

# CONTENTS

Title	page No.
الآية.....	I
Dedication.....	II
Acknowledgment.....	III
Abstract.....	VII
تجريد.....	VIII
List of Table.....	IX
List of Figure.....	IX
Nomenclature.....	XI
List of Appendix.....	XI
<b>Chapter One: Introduction</b>	
1.1 Background.....	2
1.2 Heat Exchanger Types.....	3
1.2.1 Shell-and-Tube Heat Exchanger (STHE).....	3
1.2.2 Plate Heat Exchanger (PHE).....	3
1.2.3 Open-Flow Heat Exchanger.....	4
1.2.4 Contact Heat Exchanger.....	4
1.3 Condenser.....	5
1.3.1 Classification of Condenser.....	5
1.3.1.1 Jet Condenser.....	6
1.3.1.2 None Mixing Type or Surface Condensers.....	7
1.3.1.3 Evaporative Condenser.....	9
1.4 Research Objectives.....	11
1.5 Research Methodology.....	11
<b>Chapter Two: Literature Review</b>	
2.1 Introduction.....	14
2.1.1 Improve the Performance of The Condenser in The Thermal Power Station.....	14
2.1.2 Design of Steam Condenser.....	15
2.1.3 Cooling Tower Problems in Sudan.....	16
2.1.4 The Effect of Steam Pressure In the Performance of BAHRI Thermal Station and How to Control It.....	17
2.1.5 Effect of Turbine Backpressure on Steam Cycle Efficiency.....	18
2.2 Relation Between Literature Review and Our Research.....	19

<b>Chapter Three: Condensers</b>	
3.1 Functions of Condensers.....	21
3.2 Condenser Components and their Functions.....	22
3.2.1 Shell.....	22
3.2.2 Hotwell.....	23
3.2.3 Tube Sheets.....	23
3.2.4 Tubes.....	24
3.2.5 Water box.....	24
3.2.6 Baffles.....	25
3.2.7 Air Pump.....	25
3.2.7.1 Steam Jet Air Ejector.....	26
3.2.7.2 Vacuum Pump.....	27
3.3 Condensate Pump.....	28
3.4 Type of Condensate Pump.....	29
3.4.1 Boiler Feed Pump.....	29
3.4.2 Sump Pump.....	29
3.4.3 Circulating Pump.....	30
3.5 Atmospheric Relief Valves.....	30
3.6 Cooling Tower.....	31
<b>Chapter Four: Condenser Problems</b>	
4.1 Background.....	35
4.2 Trouble-Shooting Condenser Problems.....	36
4.2.1 Fouling.....	36
4.2.2 Air Binding Problems.....	37
4.2.3 Air-Removal Equipment Problems.....	38
4.2.3.1 Poor Vacuum.....	38
4.2.3.2 Gradual Loss of Vacuum.....	40
4.2.3.3 High Outlet Water Temperature.....	40
4.2.3.4 Faulty Operation of the Steam Jet Air Ejectors..	41
4.2.3.5 Problems with Liquid Ring Vacuum Pumps (LRVPs).....	42
4.2.4 Water In-Leakage Effects.....	43
4.2.4.1 Abnormal Water Level of Condenser (Rise).....	44
4.3 Solution of problems.....	46
4.3.1 General Principles of Maintenance.....	46
4.3.2 Condenser On-Line Cleaning Systems.....	47
4.3.2.1 Sponge Ball System.....	47
4.3.2.2 Brush and Cage System.....	49
4.3.3 Mechanical Off-Line Cleaning Systems.....	51
4.3.3.1 Air/Water-Driven Systems.....	52
4.3.3.2 Mechanically Driven Systems.....	53
4.3.3.3 Pressure-Driven Systems.....	53
4.3.4 Air In-Leakage Effects.....	54

4.3.4.1 Correcting Air In-Leakage.....	55
4.3.4.2 Piping Repair or Replacement.....	55
4.3.5 Water In-Leakage.....	56
4.3.5.1 Water In-Leakage Detection Methods.....	56
4.3.5.2 Correcting Water In-Leakage.....	57
4.3.6 Chemical Cleaning.....	58
4.4 Calculations.....	58
<b>Chapter Five: Conclusion and Recommendation</b>	
5.1 Conclusion.....	62
5.2 Recommendation.....	62
<b>Reference</b> .....	64
<b>Appendix</b> .....	65

## **Abstract**

A steam power plant continuously converts the energy stored in fuels into rotate shaft work and ultimately into electricity. Energy released by burning of fuel is transferred to water in the boiler to generate steam, which then expands in turbine to produce rotate shaft work. The steam leaving the turbine is condensed into water in the condenser. This research aims at tracking the condenser problems in steam turbine efficiency it is include identification condenser function and full analysis for condenser problems. Also the research inspected the condenser effect in steam plant efficiency and solve these problems and we take PHASE II from BAHRI thermal power station (UNITE III) as study case also finding the relationship between the vacuum and heat transfer and efficiency The analysis of these data show that any increase in condenser pressure is followed by a decrease in the thermal efficiency of the unite.

## تجريد

محطات توليد الطاقة تقوم باستمرار بتحويل الطاقة المخزونة في الوقود الي شغل في عمود الدوران و أخيرا الي كهرباء.الطاقة المحررة بواسطة حرق الوقود تنتقل إلي المياه في المرجل لتوليد البخار، وبعد ذلك يتمدد في التوربين لإنتاج شغل في عمود الدوران، البخار المغادر التوربين يتكاثف إلي ماء في المكثف.هذا البحث يهدف إلى معرفة مشاكل المكثف في كفاءة التوربين البخاري فهو يتضمن دراسة المكثف والتعرف علي أجزائه وأنواعه في محطات القدرة الحرارية وكذلك دراسة المشاكل التي تؤثر علي أداء المكثف وإيجاد الحلول لها وقد اخذ المرحلة الثانية من محطة بحري الحرارية (الوحدة الثالثة) كحاله للدراسة، كما تطرق البحث إلي إيجاد العلاقات بين كل من ضغط الفراغ وانتقال الحرارة و الكفاءة. و استنتج من هذه الدراسة إن أي زيادة في ضغط المكثف يتبعه انخفاض في الكفاءة الحرارية للدورة .

## List of Table:

<b>Table No</b>	<b>Table title</b>	<b>Page No</b>
1.1	show the period of activities of the methodology.	12
4.1	Typical Off-Line Cleaning Methods and Their Effectiveness table.	51
4.2	show the data and calculation.	59

## List of Figure:

<b>Figure No</b>	<b>Figure title</b>	<b>page No</b>
1.1	General power plant.	2
1.2	Shell and tube heat exchanger (STHE).	3
1.3	Condenser in steam turbine.	5
1.4	Two pass surface condenser	7
1.5	Down and central flow Surface condenser	8
1.6	Evaporative condenser	10
3.1	Typical power plant Condenser	22
3.2	Typical steam jet air ejector	26
3.3	Show the vacuum pump for BAHRI STATION PHASE III	28

3.4	Flat port type liquid ring vacuum pump	28
3.5	Boiler feed pump BAHRI STATION PHASE III	29
3.6	Schematic of cooling tower	32
3.7	Atmospheric cooling tower	33
3.8	Mechanical draught (forced) cooling tower	33
4.1	Trouble-shooting problems with LRVs	42
4.2	Condenser diagnostics flowchart (Source: Han Moy, consolidated Edison of New York).	45
4.3	Typical ball cleaning system	48
4.4	Typical arrangement for a brush and cage tube cleaning system	50
4.5	Typical water bristle brushes	53
4.6	Water gun for brushes and scraper	53
4.7	Mechanically driven brush	53
4.8	Typical water lance heads	54
4.9	Relation between vacuum & efficiency	60

## Nomenclature:

Symbol	Description
$C.W_o$	Cooling water outlet
$C.W_i$	Cooling water inlet
$m_s$	Main steam flow
$\theta_1$	Temperature difference between exhaust steam and cooling water inlet
$\theta_2$	Temperature difference between exhaust steam and cooling water outlet
LMTD	Log mean temperature deference
$C_{p_w}$	Water heat specific at const pressure
TET	Turbine Exhaust Temperature
$Q$	Quantity of cooling water
$v$	Specific volume

## List of Appendix:

Appendix	Subject
1	Khartoum North Thermal Power Station
2	PHASE II condenser
3	PHASE III condenser doors side
4	PHASE II condensate pump
5	Cleaning balls
6	Changed tubes in PHASE III
7	The calculation in Excel sheet