Optimization of Combined Cycle Power Plants using Advanced Technology Gas Turbines

The course is taught by Professor Meherwan P. Boyce, P.E., C.Eng., who has been teaching for the past 43 years, and is in great demand for his lectures and books, and contribution to various handbooks throughout the world. Dr. Boyce's courses are in high demand due to his deep understanding of combined cycle power plant technologies and his ability to weave real-world applications and examples into each topic. He brings to his courses 50 years of practical application as a consultant on forensic problems around the world and his considerable design talent of various turbomachinery components he has brought to the various OEMs.

The course deals with the design and general operation and maintenance characteristics of gas and steam turbines in a combined cycle power plant with emphasis on the major plant components, and the performance of the plant. Overall design and operation concepts along with basic operation and maintenance problems for the various pieces of TurboMachinery (gas turbines, steam turbines, and boiler feed water pumps) are discussed. Discussions and design parameters of the Heat Recovery and Steam Generating (HRSG) systems, the feed water heaters and the condensers are also included.

Planned Optimization of the Combined Cycle Plant, for maximum efficiency and power is emphasized throughout the course. Cycle efficiency and part load characteristics are discussed in depth.

An emphasis is placed on providing practical information with minimal theory. This part of the course is aimed at engineers and operational personnel who need a broad-based introduction to practical optimization, operation and design considerations of a major combined cycle power plant. Discussion throughout the course especially of plant problems and optimization by the participants with the instructor and amongst themselves is encouraged so as to maximize the course experience.

Attendees are encouraged to bring or send in advance problems from their plants to discuss at the course. Interactive format allows for attendee discussion and extensive feedback from Dr. Boyce.
Course Topics

- Power Augmentation
- Cycle Analysis
- Performance & Mechanical Equipment Standards
- Axial Flow Compressors & Turbines
- Combustors & Fuels
- Advanced Gas Turbine Characteristics
- Metals Metallurgy & Coatings
- Steam Turbine & HRSG Technology
- Condensers & Feed Water Pumps
- Instrumentation & Condition Monitoring
- Power Plant Test Codes
- Computing Performance
- Real World Case Studies of Combined Cycle Power Plants

TESTIMONIALS OF SOME ENGINEERS WHO HAVE ATTENDED OUR RECENT WORLDWIDE COURSES ON COMBINED CYCLE POWER PLANTS:

Dr. Boyce is like a gold mine of knowledge you'll get an answer for almost any question you have.
Pablo Alvarez
GE Energy Products, France (2010)

Very comprehensive, very detailed, lots of good information, excellent course and speaker.
Mark Higgen
Calpine Corporation, Pasadena, Texas (2010)

This course covers the basic fundamentals and then dives into the details including engineering, theory, equipment design, operation techniques, and practical improvements. Regardless if you’re a young engineer or seasoned specialist, you leave with much more knowledge and understanding than you came with.
Corey Thoe
ConocoPhillips, Sweeney, Texas (2010)

Excellent, informative, speaker with a huge depth of knowledge.
Sandra Barry
Sasol Technology, South Africa (2009)

This course is fundamental to all engineers working in a simple gas cycle field and those interested to go to combined cycle.
Mohammed Aljohani
King Abdulaziz University, Saudi Arabia (2009)

Excellent grounding of the fundamentals of CCGT.
Andrew Underwood
Scottish & Southern Energy PLC
Scotland (2009)
The personal experience and well recognized knowledge of Dr. Boyce make this course worth doing.
Manuel de la Sota
CEPSA, Huelva, Spain (2008)

The course material is highly appropriate. The wealth of knowledge that Dr. Boyce brings to the course makes it actionable.
Ryan Brown

I strongly recommend this course; you can see new designs and refresh case studies and performance computation for combined cycle power plants.
José Ortiz
PDVSA Venezuela (2008)

By attending this lecture I could have a good chance to extend my knowledge about combined power plants and see the whole picture of plant manufacture and operation management.
Jeongseog Oh
Seoul National University, Seoul Korea (2008)

I strongly recommend this course; you can see new designs and refresh case studies and performance computation for combined cycle power plants.
José Ortiz
PDVSA Venezuela (2008)

It is an excellent course for plant engineers on combined cycle and gas turbine fundamentals.
Sanh Tram

I like his style and his consummate command of the subject lifetime of expertise that he still devotes to students.
Tim McConnell
Dept. of Law Civil Division (RAPA) AG Anchorage, Alaska, U.S.A.(2007)

This was an excellent course! My requirement was that I get up to speed on combined cycle technology, applications and performance calculations. The program far exceeded my expectations.
Douglas Deay

COURSE MATERIALS
• Special notes will be provided and a copy of the ASME Steam Tables.

COURSE SCHEDULE & COSTS
This course is divided into three parts. The first part deals with design and general operation characteristics of Gas Turbines, HRSG and Steam Turbines in a Combined Cycle Power Plant; the second part examines the operation and maintenance of the plant; the third section relates to the Computations of Performance Augmentation of a Combined Cycle Power Plant and the Characteristics of the Various Major Plant Components

GAS TURBINE ENGINEERING HANDBOOK, 4TH EDITION

Published date November 2011

Written by the field’s most well-known expert, Professor Meherwan P. Boyce, P.E. (US), Chartered Engineer (UK)

At a time when energy costs have reached their highest this important handbook written by an experienced engineer, expertly guides plant engineers to operate their plants with maximum efficiency and high availability.

The most complete and up-to-date reference in the field, this definitive handbook covers every aspect of gas turbine design and operation. Users will find thorough treatment of gas turbine installation, operation and maintenance (including important chapters on optimizing efficiency and reliability), as well as useful technical details on sizing, layout, fuel selection, types of drives, performance characteristics, rotor balancing techniques, lubricating practices, coupling, alignment, spectrum analysis, compressor testing and maintenance procedures.

For design engineers, there is comprehensive coverage of cycles, rotor dynamics, bearings and seal design, compressor and turbine aerodynamics and design parameters (blade and shaft stresses, blade loadings, material integrity), foundation design, vibration, gears, materials, combustion, control systems and other instrumentation, fuel washing systems, lubrication systems and selections pertaining to API gas turbine equipment.

This book is organized in five major parts:

Part I details the basic principles of the gas turbine with chapters on fundamental design criteria, cycle types, compressor and turbine performance characteristics, mechanical equipment standards, and rotor dynamics.

Part II is an in-depth treatment of major turbomachinery components. Centrifugal and axial-flow compressors, radial-inflow and axial flow turbines and various combustion configurations are all described.

Part III examines construction materials and fuels. Specific topics in the materials chapter are metallurgical behaviors (creep and rupture, ductility and fracture, thermal fatigue, corrosion), blade and wheel alloys, ceramics and coatings. In the fuel chapter, specifications, properties and treatment (fuel washing and component cleaning) are principal topics.
Part IV contains chapters on bearings, seals and gears.

Part V discusses the key elements of operations and maintenance. The chapters include lubrication (oil systems, filter systems), spectrum analysis (vibration measurement and interpretation), balancing (methods and procedures), couplings and alignment, (coupling types, failure modes, shaft alignment), compressor testing (piping arrangements, data acquisition, procedures) and maintenance (reliability improvement, cleaning, foundation repair, typical problems). Numerous illustrations complete each part.

Part VI is an extensive treatise on the many problems associated with the Gas Turbine Power Plants and some of the solutions that have achieved higher efficiencies and reliability. This chapter explains in depth the problems encountered and fully illustrates the many failures encountered in Gas Turbine Power Plant applications.
The author, Professor Meherwan P. Boyce, P.E. (US), Chartered Engineer (UK), discusses design, fabrication, installation, operation, and maintenance. Many illustrations, curves, and tables are used throughout the text. Special features include: comparison of various energy systems; latest cycles and power augmentation techniques; reviews and benefits of the latest codes; detailed analysis of available equipment; descriptions of all major equipment in CCPP; techniques for improving plant reliability and maintainability; testing and plant evaluation techniques; and advantages and disadvantages of fuels.

This handbook discusses the design, fabrication, installation, operation, and maintenance of Combined Cycle Power Plants. This reference covers all major aspects of power plant design, operation, and maintenance. It covers cycle optimization and reliability, technical details on sizing, plant layout, fuel selection, types of drives, and performance characteristics of all major components in a cogeneration or combined cycle power plant.

The book has been written to provide an overall view for the experienced engineer working in a specialized aspect of the subject and for the young engineering graduate or undergraduate student who is being exposed to the field of power plants for the first time. The book has proven to be very useful as a textbook for undergraduate and graduate courses as well as for in-house company training programs related to power generation.

The book covers the following major topics:

**Part I** introduces the reader to the latest platforms used in Power Development as well as techniques such as Carbon Sequestration Technology, for the reduction of the carbon footprint. Other chapters included in this section covers the many cycles that are being used in Power Generation, and the various performance and Mechanical Equipment Standards.

**Part II** In this section are included various chapters each covering a major piece of equipment used in the Combined Cycle Power Plant such as: Gas Turbines, Steam turbines, Boiler Feed water Pumps, Heat Recovery Steam Generators, Condensers and Cooling Towers, Generators and Electric Switch Gears. In the Second Edition in the Heat Recovery Steam Generators chapter an extensive sections on the Chemical Treatment of the water used in Combined Cycle Power Plants has been added.
Part III chapters in this section cover the various auxiliaries in individual chapters such as Fuels, Fuel Piping, and Fuel Storage; Bearing Seals, and Lubrication systems; and Control Systems and Condition Monitoring systems.

Part IV in this section there are two chapters the first covering Performance Testing of a Combined Cycle Power Plant, and the second chapter covers Maintenance Techniques. Power Industry has in the past eight years embraced the Combined Cycle Power Plants and with the new high efficiency Advanced Gas Turbines are at the center of this growth segment of the industry.

Part V this is a new Chapter and has been introduced as, Chapter 15, “Case Histories of Problems Encountered in Cogeneration and Combined Cycle Power Plants”. This is an extensive treatise on the many problems associated with the Combined Cycle Power Plants and some of the solutions that have achieved higher efficiencies and reliability. This chapter explains in depth the problems encountered, and with 145 figures fully illustrates the many failures encountered in Cogeneration and Combined Cycle Power Plant applications.

The use of Cogeneration and Combined Cycle Power Plants in all industries, and in the power generation field, has mushroomed in the past few years. It is to these users and manufacturers of Cogeneration and Combined Cycle Power Plants that this book is directed. This book serves both as an introduction to the broad subject of Combined Cycle Power Plants as well as a reference text.
Short Bio-Data

Dr. Meherwan P. Boyce

Professor Meherwan P. Boyce, PhD, P.E., C.Eng (UK), is the managing Partner of The Boyce Consultancy Group, LLC. He is a Fellow ASME (USA), IMechE(UK) & IDGTE(UK); NAFE (USA). He is also a Registered Professional Engineer in the State of Texas and a Chartered Engineer in the United Kingdom. He has 50 years of experience in the field of TurboMachinery in both industry and academia. He is presently and for the past 15 years been Chairman of The Boyce Consultancy Group, LLC. His past experience covers 20 years as Chairman and CEO of Boyce Engineering International Inc., founder of Cogen Technologies Inc., and five years as a designer of compressors and turbines for gas turbines for various gas turbine manufacturers. His academic experience covers a 15 year period, which includes the position of Professor of Mechanical Engineering at Texas A&M University and Founder of the TurboMachinery Laboratories and The TurboMachinery Symposium, which is now in its fortieth year. He is the author of several books such as the Gas Turbine Engineering Handbook (Fourth Edition, Elsevier), Cogeneration & Combined Cycle Power Plants (Second Edition, ASME Press), and Centrifugal Compressors, A Basic Guide (PennWell Books). Professor Boyce is a contributor to several Handbooks; his latest contributions are to the Perry’s Chemical Engineering Handbook Seventh and Eight Editions (McGraw Hill) in the areas of Transport and Storage of Fluids, and Gas Turbines, ASME’s Energy and Power Generation Handbook, and A Handbook on Combined Cycle Systems for near-zero emission power generation. Dr. Boyce has taught over 150 short courses around the world attended by over 3000 students representing over 400 Corporations. He is chair of ASME PTC 55 Aircraft Gas Turbine Committee which is writing the specifications for the testing of aircraft gas turbines. He is also a member of the ASME Ethics Review Board. He is a Consultant to the Aerospace, Petrochemical and Utility Industries globally, and is a much-requested speaker at Universities and Conferences throughout the world.

Dr. Boyce is Past Chairman of the Plant Engineering & Maintenance Division of ASME, the ASME Conferences Committee and the Electric Utilities Committee of the of ASME’s International Gas Turbine Institute. Dr. Boyce was the pioneer of On-Line Condition Based Performance Monitoring. He has developed models for various types of Power Plants and Petrochemical Complexes. His programs are being used around the world in Power Plants,
Offshore Platforms, and Petrochemical Complexes. He is a consultant for Major Airlines in the area of Engine Selection, Noise and Emissions.

Dr. Boyce has authored more than 150 technical papers and reports on Gas Turbines, Compressors Pumps, Fluid mechanics, and TurboMachinery, and is a holder of several U.S. Patents. Dr Boyce has been honored by being appointed to membership of the following scholarly honorary societies such as Sigma Xi, Pi Tau Sigma, Phi Kappa Phi, and Tau Beta Phi. He is the recipient of the ASME Herb Allen award for Excellence in Aerodynamics and the Ralph Teetor Award of SAE for enhancement in Research and Teaching. In 2002 Dr Boyce was chairman of two major conferences the Advanced Gas Turbine and Condition Monitoring Conference sponsored by DOE and EPRI, and the Gas Turbine Users Associations Conference. He continues to be a consultant for these two organizations.

Dr. Boyce is also on the Board of Advisors for the Department of Aerospace and Mechanical Engineering, University of Oklahoma; the Board of Advisors for the TurboMachinery Symposium, Texas A& M University; the Industrial Advisory Board of the Department of Computer Science, Southwest Texas State, the Advisory Board of University of Texas Health Center, and Chair of the University of Texas Advisory Council Dental Branch. Dr. Boyce is Chairman of the “Virtuosi of Houston” a Premier Youth Chamber Orchestra, and past President of the Houston Galveston Stavanger Sister Cities Society. He is President of the Board of Directors of the Trade Winds/Beach Club Condominiums Owners Association in Galveston, Texas, and was also past Vice President of the Board of Directors of The Huntington Council of Co-Owners, Houston, Texas. He is also a Founder Director of the World Zoroastrian Chamber of Commerce, and is still Vice President of the World Zoroastrian Organization. He is the Holder of the Bharat Scout (India’s equivalent to the Eagle Scout) and a Member of the Board of Directors Sam Houston Area Council, Boy Scouts of America.

Dr. Boyce received a B.S. (1962) and M.S. (1964) in Mechanical Engineering from the South Dakota School of Mines and Technology and the State University of New York, respectively, and a Ph.D. in (Aerospace & Mechanical engineering) in 1969 from the University of Oklahoma.