ANALYSIS OF VIBRATION EFFECT ON LOCAL EXHAUST VENTILATION SYSTEM USING STATISTICAL ANALYSIS METHOD

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DECLARATION

I declare that this Choose an item. entitled Analysis of Vibration Effect On Local Exhaust Ventilation System Using Statistical Analysis Method is the results of my own research except as cited in references. The Choose an item has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

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 (Maintenance Technology) with Honours.

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DEDICATION

I dedicate this thesis firstly to my parents and my family members for nursing with affections of love in my way to success in this journey.

ABSTRACT

Statistical analysis is a subfield of mathematics concerned with the collection, compilation, presentation, analysis, interpretation, and conclusion of data. Variables, data, samples, and populations are all fundamental notions in statistics. Variables are quantifiable aspects of a piece of data. The population encompasses all of the data that will be analysed, whereas the sample is a subset of the population. Beginning with data collection and concluding with recommendations. Although the data provides the information desired, it requires multiple processes to process the data in order to make conclusions. Data were gathered until an appropriate number was reached. Once the data has been collected, it must be organised correctly and presented in a straight forward format such as tables, graphs, charts, or diagrams. Completed data should be analysed statistically. Results will be obtained as a result of the analysis until a conclusion may be drawn based on the original data. Conclusions can be drawn from the values of the collected data and presented in a more simplified and briefer format, such as tables, graphs, or mathematical or statistical formulas. Vibration analysis, on the other hand, is described as the process of determining the vibration levels and frequencies of machinery or system and then utilising that information to determine the health of the machines or system and its components. Besides, in order to measure the local exhaust ventilation system, it all begins with the usage of an accelerometer to sense vibration. When the system is in operation, it generates vibrations. An accelerometer attached to the specific component creates a voltage signal that indicates the amount and frequency of vibration produced by the system, which is typically expressed in terms of how many times per second or minute the vibration happens. The software collects all data from the accelerometer directly into a data collector, which records the signal as amplitude vs. time, also called time waveform, amplitude vs. frequency, also called Fast Fourier Transform, or both. All of this data is analysed by computer algorithms, which are then analysed by engineers or skilled vibration analysts to determine the system's health and identify potential problems such as looseness, imbalance, misalignment, and lubrication concerns. Then, the data obtained can be interpreted to determine the appropriate course of action. Any conversation or conclusion, whether short or long term, will be lot simple to determine. As a business or industry, vibration on a certain equipment or system is critical to consider because it has a significant impact on the company's or industry's expenses and efficiency. As a result, this study of vibration analysis using statistical methods is a necessary activity in any sector of engineering in order to ensure the long-term operation of a machine or system. In this case, the machine or system needs proper maintenance activity to overcome the problem and maintain the efficiency.

ABSTRAK

Analisis statistik adalah cabang bidang matematik yang berkaitan dengan pengumpulan, penyusunan, persembahan, analisis, interpretasi, dan kesimpulan data. Pemboleh ubah, data, sampel, dan populasi adalah konsep asas dalam statistik. Pemboleh ubah adalah aspek yang dapat diukur dari sesebuah data. Populasi merangkumi semua data yang akan dianalisis, sedangkan sampel adalah subset populasi. Bermula dengan pengumpulan data dan diakhiri dengan cadangan. Walaupun data memberikan maklumat yang diinginkan, ia memerlukan banyak proses untuk memproses data untuk membuat kesimpulan. Data dikumpulkan sehingga nombor yang sesuai dicapai. Setelah data dikumpulkan, data mesti disusun dengan betul dan disajikan dalam format lurus ke depan seperti jadual, grafik, carta, atau diagram. Data yang lengkap harus dianalisis secara statistik. Hasil akan diperoleh sebagai hasil analisis sehingga kesimpulan dapat diambil berdasarkan data asal. Kesimpulan dapat diambil dari nilai-nilai data yang dikumpulkan dan disajikan dalam format yang lebih sederhana dan ringkas, seperti jadual, grafik, atau formula matematik atau statistik. Analisis getaran, sebaliknya, digambarkan sebagai proses menentukan tahap getaran dan frekuensi mesin atau sistem dan kemudian menggunakan maklumat tersebut untuk menentukan tahap kesihatan mesin atau sistem dan komponennya. Selain itu, untuk mengukur sistem pengudaraan ekzos setempat, semuanya dimulai dengan penggunaan *accelerometer* untuk merasakan getaran. Semasa sistem beroperasi, ia menghasilkan getaran. *Accelerometer* yang ditempatkan pada komponen tertentu menghasilkan isyarat voltan yang menunjukkan jumlah dan frekuensi getaran yang dihasilkan oleh sistem, yang biasanya dinyatakan dalam seberapa banyak kali sesaat atau minit getaran itu berlaku. Perisian ini mengumpulkan semua data dari accelerometer secara langsung ke pengumpul data, yang merekam sinyal sebagai amplitud vs waktu, juga disebut bentuk gelombang waktu, amplitud vs frekuensi, juga disebut *Fast Fourier Transform*, atau keduanya. Semua data ini dianalisis dengan algoritma komputer, yang kemudian dianalisis oleh jurutera atau penganalisis getaran mahir untuk menentukan kesihatan sistem dan mengenal pasti potensi masalah seperti kelonggaran, ketidakseimbangan, ketidaksejajaran, dan masalah pelinciran. Kemudian, data yang diperoleh dapat ditafsirkan untuk menentukan tindakan yang sesuai. Sebarang perbincangan atau kesimpulan, sama ada jangka pendek atau jangka panjang, akan mudah ditentukan. Sebagai sebuah perniagaan atau industri, getaran pada peralatan atau sistem tertentu sangat penting untuk dipertimbangkan kerana mempunyai kesan yang signifikan terhadap perbelanjaan dan kecekapan syarikat atau industry tersebut. Hasilnya, kajian analisis getaran ini menggunakan kaedah statistik merupakan aktiviti yang diperlukan dalam mana-mana sektor kejuruteraan untuk memastikan operasi jangka panjang mesin atau sistem. Dalam kes ini, mesin atau sistem memerlukan aktiviti penyelenggaraan yang betul untuk mengatasi masalah dan mengekalkan kecekapan.

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ABBREVIATION

RMS	Root Mean Square
RMSE	Root Mean Squared Error
LEV	Local Exhaust Ventilation
MAPE	Mean Absolute Percentage Error
HEPA	High-Efficiency Particulate Air

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CHAPTER 1

INTRODUCTION

1.1 Background

Vibration is a common occurrence that occur in all moving things. The vibration is a prevalent issue that may occur in a wide range of situations and circumstances. In sectors such as mechanical, civil, and electrical engineering, among others. Vibration is not a property of mechanical systems. It is a condition that may arise on a bridge, a structure, a system, a tool, or a plant. Consider a wave at an environmental catastrophe, offshore platforms, ships, airline cabin noise, aerospace, home machine, suspended bridge, tallest structure, and machine tool motion as examples. While vibration cannot be prevented entirely, it may be minimized to prevent something worse occurring or occurring unexpectedly. Vibration is often induced by movement effects among machine or system components and their contact surfaces especially consist of reciprocating and rotating parts or components, such as fitments, tolerances, clearances, profile, and rolling. Additionally, vibration may be utilized to ascertain the sort of structural damage that has occurred.

In local exhaust ventilation system, vibration cannot be resisted due to the rotation of fans in the system purposely to draw out the air either hot or cold from one area to another area. Local exhaust ventilation systems work by depressurizing the building according to the various of function. Hence, the system reducing the inside air pressure below the outdoor air pressure, they extract indoor air from a house or building while make-up air infiltrates through leaks in the building shell and through intentional, passive vents through ducting. Moreover, all of the components such as hoods, vents, ducting, fans and ventilation parts combine as a “local exhaust ventilation system” to exchange indoor and outdoor air without

wasting energy. Local ventilation systems can be categorized as one of four types which are exhaust, supply, balanced, and heat-recovery. The right ventilation system for a particular house or building depends upon the climate and the needs of the structure.

In addition, perform the condition monitoring and diagnosis of the entire system by record the data of routine checking, testing and analysis. It is a good activity in order to analyzing and detecting the system reliability if any problem that occur and tries to overcome the problem or failure with proper solution as soon as possible. In engineering practice, condition monitoring is the best way or method to monitor the efficiency, maintainability, risk and of the system in order to sustain the performance.

1.2 Problem Statement

Generally, every house or building that installs the local exhaust ventilation system has its certain purposes and of course, the system becomes one of the most important that needs to function properly. However, when the system is used for a relatively long period, commonly the efficiency and reliability of the entire system will be decrease due to vibration. A preventive action needs to be implemented to diagnosing the system to avoid something problem or failure occur. Prevention methods need to be considered before the system suffers severe damage and results in its operation ceasing.

As known, vibration cannot be resisted because of the presence of electrical motor in the system. The electrical motor turns on as the system starts to operate which leads to vibration. In this case, in order to sustain the system performance, the vibration must be monitor and control preferably. Furthermore, this action purposely to analyzes and maintain the rate of the vibration occur for easier incoming action of maintenance and prevention activity of the vibration level.

1.3 Research Objective

The main aim of this research is to monitor the vibration level that occur on the local exhaust ventilation system. Specifically, the objectives are as follows:

a) To measure and collect the vibration data of the system by using piezo-based sensor (vibration analyzer) by focusing on the electrical motor.

b) To analyze the collected data using vibration statistical analysis method.

1.4 Scope of Research

In order to solve the problem in achieving the objective, the scope of research is:

- Determine the spot of the high vibration occur using vibration analyzer on the electrical motor.
- Measure and collect the vibration data.
- Analyze and interpret the data by using vibration statistical analysis method.
- Implement the best maintenance activity and technique to solve the issue.

CHAPTER 2

LITERATURE REVIEW

2.1 Local Exhaust Ventilation System

Local exhaust ventilation systems are widely employed throughout the country nowadays. According to an article by Tong, L., Gao, J., Luo, Z., Wu, L., Zeng, L., Liu, G., and Wang, Y.(2019), exhaust ventilation systems with a single central fan and multiple terminals have been widely used to remove heat and contaminants from building environments. Without pressure balancing, conventional design results in an unequal distribution of exhaust airflow rate among the many outlets. Each system requires a unique specification and design configuration based on the area and circumstance. Human activity produces a diverse spectrum of molecules that can be hazardous at high enough quantities, and contaminants from outdoor sources can also affect indoor air quality. Ventilation systems help keep these contaminants at bay by regularly replenishing the indoor air and also contribute to moisture retention. Without ventilation, it would be impossible to maintain a comfortable and healthy indoor atmosphere.

2.1.1 Local Exhaust Ventilation System Design Configuration

According to Chelsy Bipat, (2017), local exhaust ventilation systems employ solely extractor fans. When the system is turned on, it provides a negative pressurization effect in inhabited spaces, pulling in fresh outdoor air to replace the evacuated air. However, it is critical to highlight that exhaust ventilation is not possible in airtight buildings, as outdoor air must be permitted to enter. After caulking and weatherstripping the building envelope, exhaust ventilation must be supplemented with intake vents.

Local exhaust ventilation systems use a single or more set of fans and ducts, which reduces their cost and installation time. Energy costs are reduced significantly because just one or more set of fans is used, and maintenance is simplified as well. The system's structure can be customized to target specific sources of pollution, ensuring that they are cleared before they spread indoors. Figure 2.1 illustrates a typical exhaust ventilation system design setup.

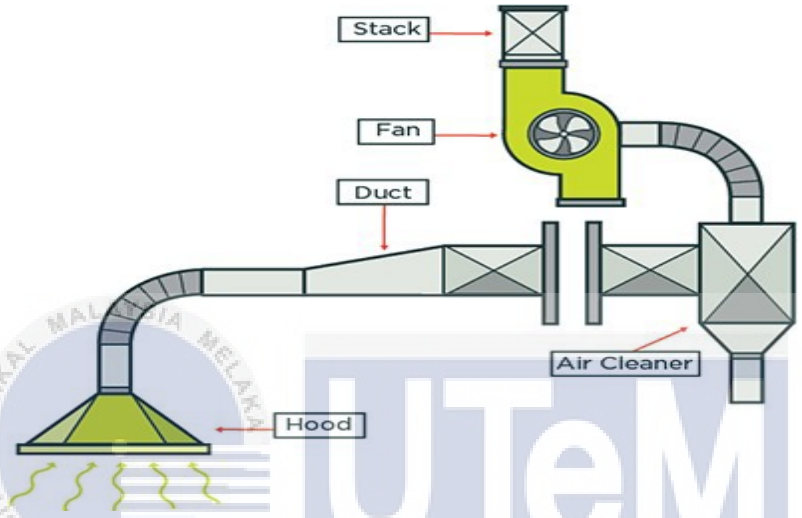

Figure 2.1 Local exhaust ventilation system control of substances hazardous health regulations (ecl.world,2002),

Additionally, local exhaust ventilation performs optimally in cold and dry climates where the external air does not require dehumidification. It is not suggested for tropical and mixed climates, as it draws in uncontrolled warm and humid external air, increasing cooling and dehumidification costs. Additionally, keep in mind that depressurization extracts air from all adjacent spaces, with limited control over the pollutant content. Exhaust ventilation is generally beneficial during cold weather and when external air pollution levels are low.

Another danger associated with exhaust ventilation is backdraft, which occurs when a combustion-based device sucks in a large volume of air unexpectedly, potentially resulting in a flashover. Due to the fact that local exhaust ventilation results in negative pressure and does not regulate air supply, there is an increased risk of backdraft or failure in operation.

2.1.1.1 Main Components

A basic local exhaust ventilation system must at least have four main components which can complete the system to be run. Table 2.1 below shows the components and its function generally.

Table 2.1 Local exhaust ventilation component and function

No	Component	Function
1	Hood	Collect the contaminant generated in air stream directed toward the hood.
2	Ducting	A ducting system is a network of ducts that connect the hood and other components of the local exhaust ventilation system.
3	Fan and Electrical Motor	The motor will rotate the fan to draw air and contaminants into the hood by inducing a negative pressure or suction in the ducts leading to the hoods
4	Air Cleaner	Remove contaminants that are carried in the contaminated air from hood which cannot be discharged into the community environment or to recover materials that have a salvage value.

2.1.2 Ventilation Applications

Ventilation brings outside air into a building or room and distributes it throughout the structure or room. According to the study Etheridge & Sandberg; Awbi (2018). State that the general objective of ventilation in buildings is to produce healthy air for breathing by diluting and eliminating pollutants generated within the structure.

2.1.2.1 Natural Ventilation

Atkinson J, Chartier Y, Pessoa-Silva CL, et al. of the World Health Organization (WHO),(2009) noted that natural forces such as wind and thermal buoyancy force caused by indoor and outdoor air density variations propel outdoor air through purpose-built, building envelope openings. Windows, doors, solar chimneys, wind turbines, and trickling ventilators