



**MAINTENANCE STRATEGY DEPLOYMENT OF HVAC SEMI
HERMETIC COMPRESSOR USING FAILURE MODE EFFECT
ANALYSIS PROCESS (FMEA) METHOD**



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2023



**Faculty of Mechanical and Manufacturing Engineering
Technology**

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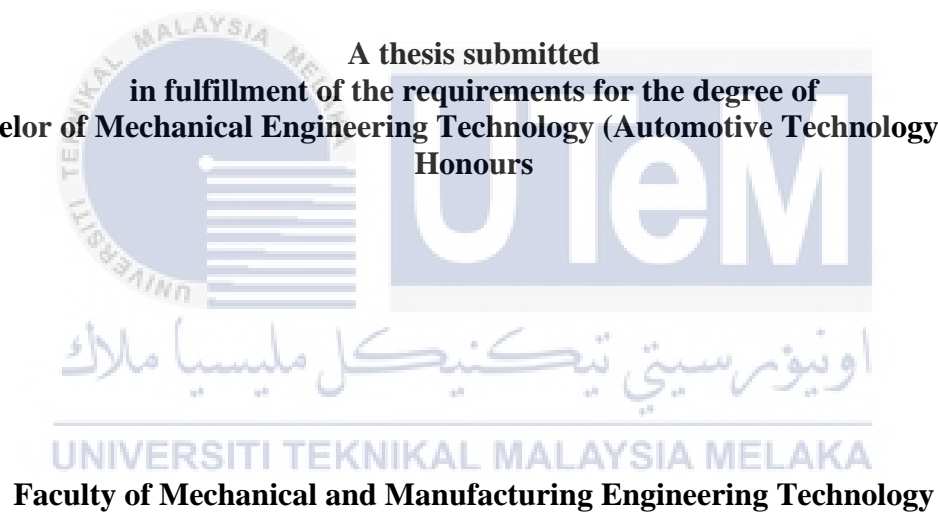
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A thesis submitted
in fulfillment of the requirements for the degree of
**Bachelor of Mechanical Engineering Technology (Automotive Technology) with
Honours**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this Choose an item. entitled “Maintenance Strategy Deployment Of Hvac Semi Hermetic Compressor Using Failure Mode Effect Analysis Process (Fmea) Method” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature



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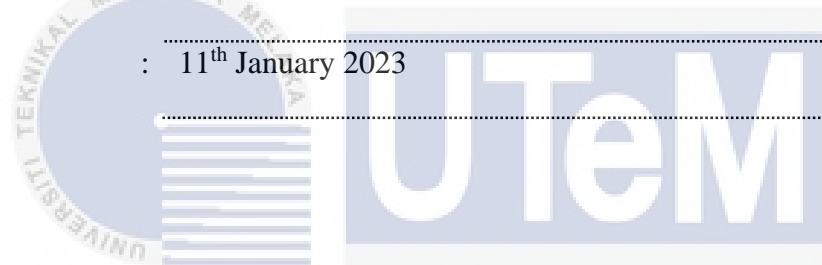
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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

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DEDICATION

I am dedicating this thesis to my parents Ibrahim Bin Mamat and Rosnani Binti Mat who give their full support through my ups and down and also to all my housemate that always there help builds my motivation up and cheer me up when i felt lost. Also, a big thanks to my project supervisor Ts. Dr. Ahmad Fuad bin Ab. Ghani and Ir. Mohd Azhar bin Shah Rizam for the guidance throughout completing this thesis and to all other UTeM lecturers. Without their dedication in teaching, I wouldn't reach until this far. Lastly, to my all-good friends, classmates and teammates through bittersweet four years' journey. Thank you I appreciate all the support and good vibe through the process.

اونيورسيتي تيكنيكل مليسيا ملاك

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ABSTRACT

Heating, Ventilation, Air Conditioning (HVAC) is a system keeps people healthy by filtering clean indoor air that and maintained the humidity levels at optimal comfort levels. The failure of the compressor results in the breakdown of the entire system. Multi criteria decision making (MCDM) focused with constructing and addressing multi criteria decisions and planning issues on to failure that occur on the compressor. In this reports, Failure Mode Effect Analysis (FMEA) was applied in order to identify the most significant failure mode using the Risk Priority Number (RPN) score. Then, the highest risk priority number score was compared between the compressor used in oil and gas platform in Terengganu with other failure occur in other wide industry application. The information identified of compressor was gathered on the maintenance reports HVAC Experts Sdn. Bhd. As a recommendation, Risk Based condition maintenance is suggested as it reduce the risk according from higher likelihood breakdown to lowest and are cost-saving.

Keyword: Semi- hermetic compressor, Hermetic compressor, FMEA Method, RPN score



ABSTRAK

Pemanasan, Pengudaraan, Penyaman Udara (HVAC) ialah sistem memastikan orang ramai sihat dengan menapis udara dalaman yang bersih dan mengekalkan tahap kelembapan pada tahap keselesaan optimum. Kegagalan pemampat mengakibatkan kerosakan keseluruhan sistem. Pembuatan keputusan pelbagai kriteria (MCDM) tertumpu dengan membina dan menangani keputusan pelbagai kriteria dan merancang isu kepada kegagalan yang berlaku pada pemampat. Dalam laporan ini, Analisis Kesan Mod Kegagalan (FMEA) telah digunakan untuk mengenal pasti mod kegagalan yang paling ketara menggunakan skor Nombor Keutamaan Risiko (RPN). Kemudian, skor nombor keutamaan risiko tertinggi dibandingkan antara pemampat yang digunakan dalam platform minyak dan gas di Terengganu dengan kegagalan lain berlaku dalam aplikasi industri yang luas. Maklumat yang dikenal pasti mengenai pemampat telah dikumpul pada laporan penyelenggaraan HVAC Experts Sdn. Bhd. Sebagai cadangan, penyelenggaraan keadaan Berdasarkan Risiko dicadangkan kerana ia mengurangkan risiko mengikut pecahan kemungkinan lebih tinggi kepada terendah dan menjimatkan kos.

Kata kunci: Pemampat separa hermetik, Pemampat hermetik, analisis FMEA, skor RPN



ACKNOWLEDGEMENTS

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

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my project main supervisor, Ts. Dr. Ahmad Fuad Bin Ab. Ghani, from Faculty Mechanical and Manufacturing, UTeM and Ir. Mohd Azhar bin Shah Rizam for all his support, advice and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered. Also, special thanks go to my Academic Supervisor Ts Khairil Amri, UTeM for all help and support I received during my study year.

Last but not least, from the bottom of my heart a gratitude to my parents Ibrahim Bin Mamat and Rosnani Binti Mat, for their encouragements and who have been the pillar of strength in all my endeavors. My respect to all my housemate, for their patience and supports. I would also like to thank my beloved parents for their endless support, love and prayers. Finally, thank you to all the individual(s) who had provided me the assistance, support, and inspiration to embark on my study.



TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF SYMBOLS AND ABBREVIATIONS	x
LIST OF APPENDICES	xi
CHAPTER 1 INTRODUCTION	12
1.1 Background	12
1.2 Problem Statement	15
1.3 Research Objective	16
1.4 Scope of Research	16
CHAPTER 2 LITERATURE REVIEW	17
2.1 Introduction	17
2.2 Background of Heating Ventilation Air-Conditioning (HVAC)	18
2.3 Basic Refrigerant Cycle	20
2.3.1 Compressor	20
2.3.2 Condenser	21
2.3.3 Expansion Valve	21
2.3.4 Evaporator	22
2.4 Research gap	22
2.5 Type of Compressors	28
2.5.1 Scroll Compressor	28
2.5.2 Screw compressor	30
2.5.3 Semi Hermetic Compressor	31
2.5.4 Hermetic Compressor	33
2.5.5 Reciprocating Compressor	34
2.6 Operating Requirements	38
2.6.1 Continuous Duty	39

2.6.2	Intermittent Duty	39
2.6.3	Emergency Duty	39
2.7	Application of Semi Hermetic and Hermetic Compressor	40
2.7.1	Application for Refrigeration in Residential Building	40
2.7.2	Application For Refrigeration in Offshore Platform	42
2.8	Maintenance of HVAC	43
2.8.1	Importance of Maintenance	43
2.8.2	Type of Maintenance	44
2.9	Risk Maintenance On Maintenance Strategy Of Compressor	47
2.9.1	Objectives of Risk Assesment	47
2.9.2	Steps in the Risk Assesment Process	47
2.10	Pressure Requirements Of HVAC Compressors Commonly Used At The Platform	50
2.11	Cause and Impact of Vibration on HVAC Compressors	51
2.12	Special Design Of Explosion-Proof HVAC Compressors For Onshore	52
2.13	Effect of High Suction And Discharge Temperature of HVAC Compressors	52
2.14	Study of caused compressor motor damage	54
2.15	Failure Mode and Effect Analysis (FMEA)	57
2.15.1	FMEA Purpose	57
2.15.2	FMEA Procedure	58
2.15.3	Identify Failure Mode	59
2.15.4	FMEA Failure Effect	60
2.15.5	FMEA Disposition	60
CHAPTER 3 METHODOLOGY		61
3.1	Introduction	61
3.2	Methodology Procedure	62
3.3	Gathering Data Analysis	63
3.4	Pareto Analysis	69
3.5	Instrumentation	71
3.6	Summary	73
CHAPTER 4 RESULTS AND DISCUSSION		74
4.1	Introduction	74
4.2	Results and Analysis of FMEA for Company B	75
4.2.1	Pareto analysis of Company B	79
4.2.2	Identifying The Mechanical and Electrical Failures	82
4.2.3	Comparison Between Company A Case and Company B Case Study	88
4.2.4	FMEA Merge of Company A and Company B	89
4.2.5	Pareto Analysis of Company A and Company B Merged	96
4.2.6	Mechanical Problems on Semi Hermetic Compressor in Multiple Application	97
4.2.7	Pareto Analysis of Failure Mode Occurs on Semi Hermetic Compressor in Multiple Application	105
4.2.8	Cost Semi Hermetic Compressor Parts	108
4.3	Summary	111
CHAPTER 5 CONCLUSION AND RECOMMENDATIONS		114

5.1	Conclusion	114
5.2	Recommendations	116
5.3	Project Potential	116
REFERENCES		117
APPENDICES		121



LIST OF TABLES

TABLE	TITLE	PAGE
Table 2-1	Research gap	23
Table 2-2	Main Components of Reciprocating Compressor (Hermetic)	34
Table 2-3	Severity of Hazard	48
Table 2-4	Likelihood of Occurrence	48
Table 2-5	Risk Matrix	49
Table 2-6	Priority Based on the Range	49
Table 3-1	FMEA Table of Company A	67
Table 3-2	Pareto Analysis of Company A	69
Table 3-3	Parameter Instrumentation	72
Table 4-1	FMEA of Company B	78
Table 4-2	Pareto analysis (Company B)	79
Table 4-3	FMEA of merge Company A and Company B	95
Table 4-4	Pareto analysis Company A and Company B Merged	96
Table 4-5	Failures occurs on semi hermetic compressor in multiple application	104
Table 4-6	Pareto analysis of Failure Mode Occurs on Semi Hermetic Compressor in Multiple Application	105
Table 4-7	Cost semi hermetic compressor parts (Company A)	108
Table 4-8	Cost semi hermetic compressor parts (Company B)	108
Table 4-9	Acquisition cost of Semi Hermetic Compressor Parts (Company A)	109
Table 4-10	Acquisition cost of Semi Hermetic Compressor Parts (Company B)	110

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2-1	Basic System of HVAC	19
Figure 2-2	Basic Refrigerant Cycle	20
Figure 2-3	Scroll Compressor with fixed and orbiting scrolls enclosed in hermetic shell	29
Figure 2-4	MAS oil injected screw compressor for marine.	30
Figure 2-5	Semi Hermetic Compressor	31
Figure 2-6	semi hermetic (Couplant Compressor) Emerson's brand	32
Figure 2-7	Hermetic Compressor	33
Figure 2-8	A Digital Semi Hermetic Compressor Application At Supermarket.	41
Figure 2-9	A Water-Cooled Chiller With Hermetic & Semi Hermetic Compressor Used For Marine Air Conditioning System By DMA Marine Group	42
Figure 2-10	Type of Maintenance	44
Figure 3-1	Maintenance Report from HVAC Experts Sdn. Bhd	63
Figure 3-2	Picture failure of crankshaft	68
Figure 3-3	Picture failure of piston	68
Figure 3-4	Pareto chart of failure mode occur on semi hermetic compressor	70
Figure 3-5	Pie chart of failure mode occur on semi hermetic compressor.	70
Figure 4-1	Pareto chart of failure mode occur compressor (Company B)	80
Figure 4-2	Pie chart of failure mode occur on compressor (Company B).	80
Figure 4-3	Pareto chart of category number of failures occur on semi hermetic compressor.	96

Figure 4-4 Pie chart of category number of failures occur on semi hermetic compressor.	96
Figure 4-5 Pareto chart of failure mode occur on semi hermetic compressor in multiple application	106
Figure 4-6 Pie chart of failure mode occur on semi hermetic compressor in multiple application.	106



LIST OF SYMBOLS AND ABBREVIATIONS

FMEA	-	Failure Mode Effect Analysis
HVAC	-	Heating Ventilation and Air Conditioning
Sdn Bhd	-	Sendirian Berhad
RPN	-	Risk Priority Number
FMEA	-	Failure Mode Effect Analysis
HVAC	-	Heating Ventilation and Air Conditioning
	-	
	-	



LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A	Cost of semi hermetic compressor parts	121



CHAPTER 1

INTRODUCTION

1.1 Background

HVAC stand for Heating Ventilation and Air Conditioning or in the simple way system that are used to keep people warm and cool in both residential and commercial facilities. It is known as heating, ventilation, and air conditioning, and it keeps people cool and comfortable in places like Malaysia, where the weather is typically hot and humid. Because the systems utilized free-moving air particles in both residential and commercial buildings, they keep people healthy by filtering clean indoor air and maintaining humidity levels at appropriate comfort levels. The heating and air conditioning system is one of the most complex and comprehensive systems in a structure, and if one component fails, it can damage the entire system. The primary function of air conditioning is to decrease extreme temperatures. There is also a technique of eliminating heat and moisture from the interior of a closed space to improve the comfort of the atmosphere indoors. Furthermore, there is a process known as ventilation, which gets its source from fresh outside air intake and exchanges it to replenish oxygen while removing undesirables including foul odors, carbon dioxide, and excessive wetness. The air returns for ventilation, ducting, electrical elements, compressor, condenser, expansion valve, outside unit, and blower are just a few of the components that keep the system running.

Before, there are many gaps between the ventilation process into the building caused from the open and closed door system. But nowadays, the modern construction tightly focused on the sealed so ventilation process can be improving. After the outdoor air is brought in the HVAC system itself will work to filter the air, remove dirt, excessive moisture, dust and other particles to keep people inside breathe clean air. When the process is done, the air will direct into the space provided such as home living rooms, cars, classes, laboratory and factories. So taking care from the earlier stage is crucial and support as mentioned by researchers (Haberschill et al., n.d.) in designing the system, it is crucial to study and investigate the performance of each component as there are a wide variety of operating circumstances also the interactions between the component in the system. It is to prevent excessive failure, experimenting to determine performance may be costly and time consuming.

An air conditioner that has undergone an air conditioning system check is critical for improving efficiency, lowering energy consumption, operating expenses, and lowering carbon emissions. Building owners, operators, engineers, managers, and others who are responsible for the overall functioning of the system have legal obligations and responsibilities in the operation and maintenance of air conditioning systems. That system's ability to generate healthy and comfortable environments must be monitored and maintained on a regular basis. Routine inspections and maintenance must highlight the system's capacity to offer healthy and comfortable conditions for building occupants while minimizing refrigerant gas leaks.

Compressor is like the heart to the HVAC system. The failure of the compressor results in the entire system failing. It's usually the root of a lot of system issues. Based

on the maintenance report, the key component of the system was identified, and Failure Mode Effect Analysis (FMEA) was used to determine the most significant failure mode impacting parameter first. The FMEA examines numerous failure modes and their effects on the system, then assesses the severity of the failure based on failure rate and failure effect incidence (Jomde et al., 2017). The analytical data should be updated because it will assist the system in the long run. By overcoming the failure via analysis, the facility's overall operating and maintenance costs will be reduced, and the system's performance will be enhanced. The FMEA approach was adopted in accordance with the American Bureau of Shipping (ABS) standard, which was incorporated by Act of the Legislature of the State of New York in 1862 and modified in 2015.

As part of this report, the performance of HVAC support system maintenance reports produced by HVAC experts Sdn.Bhd, such as blower compressor, and refrigerant data in industrial facilities, has been compiled into this report to study the failure mode through Failure Mode Effect Analysis (FMEA) analysis. The file database, which was generated from 2015 to 2020, was used to identify possible failure mechanisms and unfavourable scenarios that may damage the system. As a result, throughout the system's existence, maintenance of each component is necessary. Significantly, new HVAC systems are more expensive than current HVAC systems owing to compliance with safety laws and industry standards. The oil and gas platform's HVAC system was scheduled for maintenance as per usual practise (Preventive maintenance, Corrective maintenance, and Risk-based inspection). While running a maintenance plan, these would be frequent possibilities for the maintenance department.

1.2 Problem Statement

Semi hermetic compressor is known as sealed type compressor. Semi hermetic screw compressors are often used in marine refrigeration, residential structures, petrochemical, pharmaceutical, and chemical operations, industrial refrigeration, and high temperature ammonia heat pumps. Failures in the oil and gas industry can have a wide variety of ramifications, hurting both business and safety. As a result, evaluating failures is crucial in order to prevent them from happening again. The majority of compressor failures are caused by system defects that must be rectified to prevent recurrent problems. During a field inspection of a failed compressor, symptoms of system problems are usually detected. The system's ability to offer healthy and comfortable conditions for building occupants while lowering energy consumption should be the emphasis of the inspection and maintenance routine.

The failure mode of the compressor was investigated in this study for the HVAC support system. One of the components that keeps the HVAC system operating is the compressor. When the compressor fails, the entire system fails, according to Jomde et al. 2017. Corrective and preventative maintenance are two types of maintenance that are currently in use. It has a high price tag. Semi hermetic and hermetic compressors are widely utilized in a variety of applications; they are designed to provide cost-effective maintenance while maintaining optimal compressor performance.

1.3 Research Objective

The main aim of this research is to find integrity assessment to be applied of HVAC support system. The following are the objectives of this research:

- a) To perform Failure Mode and Effect Analysis (FMEA) and formulate solution on maintenance strategy.
- b) To analyze and access problem, potentially dangerous situations, addressing gaps and improving safety, environmental performance of semi hermetic compressor.

1.4 Scope of Research

The scope of this research are as follows:

- The FMEA method was applied limited to an offshore perspective.
- The analysis to ensure that the failure often happen in mechanical, electrical and piping.
- Mainly focused on the semi hermetic compressor.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Energy efficiency is recognized as a key strategy in today's modern society to address growing issues such as rising electricity costs, utility costs, unexpected and high costs of equipment repairs, climate change, and energy crisis. However, without proper commissioning and installation, it can harm and have an impact on building management. Due to unexpected increases in energy costs over time, many companies around the world have been forced to save energy in their buildings in order to reduce operating costs. This has also led to the creation of green companies, as many existing commercial buildings are built with low carbon emission features. Because of the improvements, the building's environmental performance is improved. However, currently, energy efficiency in commercial buildings may be achieved by redeveloping the building's heating, ventilation, and air conditioning (HVAC) system to be more energy efficient.

Compressors are one of the HVAC/R support systems. Compressor, condenser, expansion valve, and evaporator are also included in the basic HVAC system. There are several types of compressors listed in the business. Semi-hermetic refrigeration compressors are a common type of compressor because of its benefits, which include steady operation, dependability, high efficiency, and a compact structure.

2.2 Background of Heating Ventilation Air-Conditioning (HVAC)

HVAC are stand for Heating Ventilation and Air Conditioning. Refrigeration "R" is sometimes added, resulting in "HVACR." The technique of managing the temperature of a constrained space to satisfy the demands of the people or goods within it is referred to as HVAC. HVAC systems are in charge of not just heating and cooling, but also maintaining indoor air quality (IAQ). In the winter, the air is heated, and in the summer, the air is cooled. In HVAC systems, thermodynamics, fluid mechanics, and heat transport are all employed. These fields are all utilized in different HVAC components. Indoor air quality (IAQ) refers to the air quality inside a building or structure as it relates to the health and safety of its occupants. IAQ is affected by gas inclusion or contamination, as well as uncontrolled mass and energy transmission. Heating, cooling, and air conditioning systems are used in a range of applications, including houses, buildings, industries, automobiles, aquariums, and more. The use of HVAC systems is becoming increasingly widespread, and more study is being done in this area. While the field of application expands, the HVAC sector grows. A heating and cooling system, as well as interior temperature control, is simply a collection of many pieces of equipment that are all connected. HVAC systems employ mechanical and electrical components to provide comfort to building/space occupants or to maintain items, products, or anything else placed in space.

HVAC cooling systems can be coupled with HVAC heating systems or placed separately, depending on the HVAC design. HVAC systems keep machinery running on a large scale by regulating the temperature of the space/hall/room where they are placed. HVAC water chillers have become vital in any industry for a multitude of reasons. In the backdrop of the HVAC system, a water chiller produces chilled water,