PREVENTIVE MAINTENANCE FOR EFFECTIVE OPERATION OF BOILERS IN KUWAIT INDUSTRY

BY

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ABSTRACT

There have been several studies on heat transfer surfaces, where air and water temperatures are elevated by the heat transfer from other media. This research presented a new approach which entails a preventive maintenance technique, for improving the boiler efficiency, analysed using a specific methodology and literature data. A high boiler efficiency can be achieved, using an optimal approach of the preventive method, with an optimisation technique. Particularly in the State of Kuwait, steam boilers used to be more in numbers, and in some industries, breakdown and failures during the operation have been found. Therefore, in these cases, some additional care is required on such studies; a preventive maintenance technique is a suitable approach for the boilers used in the oil and gas industries in Kuwait. This approach has numerous advantages that make this technique helpful for any plant size. Most of the oil and gas industries in Kuwait are significant, and this approach will be cost-effective and efficient for large industries. When the plant assets value is high, the return will be high, and while using this approach, the proper maintenance helps to keep the high boiler performance, even for the old system. The results obtained showed that, the preventive maintenance is essential not only for improving the production rate of the industry, it also helps to make the boilers safe for the operators to work there. Based on the analysis conducted, it was revealed that, the preventive maintenance reduces the operating costs by preventing boiler failures. The research further recommended that, the results produced in the present thesis proved the benefits of the preventive maintenance for a high boiler efficiency in oil and gas industries in the State of Kuwait.

ملخص البحث

توجد هناك العديد من الدراسات حول أسطح نقل الحرارة، حيث ترتفع درجات حرارة الهواء والماء عن طريق نقل الحرارة من الوسائط الأخرى. يقدم هذا البحث طريقة جديدة تنطوي على تقنية الصيانة الوقائية لتحسين كفاءة المرجل (الغلاية)، وتحليلها باستخدام منهجية محددة وبيانات الدراسات السابقة. يمكن تحقيق كفاءة المرجل العالية باستخدام النهج الأمثل للطريقة الوقائية بتقنية التحسين. على وجه الخصوص في دولة الكويت، تكون الغلايات البخارية عادةً أكثر من حيث العدد، وفي بعض الصناعات تم العثور على أعطال وإخفاقات أثناء التشغيل. لذلك، هناك حاجة إلى بعض العناية الإضافية في مثل هذه الدراسات؛ تقنية الصيانة الوقائية هي طريقة مناسبة للغلايات المستخدمة في صناعات النفط والغاز في الكويت. يتمتع هذا الأسلوب بالعديد من المزايا التي تجعل هذه التقنية مفيدة لأي حجم لمحطة توليد الطاقة. تعتبر معظم صناعات النفط والغاز في الكويت مهمة، وستكون هذا الطريقة فعالةً من حيث التكلفة وفعالةً للصناعات الكبيرة. عندما تكون قيمة أصول المصنع عالية، سيكون العائد مرتفعًا، وأثناء استخدام هذه الطريقة، تساعد الصيانة المناسبة في الحفاظ على أداء المرجل عالياً، حتى بالنسبة للنظام القديم. أظهرت النتائج التي تم الحصول عليها أن الصيانة الوقائية ضرورية ليست فقط لتحسين معدل الإنتاج في الصناعة، بل تساعد أيضًا في جعل الغلايات آمنة للمشغلين. بناءً على التحليل الذي تم إجراؤه، تم الكشف على أن الصيانة الوقائية تقلل من تكاليف التشغيل من خلال منع أعطال الغلايات. كما أوصى البحث بأن النتائج التي تم التوصل إليها في هذه الأطروحة أثبتت فوائد الصيانة الوقائية لكفاءة المرجل العالية في صناعات النفط والغاز في دولة الكويت.

APPROVAL PAGE

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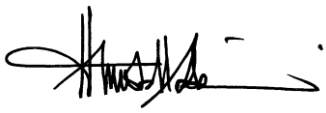

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DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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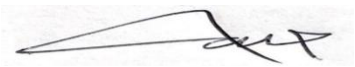

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Signature Date

This thesis is dedicated to my parents and family, for their endless support, love and encouragement throughout this study

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In the Name of Allah, the Most Compassionate, the Most Merciful

Allah - beginning with the name of - the Most Gracious, the Most Merciful Most Auspicious is He in whose control is the entire Kingship; and He is able to do all things [67:1]. All Praise be to Allah, the Lord of the creation, and countless blessings and peace upon our Master Mohammed, the leader of the Prophets.

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LIST OF ABBREVIATIONS

AEC	Architecture, Engineering and Construction
AHP	Analytical Hierarchy Process
BCMPs	Best Co-Management Practices prioritisation
BIM	Building Information Modelling
BMPs	Best Management Practices
GBC	Green Building Construction
KW	Kilowatt
HR	Human Resource
MAUT	Multi Attribute Utility Technique
MCDM	Multiple-Criteria Decision-Making
SPSS	Statistical Package for the Social Sciences
PMBOK	Project Management Body of Knowledge

LIST OF SYMBOLS

psi	pascals
kw	kilowatt
t	temperature
p	pressure
ρ	density

CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW

The word boilers, as the name suggests, are hot water or steam generating and dispenser units, where the hot water and the steam are supplied and passed through the pipes for heating, or the process included in the use. A boiler is a closed metal vessel or chamber that is designed in such a way that, the chemical energy used as the fuel can be utilized well as a heating element and used as a heating and other power-related instrument. The said process can be achieved if the water is heated above its tolerance limit and desired atmospheric pressure and temperature. After reaching the desired temperature and its threshold limit, the boiler supplies the required type of steam under pressure and vacuum to the process and hence can be called the water into steam converter/producer. The input of a boiler could be any standardised liquid or fluid, that is later processed into the form of vapors, and the complete process can be called the evaporation process. Many fuels are used in the boiler as the firing element and work as the input/feed of the boiler that could be either fossil fuels or non-fossil fuels, but the most common fuels used as the feeds are oil, coal, and natural gases. The Kuwait industry has been studied for steam boilers and hot water boilers, and advantages and disadvantages with benefits were also considered.

1.2 BACKGROUND OF THE STUDY

In Kuwait, industrial boilers are used in food factories, oil and gas plants, oil fields, etc. A complete boiler system consists of many small units that are combined in the plant. Figure 1.1 illustrates a schematic diagram of an overall view of the boiler

system. The complete boiler system is shown with the additional add-on, and the associated internal/external units.

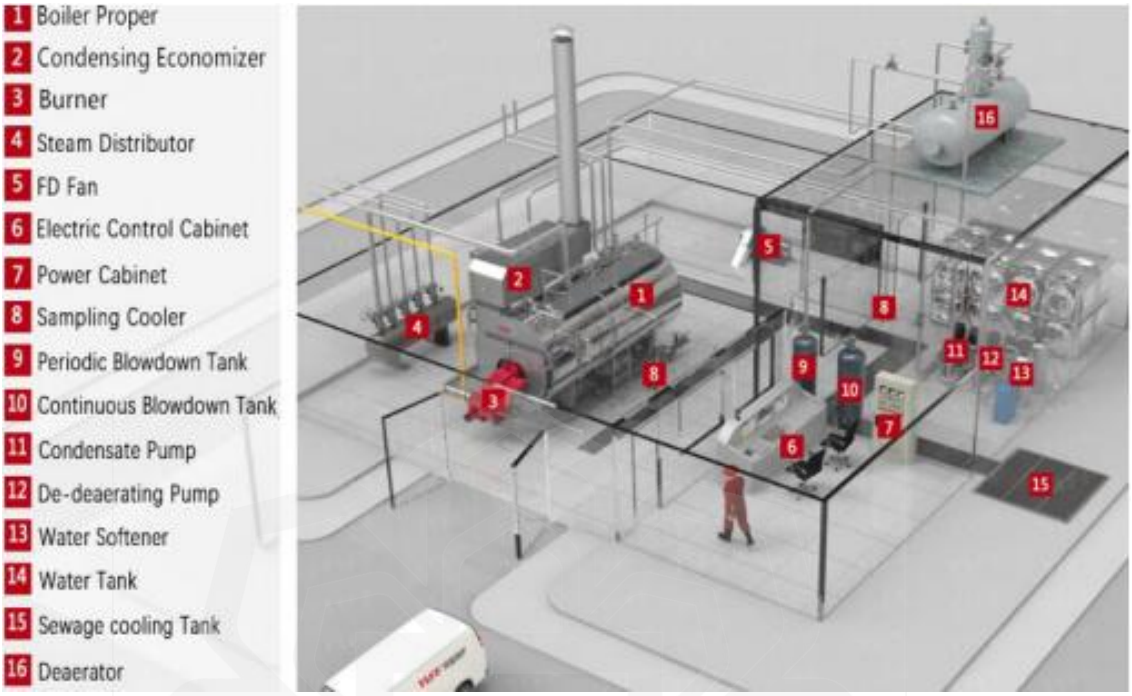

Figure 1.1 Overview of a boiler system in a plant (Gaps, 2018)

Figure 1.2 illustrates a very well-installed series of boilers in the industry. The pipes connected to the boiler are the passage of the fluid. The safety features are also present as shown in Figure 1.2, including the safety valves and different controllers.

Figure 1.2 A series of the boilers with pipes used in it (Kleva, 2009)

1.3 STATEMENT OF THE PROBLEM

Preventive maintenance is not a new topic; many studies have already been performed in this field. Conclusion: there are different methods and approaches used to find out the factors, with which, the performance of a boiler can be improved. In this research work, the main objective was to find out the various anomalies present in each method and analyses factors which play a significant role in improving the boiler efficiency. This research was based on the preventive maintenance of boilers used in different oil and gas industries in Kuwait. There are various factors which affect the efficiency of a boiler, as revealed in the literature. In Kuwait, boilers are the enormous tool used in industries to supply heat for different applications.

1.4 RESEARCH MOTIVATION

Maintenance is required for each equipment to ensure that it operates as desired. A new system can start giving deficient performance if regular maintenance and inspection are not provided. A boiler is one of the large equipment which consists of several components. Each component design is complex and requires proper care and maintenance from time to time. Several maintenance programmes are available, including corrective maintenance, pre-determined maintenance, preventive maintenance, and predictive maintenance.

One of the crucial decisions is to select the suitable type of maintenance as per the requirement. Each maintenance type incurs a different cost, which can be very costly. Therefore, it is essential to know the types of maintenance that will be required for the specific system. This study selected preventive maintenance for the boiler's efficiency improvement. In the literature review chapter, various anomalies were found and illustrated in this research work.

1.5 RESEARCH PHILOSOPHY

Kuwaiti manufacturing sectors depend on the labour force of its own and international experts and employees. Many facilities have been subcontracted to local and international firms for years. People at work come from diverse nationalities, languages, and cultures. However, most organisations do not have an induction curriculum for harmonisation, language, and professional preparation to improve the ecosystem at work. As a result, there are gaps in recognising professional roles and procedures. It is also believed that, there is no well-designed plan for the preventive maintenance of steam boilers in the Kuwaiti industry or that the current techniques for the safe and effective operation of steam boilers cannot be strictly pursued.

1.6 RESEARCH OBJECTIVE

The main contribution of this research is to study the importance of a specific maintenance programme, known as preventive maintenance. Primary and other specific objectives covered in this research work are as follows.

1- To carry out preventive maintenance of boilers used in different oil and gas industries.

2- To identify the parameters which contribute towards the decrease in the boiler efficiency.

3- To find out which factors should be included in the preventive maintenance programme, which are not yet focused on, through the literature review.

1.7 RESEARCH QUESTIONS

The research questions are listed as follows:

1. What are the parameters which contribute towards the decrease in the boiler efficiency?
2. Which factors should be included in the preventive maintenance programme?
3. According to job designation, is there any significant association in the degree of response towards preventive maintenance for efficient operations of boilers?
4. What type of features should be preventive for effective maintenance of boilers in Kuwait industry?

1.8 RESEARCH HYPOTHESIS

The hypothesis of the work is listed as follows:

1. According to the job designation, there is no significant difference in the degree of response towards preventive maintenance, for the efficient operations of boilers.
2. There is no significant association between job designation and response towards the preventive maintenance, for efficient operations of boilers.
3. The level of significance among classes of rupture is null and alternative.
4. The significance level among the factors responsible for tube failure is null and alternative.

1.9 RESEARCH SIGNIFICANCE

An efficient boiler will reduce fuel consumption and improve the overall production rate of any oil and gas industry. A suitable and low-cost maintenance technique improves the system's operating cost, while also preventing unexpected breakdowns. A good maintenance programme includes all the daily, monthly, and annual inspection, using appropriate checklists. Some components in the boilers require daily inspection, while some parts require an annual inspection. It is essential to cover all the inspections as per the requirement.

In a preventive maintenance, a systematic inspection is most likely performed. This type of inspection includes several tasks such as lubrication, cleaning, oil change, repair, adjustment of parts, etc. The cost of this maintenance approach is less than the other maintenance methods. However, there are specific parameters that this method does not cover. We aimed to find out these parameters and add them to the preventive