



Faculty of Manufacturing Engineering

**STUDY AND ANALYSIS THE IMPACT OF TEMPERATURE IN
TURBINE ROOM ON THE PERFORMANCE OF WORKERS IN
POWER STATIONS**

Ahmed Ali Ajmi

Master of Science in Manufacturing Engineering

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**STUDY AND ANALYSIS THE IMPACT OF TEMPERATURE IN TURBINE
ROOM ON THE PERFORMANCE OF EMPLOYEES IN POWER STATIONS**

AHMED ALI AJMI

**A thesis submitted
in fulfilment of the requirements for the degree of Master of Science
in Manufacturing Engineering**

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2016

DECLARATION

I declare that this thesis entitled “Study and Analysis the Impact of Temperature in Turbine room on the performance of employees in power stations Case Study in Al-Dora power station / Iraq” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :
Name : Ahmed Ali Ajmi
Date : 05 / 07 / 2016

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Industrial Engineering).

Signature :
Supervisor Name : Dr.Seri Rahayu bint Kamat
Date : 05 / 07 / 2016

DEDICATION

I dedicate my thesis work to my family. A special feeling of gratitude to my wife, who words of encouragement and push for tenacity ring in my ears. This thesis work is dedicated to my parents, for their endless love, support and encouragement along my life. To my beloved kids: Mohammed, Lina and Rzan. To my beloved sisters, whom I cannot force myself to stop their love. To all my family, the symbol of love and giving. My friends who encourage and support me. I dedicate this thesis.

ABSTRACT

Environmental ergonomics deals with the effect of environmental factors on human health, comfort and performance. This day-to-day interaction between humans and environment affects performance and productivity of employees in various industries. Indoor temperature is one of the fundamental characteristics of the indoor environment. The work environment has an effect on the performance of workers. The thermal work environment in various sectors will determine the way in which such enterprises prosper. The main problem in this study is the effects of the high temperature of the turbine room on the workers performance at Al-Dora power station in Iraq, because there are many of power stations in Iraq are suffering from reduced in the performance of workers in the turbine rooms due to the high temperature emitted from the turbine and equipment located inside the turbine room. The objective of the study to investigate the temperature effects in the turbine room and equipment on the workers performance and then analyze model framework which will evaluate workers who are suffering from the bad environment in AL-Dora power station. Primary data have been generated through structured questionnaires with close-ended questions by the survey in Iraqi Ministry of Electricity (AL- Dora power station). Statistical Package for the Social Sciences (SPSS) has been used to test the research hypotheses. The sample for this study include the (workers, operators, technicians, and engineers) who work in the turbine rooms at AL-Dora power station are 226 respondents, representing 100% of the target population. This study has been used two types of tools SPSS software the first type was a parametric test like the correlations, mean, standard deviation, regression analysis, histograms, P-P plot and moderation tool. While the second type of test was non-parametric tests like Mann-Whitney U test and Kruskal-Wallis H test. This research is the first study of its kind in the Iraqi Ministry of Electricity to investigate the factors and temperature that affecting on workers performance in turbine room in Iraq, and considered very important and has economic feasibility. Therefore, this study will help the Iraqi Ministry of Electricity to improve performance in turbine room. Results revealed that the temperature inside the turbine room as a moderation has the direct effect of the variables (performance pressure, bad environment, work area, turnover intention) that had direct and significant effects on worker performance which points out to the importance of using methods to reducing the temperature in turbine room and thus increase the performance of workers.

ABSTRAK

Alam Sekitar yang Egonomik adalah berkaitan kepada kesan alam sekitar terhadap kesihatan, keselesaan dan prestasi manusia. Interaksi harian diantara manusia dan alam sekitar memberi kesan kepada prestasi dan produktiviti pekerja dalam pelbagai industri. Suhu dalaman adalah salah satu ciri-ciri asas persekitaran tertutup. Persekitaran kerja mempunyai kesan ke atas prestasi pekerja dimana persekitaran kerja yang selesa dalam pelbagai sektor akan menentukan cara di mana perusahaan itu berjaya. Masalah utama dalam kajian ini adalah berpunca daripada kesan suhu yang tinggi di dalam bilik turbin yang mana prestasi pekerja di stesen kuasa Al-Dora di Iraq berkurangan. Pengurangan prestasi pekerja dalam bilik turbin ini disebabkan oleh suhu yang tinggi yang dipancarkan dari turbin dan peralatan yang terletak di dalam bilik turbin. Objektif utama didalam kajian ini adalah untuk menyiasat kesan suhu di dalam bilik turbin dan peralatan kepada prestasi pekerja, menganalisis rangka kerja model yang akan menilai pekerja yang mengalami persekitaran yang buruk dalam stesen kuasa AL-Dora. Data primer telah dihasilkan melalui kaedah soal selidik yang soalnya berstruktur dengan kajian Kementerian Elektrik (stesen kuasa AL- Dora) di Iraq. Program Statistik untuk Sains Sosial (SPSS) telah digunakan untuk menguji hipotesis kajian. Sampel kajian adalah seramai 226 responden yang mewakili 100% daripada populasi sasaran di stesen kuasa AL-Dora yang terdiri daripada pekerja, operator, juruteknik dan jurutera. Didalam kajian ini dua jenis perisian telah digunakan iaitu perisian alat SPSS untuk mengujian parametrik seperti korelasi, min, sisihan piawai, analisis regresi, histogram, P-P plot dan alat sederhana. Manakala jenis kedua adalah ujian bukan parametrik seperti ujian Mann-Whitney U dan ujian Kruskal-Wallis H. Dalam kajian ini perkataan pekerja merujuk kepada pekerja yang bekerja di dalam bilik turbin termasuk (operator, jurutera, juruteknik dan pekerja) di stesen Power AL-Dora. Kajian ini adalah kajian pertama seumpamanya di Kementerian Iraq Elektrik untuk menyiasat faktor dan suhu yang memberi kesan kepada prestasi pekerja dalam bilik turbin di Iraq. Kajian ini adalah dianggap sangat penting dan mempunyai daya maju ekonomi untuk negara Iraq. Hasil dapatan daripada kajian ini akan membantu Kementerian Iraq Elektrik untuk meningkatkan prestasi dalam bilik turbin. Hasil kajian juga telah menunjukkan bahawa suhu di dalam bilik turbin penyederhanaan mempunyai kesan langsung kepada pembolehubah (tekanan prestasi, persekitaran yang buruk, kawasan kerja, perolehan niat) yang mempunyai kesan yang agak besar ke atas prestasi pekerja. Oleh yang demikian pengurangan suhu di dalam bilik turbin perlu diperbaiki dalam meningkatkan prestasi pekerja.

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LIST OF ABBREVIATIONS

KP	Kelo Pascal
Temp	Temperature to comparative measure of hot or cold
AAT	Ambient Air Temperature
WBGT	Wet-Bulb Globe Temperature
SPSS	Statistical Package for the Social Sciences
ISO	International Standards Organization
MOE	Ministry of Electricity
CO ₂	Carbon Dioxide
NO ₂	Nitrogen Dioxide
IV	Independent Variables
DV	Dependent variables
TRA	Theory of Reasoned Action
PP	Performance Pressure
PE	Bad Environment
WP	Worker performance
WA	Work Area
TI	Turnover Intention
GT	Gas Turbine
KW	Kilowatts
MW	Megawatt
P	Pressure

°F	Scales of temperature by Fahrenheit
°C	Scales of temperature by Celsius
V	Volume
OPF	Optimal Power Flow

LIST OF PUBLICATIONS

The following publications have been achieved by this research work:

Journals:

1. **Ahmed Ali Ajmi**, Seri Rahayu Kamat, Noor Shakir Mahmood, (2016),“ Analysis of the Results Effects of Temperature in the Turbine Rooms on the Performance of Workers in the Power Stations”, *MAGNT RESEARCH REPORT* (ISSN. 1444-8939), Vol.4 (2). PP. 65-74. **(ISI)**.
2. Seri Rahayu Kamat, **Ahmed Ali Ajmi**, Noor Shakir Mahmood " THERMAL COMFORT AT THE TURBINE ROOM IN THE POWER STATION: A SYSTEMATIC REVIEW", *Journal of Advanced Manufacturing Technology (JAMT)* ISSN: 1985-3157 (2016).
3. Noor Shakir Mahmood, Seri Rahayu Kamat, **Ahmed Ali Ajmi**, (2016), “Increase the Performance of Power Station: Results and Analysis of an Empirical Study of the ISO 50001 Energy Management Systems in the Iraqi Ministry of Electricity”, *MAGNT RESEARCH REPORT* (ISSN. 1444-8939), Vol.4 (2). PP. 75-86. **(ISI)**.
4. Seri Rahayu Kamat, Noor Shakir Mahmood, **Ahmed Ali Ajmi** "REVIEW AND ESTABLISHING FRAMEWORK MODEL TO ADOPTION ISO 50001 ENERGY MANAGEMENT SYSTEM IN POWER STATIONS", *Journal of Advanced Manufacturing Technology* (ISSN: 1985-3157) 2016.

CHAPTER 1

INTRODUCTION

1.1 Introduction

With the increasing population growth around the world, and thus the demand for electricity also increased dramatically. Consequently, many countries have started using the techniques and efficient plants in the production of energy, including gas turbine stations to produce energy (Barelli and Ottaviano, 2015).

Several gas turbines are being widely used for power generation in several countries all over the world. Obviously, many of these countries have a wide range of climatic conditions, which impact the performance of gas turbines. These countries are beginning to move towards the use of gas turbines to produce electricity because of the low maintenance cost compared to thermal stations and easy installation as well as reduced infrastructure requirements. In addition, it has a high capacity for energy production (Giampaolo, 20014).

The gas turbines design is based on International Standards Organization (ISO) 3977 conditions which specify the following air inlet conditions:

- I. Air temperature 15°C.
- II. Relative humidity 60%.
- III. Absolute pressure (sea-level) 101.325 kP (Brun and Moore 2002).

According to Zeng et al. (2010) depending on the ISO standards, if increased the air temperature above (15 °C) the gas turbine turbines will lose rate between 5 to 10 percent of their efficiency (Zeng et al. 2011).

The gas turbines are capable to achieve 65 percent efficiency if the air temperature increases inside the turbine, Some factors which lead to their improve efficiency or in other words some technologies which improve gas turbines performance are reducing internal losses, and also reducing the inlet air temperature of compressor to ISO condition (Al-Ibrahim and Avraham, 2010).

Theory of turbine gas depends on "The Brayton cycle" which describes what happens to air as it passes throughout the gas turbine. The Brayton cycle usually describes the relationship between the space occupied by the air in the system called volume, and the pressure,. According to a "Brayton cycle" in turbine gas the air enters the compressor through filters rooms for disposal of dust and impurities, the air pressure inside the compressor is equal to atmospheric pressure and about 1 bar according to the Brayton Cycle in Mechanical Engineering Brayton cycle (Singh et al., 2014). Figure 1.1. Shows the principle of Brayton cycle in the turbines gas.

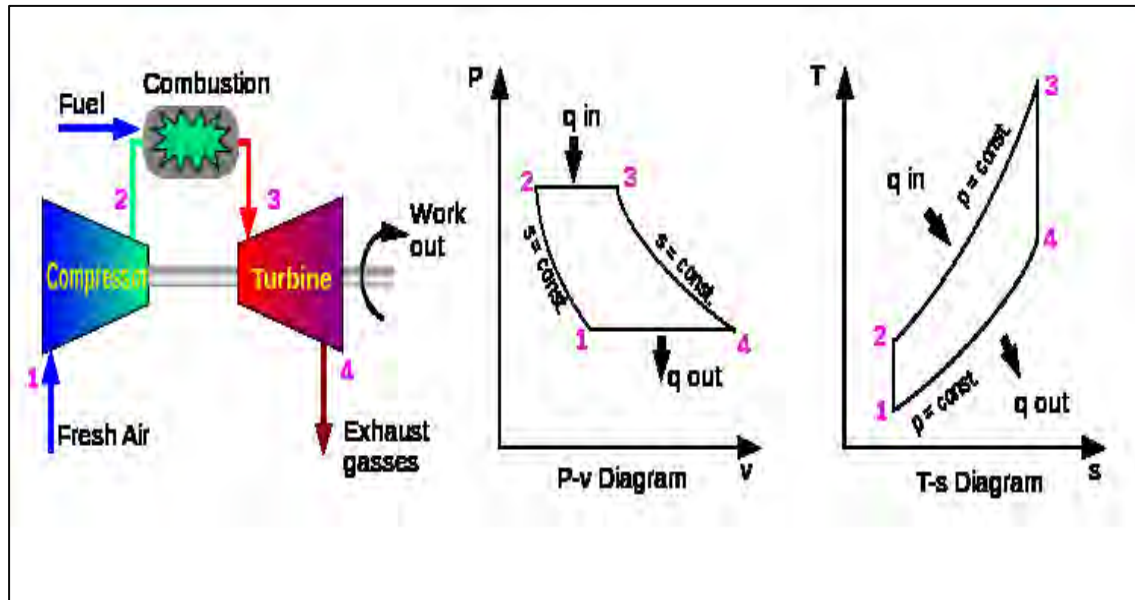


Figure 1.1: Brayton cycle (Singh et al., 2014).

In the gas turbine instead of boiler generating gasses to high temperature and pressure as in the thermal plant, a gas turbine uses a compressor to increase the pressure of air. Fuel is then added to the high-pressure air in the combustion chamber to increase its temperature. The high temperature and pressure gasses are then expanded in the turbine to do the mechanical work. The mechanical work is converted into electricity using the generator. The schematic of a gas turbine is shown in Figure 1.2.

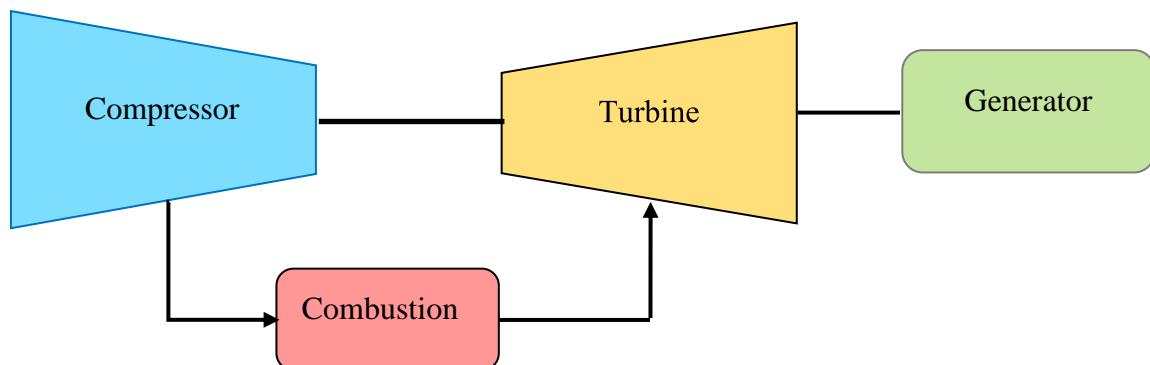


Figure 1.2: Gas turbine plant (Andersson et al., 2016).

The temperature rise in the industrial sectors in general and in the electricity sector particular has a common effect on performance. Any rise in air temperature of the gas turbine which will help in the combustion process will reduce the efficiency of the energy produced and then increase the temperature of the turbine room (Andersson et al., 2016). The increase in the temperature of the turbine room that resulted from the turbine has a negative effect on the performance of workers in the power plants, and thus affects the overall performance of the power station.

The performance of workers in power plants is very important to increase the level of productivity and then increase output power. The conditions of the working environment in most of the power stations are not up to the optimum desired health standards, such as poorly designed workstations, lack of ventilation, performance pressure and the air temperature in the turbine room (Morrow et al., 2014).

In addition, these factors can play important roles in increasing or decreasing productivity and this relationship has attracted a large number of researchers who globally investigate this issue. Thus, productivity can obviously influence the overall performance of any power plants. Temperature could influence productivity indirectly through its impact on the performance. However, for cost-benefit calculations it is most feasible to use the available data linking directly temperature, or thermal state, to productivity. Seppänen et al. (2003) studied a relation between performance and temperature. They showed that the performance will decrease by 2% for each one °C with an increase of the temperature in the range of 28-32 °C, and no effect on performance in the temperature range of 21-28 °C. The data for this research has been gathered from a questionnaire from employees working at AL- Dora power station in Iraq.