
- Status of the technology
- Operational performance
- Efficiencies
- Availability and reliability
- Operational flexibility
- Fuel flexibility
- Environmental performance
- Plant Sizes
- Steam conditions
- Design variants

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- Applications
- Developments in circulating fluidized bed combustion
- Furnace design
- Furnace dimensions
- Lower furnace designs
- Solid separation systems
- Cyclones
- Impact separators
- Sidewall membrane panels
- Optimized arrangement of solid separators
- External heat exchangers
- Scale-up
- Advanced circulating fluidized bed steam cycle with once-through boiler technology
- Availability and reliability
- Fluidized bed ash coolers
- Co-combustion
- Conclusions
- Status of circulating fluidized bed technology
- Operational performance
- Applications
- Recent developments in circulating fluidized bed combustion technology
- Scaling-up
- Advanced steam cycle with once-through boiler technology
- Other developments
- Oxy-fuel circulating fluidized bed combustion technology
- Oxy-circulating fluidized bed boiler design challenges
- Developments in oxy-circulating fluidized bed combustion
- Performance and costs
- Oxy-pulverized coal versus oxy-circulating fluidized bed boilers
- Methods used to improve the heat rate of circulating fluidized bed boilers
- Supercritical Once-Through Internal Recirculation-Circulating Fluidized Bed Boilers (IR-CFB) Boilers for Power Generation
- IR-CFB Technology
- Segmented U-beam particle separators
- Proven design features
- High solid collection efficiency
- Controlled furnace temperature
- Low auxiliary power
- Uniform gas flow
- High solid separator reliability
- Minimal refractory use

- Low maintenance
- Dynamic load change
- Wide turndown ratio
- Operating experience
- Reduced diameter zone (RDZ) design for erosion protection at the upper refractory edge
- New commercial projects
- Arrangement of circulating fluidized bed boilers
- New developments in circulating fluidized bed design
- 300 MW IR-CFB boiler
- Supercritical once-through circulating fluidized bed with in-bed heat exchanger (IBHX)
- Internal Bed Heat Exchanger
- Supercritical once-through circulating fluidized bed design study
- Water and steam circuitry
- Flue gas path
- Reheat temperature control
- In-bed heat exchanger development
- In-bed heat exchanger design
- Open-bottom bed drain system
- Conclusions
- Ultra supercritical circulating fluidized bed boilers
- Efficient combustion and fuel flexibility
- Low Inherent NOX emissions at 50 – 200 Mg/NM3
- Low SO2 emissions with 95 – 98% sulfur removal
- Product specifications

CIRCULATING FLUIDIZED BED BOILERS

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Frequently Asked Questions (FAQs)

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2. Where is PowerEdge based?

PowerEDGE is headquartered in Singapore but we run our training programmes in different venues around Asia.

3. What does PowerEdge do?

We are a Power & Utilities Training Specialist.

4. Can this course be done in our city?

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5. Can you reduce the price of our preferred course?

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6. Can you change the dates of the course?

If you have a special requested date, let us know and we will arrange another session for you.

7. Who are the companies that will be participating?

This varies from a diversity of Power Operators, Regulators, Financiers, to Vendors in the Power & Utilities industry.

8. Where is the venue for the course?

We usually engage a 4 to 5 star hotel meeting room to ensure the comfort of our participants.

9. How many delegates should we expect for each course?

This varies from 15 to 20 participants. Class sizes are kept small to allow trainers to focus better on each participant.

10. What are the different payment modes?

We accept Visa/MasterCard, cheques, bank transfers and cash on site.

11. Is accommodation included when I sign up for a course?

Accommodation is not included in the course fee but we are always happy to advise on available accommodations.

12. Can I get a cheaper accommodation through PowerEdge?

We will be pleased to help you negotiate a better rate with hotels.

13. Is lunch provided during the course?

We provide lunch and 2 tea breaks every day during our training programmes.

14. Are the training materials included once I have signed up for a course?

Yes, training and course materials are included in the course fee.

15. Will there be a certificate for the course?

Yes, there will be a certificate of participation upon completion of a course.

16. Who are PowerEdge trainers?

They are expert consultants and practitioners with many years of experience in the subject matter that they deliver on.

17. Are PowerEdge trainers competent?

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18. Can PowerEdge assist with Visa travel applications?

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19. Can we purchase training materials without attending a course?

Unfortunately this option is not available as training materials are specially developed for courses.

20. Can course content be tweaked to cater to our needs?

Of course! Just let us know your request and we will get the trainer to assist in carrying it out.

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