

Gas Turbine And Ccgt Conceptual Plant Design A Refresher

Gas Turbine And Ccgt Conceptual Plant Design A Refresher Gas Turbine and CCGT Conceptual Plant Design A Refresher 1 Gas turbines and combined cycle gas turbine CCGT plants play a crucial role in modern power generation Offering high efficiency low emissions and quick startup capabilities these technologies contribute significantly to global energy demands This document serves as a refresher on the key principles of gas turbine and CCGT plant design focusing on the conceptual aspects 2 Gas Turbine Basics A gas turbine is a type of internal combustion engine that converts the chemical energy of fuel into mechanical energy through a series of stages involving compression combustion and expansion 21 Components Compressor Compresses ambient air increasing its density and temperature Combustion Chamber Combusts fuel typically natural gas with the compressed air generating hightemperature highpressure gases Turbine Extracts energy from the expanding combustion gases driving the compressor and an external load Exhaust System Discharges the remaining combustion gases to the atmosphere 22 Operating Principles Brayton Cycle Gas turbines operate on the Brayton cycle which involves four thermodynamic processes adiabatic compression constantpressure heat addition adiabatic expansion and constantpressure heat rejection Efficiency The efficiency of a gas turbine is primarily determined by its pressure ratio ratio of outlet to inlet pressure of the compressor and the turbine inlet temperature Higher pressure ratios and higher temperatures generally result in higher efficiencies 3 Combined Cycle Gas Turbine CCGT Plants 2 CCGT plants combine the high efficiency of gas turbines with the heat recovery potential of steam turbines significantly improving overall efficiency 31 Components Gas Turbine As described in Section 2 Heat Recovery Steam Generator HRSG Recovers heat from the gas turbine exhaust to generate steam Steam Turbine Extracts energy from the steam to generate electricity Condenser Condenses the steam after it has passed through the steam turbine 32 Operating Principles Combined Cycle The exhaust gases from the gas turbine are used to heat water in the HRSG producing steam This steam drives the steam turbine generating

additional power Higher Efficiency The CCGT cycle achieves higher efficiency due to the utilization of waste heat from the gas turbine improving the overall energy conversion process 4 Conceptual Plant Design 41 Plant Layout Site Selection Factors considered include proximity to fuel sources transmission lines and water resources Layout Optimization Designing a layout that minimizes piping runs maximizes equipment accessibility and ensures safe operation is crucial Modular Design Using preengineered and modular components can significantly reduce construction time and costs 42 Major Equipment Selection Gas Turbine Selection based on power output efficiency emissions and operating conditions HRSG Selection based on steam parameters heat recovery efficiency and operating conditions Steam Turbine Selection based on steam parameters power output and efficiency Cooling System Selection based on water availability cooling requirements and environmental considerations 43 System Integration Control System Integrating the gas turbine HRSG steam turbine and cooling systems to ensure reliable and efficient operation 3 Instrumentation and Monitoring Ensuring proper monitoring and control of critical plant parameters Safety Systems Implementing safety features to mitigate potential hazards and ensure safe operation 5 Key Considerations for Conceptual Design 51 Performance Power Output Matching the plant output to the power demand of the grid Efficiency Optimizing plant design to achieve high thermal efficiency and reduce fuel consumption Emissions Meeting regulatory requirements for emissions of pollutants such as NOx CO and SOx 52 Economics Capital Costs Balancing the cost of equipment construction and site preparation Operating Costs Minimizing fuel consumption maintenance and operating expenses Financial Viability Ensuring a profitable return on investment 53 Environment Emissions Control Employing technologies for minimizing air pollution and greenhouse gas emissions Water Consumption Minimizing water usage for cooling and other operations Noise Reduction Implementing noise mitigation measures to minimize community impact 6 Conclusion Conceptual plant design for gas turbine and CCGT plants requires a thorough understanding of the underlying technologies performance requirements economic considerations and environmental impacts By carefully addressing these aspects it is possible to develop efficient reliable and environmentally friendly power generation facilities that meet the growing energy demands of the world

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combined power plants

this volume provides detailed analysis of the basic thermodynamics and economic implications of combined power plants it includes details of developments in europe the usa and japan and should

be useful to practising engineers policy makers and students in mechanical engineering

this thesis deals with modelling and performance enhancements of a gas turbine combined cycle power plant a clean and safe energy is the greatest challenges to meet the requirements of green environment these requirements given way the long time governing authority of steam turbine st in the world power generation and gas turbine gt and its combined cycle ccgt will replace it therefore it is necessary to predict the characteristics of the ccgt system and optimize its operating strategy by developing a simulation system several configurations of the gt and ccgt plants systems are proposed by thermal analysis the integrated model and simulation code for exploiting the performance of gas turbine and ccgt power plant are developed utilizing matlab code new strategies for gt and ccgt power plant s operational modelling and optimizations are suggested for power plant operation to improve overall performance the effect of various enhancing strategies on the performance of the ccgt power plant two shaft intercooler regenerative reheat and multi pressure heat recovery steam generator hrsg based on the real gt and ccgt power plants an extensive thermodynamic analysis of the modifications of the most common configuration s enhancements has been carried out the performance code for heavy duty gt and ccgt power plants are validated with the real power plant of baiji gt and marafiq ccgt plants the results have been satisfactory the simulating results show that the reheated gt has a higher power 388mw while the higher thermal efficiency occurs in the regenerative gt 52 with optimal pressure ratio and turbine inlet temperature the performance enhancing strategies results show that the higher power output occurs in the intercooler reheat gt strategy 404mw furthermore the higher thermal efficiency 56 9 and lower fuel consumption 0 13kg kwh occur in the intercooler regenerative reheat gt strategy the analyses of the hrsg configurations show that the maximum power output 1238mw occurred in the supplementary triple pressure with reheat ccgt while the overall efficiency was about 56 6 the intercooler reheat ccgt strategy has higher power output 1637mw and the higher overall thermal efficiency 59 4 and lower fuel consumption 0 047kg kwh occur with the regenerative reheat ccgt strategy the simulation result shows that the proposed gt system improved 19 of thermal efficiency and 22 of power output in addition the proposed ccgt system improved 4 6 of thermal efficiency for and 22 5 of power output the

optimization result shows that the optimum power 1280mw and the overall thermal efficiency 65 of the supplementary triple pressure with reheat ccgt therefore the optimization procedure is reasonably accurate and efficient thus the operation conditions and ambient temperature are strongly influenced on the overall performance of the gt and ccgt the optimum efficiency and power are found at higher turbine inlet temperatures it can be comprehended that the developed models are powerful tools for estimating the overall performance of the ccgt plants the energy and exergy analysis models for the gt and ccgt plants are highly recommended for predicting them performance based on inlet air cooling system

combined cycle technology is used to generate power at one of the highest levels of efficiency of conventional power plants it does this through primary generation from a gas turbine coupled with secondary generation from a steam turbine powered by primary exhaust heat generating power at high efficiency thoroughly charts the development and implementation of this technology in power plants and looks to the future of the technology noting the advantages of the most important technical features including gas turbines steam generator combined heat and power and integrated gasification combined cycle igcc with their latest applications reviews key developments in combined cycle technology uses examples drawn from plants around the world looks at how combined cycle technology can evolve to meet future energy needs

primarily this book describes the thermodynamics of gas turbine cycles the search for high gas turbine efficiency has produced many variations on the simple open circuit plant involving the use of heat exchangers reheating and intercooling water and steam injection cogeneration and combined cycle plants these are described fully in the text a review of recent proposals for a number of novel gas turbine cycles is also included in the past few years work has been directed towards developing gas turbines which produce less carbon dioxide or plants from which the co2 can be disposed of the implications of a carbon tax on electricity pricing are considered in presenting this wide survey of gas turbine cycles for power generation the author calls on both his academic experience at cambridge and liverpool universities the gas turbine laboratory at mit and penn state university and his industrial work primarily with rolls royce plc the book

will be essential reading for final year and masters students in mechanical engineering and for practising engineers

combined cycle gas turbines ccgt play a major role in power generation since they combine the gas turbine cycle with the steam turbine cycle which are capable of reaching efficiencies as high as 60 this publication looks at the thermodynamic and engineering approach based on the first and second laws of thermodynamics and is adopted in the development of a mathematic model using microsoft excel program for the design of the compressor combustor gas turbine and steam turbine as well as determining the overall efficiency and power generation capacities the model generates actual pinch point conditions to operate at ensuring the ccgt is efficient

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a selection of annotated references to unclassified reports and journal articles that were introduced into the nasa scientific and technical information system and announced in scientific and technical aerospace reports star and international aerospace abstracts iaia

this handbook offers a tool for environmental managers and environmental officers alike it contains ideas case studies and methodologies which stimulate continuous improvement thinking and help train staff to implement sustainability and environmental management concepts

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