



Enhancing the Performance of Combined Cycle Power Plants through Intake Air Cooling

By

Eng. Anas Abdel-Motaleb Ali Mostafa

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
Mechanical Power Engineering

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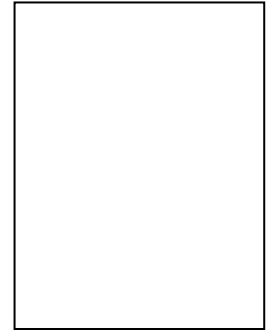
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Title of Thesis: Enhancing the Performance of Combined Cycle Power Plants through Intake Air Cooling

Key Words: Power Generation; Economical Study; Absorption Chiller; Inlet Air Cooling, Thermal Storage.

Summary:

The thesis investigates the effects of entry air cooling on the performance enhancement of combined cycle power plants. Air cooling is achieved by chilled water that obtained by either a mechanical or absorption chiller. The work is applied to 801 MW El-Kuriemat combined cycle power plant, Egypt as a case study. Thermodynamic model was developed to simulate the combined cycle before and after the integration to the proposed cooling systems. Direct data are collected from the plant. Two sets of correlations between the performance parameters and the inlet temperature are developed. The governing equations and the developed correlations are solved using Engineering Equation Solver (EES) and the results are compared with those of each other. The power plant performance without and with the proposed two air cooling systems are obtained at different ambient conditions. Net income due to the power increase and the payback period are obtained. The results of each system are compared with that obtained by the other one as well as the similar results available in the literature. Using the chiller cooling system to reduce the ambient temperature of 30.5 to 15 °C and 100% relative humidity could increase the instantaneous net output power by 8.6 %, and 11% for mechanical and absorption chillers, respectively. The payback periods are 3.3 and 3.85 years for mechanical and absorption chillers, respectively. The internal rate of return is 30.63 % and 25.91%, years for mechanical and absorption chillers, respectively. The net present value is 8.28 and 6.24 MUS\$ for mechanical and absorption chillers, respectively. The total electric energy increase is 190,228 MWh/year and the net cash flow is 2.64 MUS\$/year obtained after using the mechanical system while the corresponding values produced after using the absorption system are 181,994 MWh/year and the net cash flow 2.38 MUS\$/year.

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"They said, glory to you, we have no knowledge except what you have taught us, indeed you are the all-knowing and the all-wise", Al-Baqara, verse 32

"And of knowledge, you (mankind) have been given only a little", Al-Isra', verse 85

DEDICATION

*To my father .. my backbone in my life .. who gives me
direction and support to the sky*

To my mother who gives me lovely life

To my wife who shines my heart

To my brothers and sister who gives me support

TABLE OF CONTENTS

ACKNOWLEDGMENT	I
DEDICATION	II
TABLE OF CONTENTS	III
LIST OF TABLES	VI
LIST OF FIGURES	VIII
NOMENCLATURE AND ABBREVIATIONS	XII
ABSTRACT	XV
CHAPTER 1: INTRODUCTION	1
1.1 General Overview.....	1
1.2 Problem Statement.....	2
1.3 Electrical Energy Demand and Generation Mix in Egypt.....	4
1.4 Thesis Outlines.....	5
CHAPTER 2: ELECTRIC POWER GENERATION AND ENTRY AIR COOLING	6
2.1 Worldwide Production of Electricity.....	6
2.2 History and Background of Electricity in Egypt.....	7
2.3 Gas Turbine.....	7
2.3.1 Factors That Affect Gas Turbine Performance	10
2.3.2 Performance Enhancements.....	10
2.4 Steam Turbine.....	10
2.5 Combined Cycle.....	11
2.6 Entry Air Cooling Methods.....	12
2.6.1 Evaporative Cooling.....	12
2.6.2 Fogging Cooling	13
2.6.3 Mechanical Chillers Cooling.....	15
2.6.4 Absorption Chillers Cooling	16

2.6.5 Thermal Energy Storage (TES)	18
CHAPTER 3: LITERATURE REVIEW	20
3.1 Introduction.....	20
3.2 Improving Performance by Switching to Combined Cycle.....	20
3.3 Evaporative Cooling.....	21
3.4 Fog Cooling	21
3.5 Mechanical Chiller.....	23
3.6 Absorption Chiller.....	24
3.7 Refrigeration Cooling with Thermal Storage.....	25
3.8 Multiple Cooling.....	28
3.9 Comparing Techniques of Improving the Performance of Power Plants.....	30
3.10 Thesis Objectives.....	33
CHAPTER 4: ENERGY ANALYSIS.....	34
4.1 Brayton Cycle of Gas Turbine Power Plants.....	34
4.2 Rankine Cycle of Steam Turbine Power Plant.....	37
4.3 Combined Cycle Power Plants.....	38
4.4 Case Study: El-Kuriemat Combined Cycle Power Plant.....	41
4.5. Solution Procedures.....	44
4.5.1 Gas turbine parameters calculations without cooling.	45
CHAPTER 5: COMBINED CYCLE INTEGRATED WITH CHILLER COOLING SYSTEM.....	51
5.1 Principle of Operation.....	51
5.2 Cooling Load Calculation.....	53
5.3 Weather Data.....	56
5.4 Chiller Size Selection.....	59
5.5 Thermal Energy Storage (TES) System.....	60
5.6 Gas Turbine Parameters Calculations.....	62
CHAPTER 6: RESULTS AND DISCUSSION.....	68
6.1 Effect of Cooling on Air and Fuel Mass Flow Rates.....	69
6.2 Mechanical Chiller (MC).....	70

6.2.1 The Effect of Changing Electricity Tariffs.....	78
6.2.2 The Effect of Changing Fuel Price.....	79
6.2.3 The Effect of Discount Rate.....	80
6.3 Absorption Chiller (AC).....	81
6.4 Comparison Between the Effects of Mechanical and Absorption Chillers.....	90
6.5 Comparison Between the Present Work and Published Previous Works.....	101
6.5.1 Mechanical Chiller.....	101
6.5.2 Mechanical Chiller Versus Evaporative Cooling.....	103
6.5.3 Absorption Chiller.....	104
CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK.....	106
7.1 Summary.....	106
7.2 Conclusions	107
7.3 Recommendations for Future Work.....	107
REFERENCES.....	108
APPENDIX A: Climate Profile Temperature for the El-Kuriemat Site Through 2016...	114
APPENDIX B: Chillers Selection.....	117
APPENDIX C: Actual Data of El-Kuriemat Power Plant	122
APPENDIX D: Mechanical Chiller Results.....	125
APPENDIX E: Absorption Chiller Results.....	131
APPENDIX F: Electricity Sale Prices in Egypt.....	135
APPENDIX G: Engineering Equation Solver (EES).....	136

LIST OF TABLES

Table Number

1.1: Total installed capacity of electric power plants in Egypt at 2014/2015 [21].....	5
2.1: Worldwide electricity production during year 2016 [24].....	6
4.1: The ISO data of the combined cycle power plant of El-Kuriemat, Egypt [4].....	44
6.1: Results of Combined Cycle without cooling.....	71
6.2: Results of Combined Cycle parameters with cooling by mechanical chiller system	72
6.3: The capital cost of the mechanical chiller cooling system [97].....	76
6.4: Economic analysis of using mechanical chiller.....	77
6.5: Energy enhancement due to cooling of Gas Turbine by absorption chiller system..	81
6.6: Energy enhancement due to cooling of Combined Cycle by absorption chiller system.....	82
6.7: The capital cost of the absorption chiller inlet air-cooling system [97].....	88
6.8: Economic analysis of using absorption chiller.....	89
6.9: Comparison between the mechanical chiller results and previous work.....	102
6.10: Comparison between the present results of mechanical chiller and previous work of evaporative cooling.....	103
6.11: Comparison between the absorption chiller results and previous work.....	105
B.1: Mechanical Chiller.....	117
B.2: Absorption Chiller.....	119
C.1: Power, efficiency, compression ratio, and ambient temperature at 13/1/2013.....	122
C.2: Power, efficiency, compression ratio, and ambient temperature at 24/10/2013...	122
C.3: Power, efficiency, fuel mass flow rate, ambient temperature, and gas mass flow rate at 15/8/2013.....	123
C.4: Power, efficiency, fuel mass flow rate, ambient temperature, and gas mass flow rate at 17/6/2014.....	123
C.5: Power, efficiency, fuel mass flow rate, ambient temperature, and gas mass flow rate at 7/6/2014.....	124
C.6: Power, efficiency, fuel mass flow rate, ambient temperature, and gas mass flow rate at 12/8/2013.....	124
D.1: Results of GT without cooling.....	125

D.2: Results of GT parameters with cooling by mechanical chiller system.....	126
D.3: Energy enhancement due to cooling of Gas Turbine by mechanical chiller system	127
D.4: Energy enhancement due to cooling of Combined Cycle by mechanical chiller system.....	128
D.5: Effect of cooling on Gas Turbine efficiency by mechanical chiller system.....	129
D.6: Effect of cooling on Combined Cycle efficiency by mechanical chiller system....	130
E.1: Results of GT parameters with cooling by absorption chiller system.....	131
E.2: Results of Combined Cycle parameters with cooling by absorption chiller system	132
E.3: Effect of cooling on Gas Turbine efficiency by absorption chiller system.....	133
E.4: Effect of cooling on Combined Cycle efficiency by absorption chiller system.....	134

LIST OF FIGUERS

Figure Number

1.1: Relation between ambient temperature and GT performance parameters [4].....	2
1.2: Screen Shot from El-Kuriemat power plant that displays the effect of ambient temperature on gas turbine performance [4].....	3
1.3: Gross generated energy (GWh) in Egypt during the period 2011/2012 - 2015/2016[17-21].....	4
2.1: Gas turbine engine components [5].....	8
2.2: Performance of Gas turbine engines; (a) Simple cycle; (b) combined cycle [2]..	9
2.3: A sketch of combined cycle power plant [38].....	11
2.4: Effect of compressor inlet temperature on engine characteristics [2].....	12
2.5: A sketch of evaporative Cooling system [47].....	13
2.6: Variation of power increase due to evaporative cooling [36].....	14
2.7: A sketch of Fogging cooling system [49].....	15
2.8: Mechanical chiller flow diagram.....	16
2.9: Flow diagram of LiBr absorption chiller [51].....	17
2.10: Flow diagram an absorption refrigeration cycle [52].....	18
2.11: Flow diagram of a chiller system with thermal energy storage [51].....	19
3.1: A sketch of the power plant flow diagram considered by Ameri et al. [83].....	26
3.2: The flow diagram of the power plant considered by Venkateswararao et al. [84]	27
3.3: Flow diagram of a gas turbine with a chiller system [85].....	28
4.1: Simple gas turbine cycle [91].....	34
4.2: T-S diagram of simple gas turbine cycle [91].....	35
4.3: Flow diagram of simple Rankine cycle [91].....	37
4.4: T-S diagram of simple Rankine Cycle [91].....	38
4.5: Flow diagram of the combined cycle power plant [91].....	39
4.6: T-S diagram of combined cycle power plant [91].....	40
4.7: Location of El- Kureimat combined cycle power plant, Egypt [4].....	41
4.8: Flow diagram of the combined cycle power plant of El-Kuriemat, Egypt [4]...	42
4.9: Steam turbine data of El-Kuriemat power plant [4].....	43
4.10: Heat recovery steam generator data of El-Kuriemat power plant [4].....	43

4.11: Power-temperature profile at different compression ratio.....	45
4.12: Thermal efficiency-temperature profile at different compression ratio.....	46
4.13: Power-temperature profile at different turbine inlet temperature.....	47
4.14: Thermal efficiency-temperature profile at different turbine inlet temperature..	47
4.15: Power-temperature profile at different turbine efficiency.....	48
4.16: Thermal efficiency-temperature profile at different turbine efficiency.....	48
4.17: Power-temperature profile at different compressor efficiency.....	49
4.18: Thermal efficiency-temperature profile at different compressor efficiency.....	50
5.1: Flow diagram of El-Kuriemat power plant integrated with chiller cooling system and thermal storage tank.....	52
5.2: The air cooling process on psychometric chart.....	55
5.3: Variation of cooling load with dry-bulb and relative humidity [76].....	56
5.4: Distribution of average dry-bulb during 2016 at El-Kuriemat site [16].....	57
5.5: Distribution of average relative humidity during 2016 at El-Kuriemat site [16].	57
5.6: Distribution of dry bulb temperature and relative humidity during 21 st of July, 2016 [16].....	58
5.7: Monthly average dry bulb temperature and relative humidity during 2016 [16].	59
5.8: Thermal Energy Storage System through 21 st of July 2016.....	61
5.9: Output power generated from one gas turbine in comparison with the manufacturer expected results.....	64
5.10: Actual efficiency of the gas turbine in comparison with the manufacturer expected results.....	64
5.11: Power-temperature profile for Siemens gas turbine V94.3A2 [4].....	65
5.12: Efficiency-temperature profile for Siemens gas turbine V94.3A2 [4].....	66
5.13: Power-temperature profile for Siemens gas turbine.....	67
5.14: Efficiency-temperature profile for Siemens gas turbine.....	67
6.1: Relation between air mass flow rate and temperature over months during 2016.....	69
6.2: Relation between fuel mass flow rate and temperature over months during 2016.....	70

6.3: Relation between cooling load system and power output with and without cooling using mechanical chiller over the months during 2016.....	73
6.4: Combined cycle power output without cooling and net power with cooling using mechanical chiller over the months during 2016.....	73
6.5: The plant thermal efficiency with and without cooling over the months during 2016.....	74
6.6: The heat rate of the combined cycle with and without cooling over months during the year 2016.....	75
6.7: The cost and income when using mechanical chiller	77
6.8: Sensitivity analysis of the effect of electricity tariff on the payback period of using mechanical chiller	78
6.9: Sensitivity analysis of the effect of fuel tariff on the payback period of mechanical chiller.....	79
6.10: Sensitivity analysis of the effect of discount rate on the discounted payback period of mechanical chiller	80
6.11: Relation between cooling load system and power output with and without cooling using the absorption chiller over months during 2016.....	83
6.12: Combined cycle power output without cooling and net power with cooling over months during 2016.....	84
6.13: Relation between plant thermal efficiency with and without cooling over months during 2016.....	85
6.14: Distribution of absorption chiller steam mass flow rate and temperature over months during the year 2016.....	86
6.15: Distribution of cooling load system and steam turbine power decrease with increasing extraction over the months during 2016.....	86
6.16: Distribution of heat rate with and without cooling over months during 2016.	87
6.17: Cost and income when using the absorption chiller.....	88
6.18: Distribution of the net enhanced power with MC and AC during 2016.....	90
6.19: Distribution of cooling system consumption power used by mechanical and absorption chillers over the months during 2016.....	91
6.20: Distribution of gross power when using mechanical and absorption chillers over the months during 2016.....	92

6.21: Distribution of net energy gained when using mechanical and absorption chillers over the months during 2016.....	93
6.22: Distribution of the thermal efficiency when using mechanical and absorption chillers over the months during 2016.....	94
6.23: Distribution of heat rate when using mechanical and absorption chillers over the months during 2016.....	95
6.24: Initial cost of the mechanical and absorption chillers	96
6.25: Distribution of the extra energy annual income when using mechanical and absorption chillers over the months during 2016.....	97
6.26: Running cost of using mechanical and absorption chillers during 2016.....	98
6.27: Net income when using mechanical and absorption chillers during 2016.....	99
6.28: Pay-back period when using mechanical and absorption chillers	100
A.1: Temperature profile during January.....	114
A.2: Temperature profile during February.....	114
A.3: Temperature profile during March.....	114
A.4: Temperature profile during April.....	114
A.5: Temperature profile during May.....	115
A.6: Temperature profile during June.....	115
A.7: Temperature profile during July.....	115
A.8: Temperature profile during August.....	115
A.9: Temperature profile during September.....	116
A.10: Temperature profile during October.....	116
A.11: Temperature profile during November.....	116
A.12: Temperature profile during December.....	116