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Optimization of Industrial Machine Balancing Processes for Fastening Precision and Efficiency

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ABSTRACT

The industrial sector in Indonesia is experiencing rapid development, which encourages the need for optimal and efficient production processes. This research focuses on optimizing the screw conveyor balancing process using the HOFMAN HL-28 balancing machine at PT Petrokimia Gresik. The main goal of this research is to improve precision and efficiency in machine operation, as well as reduce unwanted vibrations in mechanical equipment such as screw conveyors. The research method involves tool preparation, balancing testing, and data collection related to parameters such as weight, dimensions, and tolerances. The test results show that proper balancing can significantly reduce vibration, improve machine operation stability, and extend the service life of the equipment. Thus, this study concludes that optimizing the balancing process on screw conveyors not only improves operational efficiency but also plays a role in reducing downtime and improving production quality. This optimization is very important to support the performance of the industry in order to compete globally.

Introduction

The development of the industrial sector in Indonesia has progressed rapidly. Fierce competition in the industrial world requires companies to further improve their performance to be able to compete with competitors (Anaam et al., 2022). Companies need to adjust the level of consumer needs to the available production capacity to be able to produce optimal production levels. Problems The development of the modern era is in line with the rapid development of science and technology, forcing companies to produce a high level of productivity (Manurung, 2010). High productivity can be achieved if the production process runs effectively and efficiently (Sultan et al., 2018). Line balancing is part of the production process where the material moves through the workstation and aims to process the material into a sub-assembly to then become a finished product. The time to complete a product is determined by the speed of the processing path (Harbintoro, 2019).

Manufacturing is an industry that deals with the use of advanced equipment such as industrial machinery, a regular and measurable management program to convert raw materials into finished goods and marketable products (Harahap, 2024). Examples of manufacturing industries include textile companies, garment industries, handicraft industries, electronics industries, and automotive industries (Aldimiyyathi et al., 2023). The fabrication process is defined as part of the activities of a company that is oriented towards fulfilling material aspects with the final stage in the form of the production of finished goods as part of several materials (Julian et al., 2022).

PT Petrokimia Gresik is one of the parts of Pupuk Indonesia Holding Company (PIHC) which is a State-Owned Enterprise (BUMN) that was formerly known as PT Pupuk Sriwidjaja (persero) or PUSRI (persero). 9 other companies are members of PIHC, namely PT Pupuk Iskandar Muda, PT Pupuk Sriwidjaja Palembang, PT Pupuk Kalimantan Timur and PT Pupuk Kujang Cikampek, PT Pupuk Indonesia Energi, PT Pupuk Indonesia Pangan, PT Pupuk Indonesia Logistik, PT Mega Eltra and PT Rekayasa Industri (Salim et al., 2016). PT Petrokimia Gresik is engaged in the production of fertilizers, chemicals, and other services such as construction or design services, equipment, engineering, and engineering which occupies an area of 450 hectares in Gresik Regency, East Java. The government designed the existence of PT Petrokimia Gresik in 1956 through the State Planning Bureau (BPN). Initially, the fertilizer factory to be built in East Java was called the Surabaya Petrochemical Project. The name Petrokimia itself comes from "Petroleum Chemical" which is abbreviated as Petrochemical, which is chemicals derived from oil and natural gas (Ahyan, 2020).

The service and fabrication department of Balancing is a very important part of the process used to adjust or balance equipment or mechanical components to operate stably and efficiently. The main goal of the balancing process is to reduce or eliminate unwanted vibrations that may occur on mechanical equipment such as shafts, wheels, fans, or other components (Hapid & Supriyadi, 2021).

Manufacturing companies generally have an assortment of products with different designs and functions. To realize the goal of forming a product that is by the design standard, the raw materials will first go through the fabrication process. Raw materials that are generally used as raw materials are plates, pipes, steel, stainless steel, aluminum, and other metals. Later, this raw material will be formed by a fabrication machine according to the desired function of the manufacturing plant (Suharman et al., 2018). The fabrication process at PT Petrokimia Gresik, especially the fabrication department, produces screw conveyors. A screw conveyor is a mechanical device used to transport materials in the form of powders, granules, or masses over relatively short distances. This conveyor consists of a rotating spiral called a flighting or auger that is attached along the axis in a closed pipe or channel.

The stages in the work of the screw conveyor are marking, cutting, drilling, assembling, welding, checking, finishing, blasting, and painting. To distribute the mass of the rotating system so that the center of mass is at the same time as the axis of rotation, the Balancing Screw Conveyor is balanced. This helps to minimize vibration and improve

the overall performance and life of the equipment which is one of the reasons for balncing on the Screw Conveyor. The balancing machine of the fabrication department uses HOFMAN HL-28, the balancing machine is very important to maintain the optimal performance of the screw conveyor, and reduce the noise or vibration of the screw conveyor which can interfere with the quality of machine performance.

Several previous studies have discussed balancing processes in industrial equipment to improve efficiency and reduce adverse vibrations. Kalmegh and Bhaskar (2012) examined balancing impellers in centrifugal pumps to improve engine service life and operating efficiency. The results of the study show that proper balancing can reduce vibration and extend the service life of engine components. In addition, research by Kholil (2014) at PT LG Electronics Indonesia also focuses on line balancing in the production process to improve time efficiency and productivity. These studies show the importance of balancing in the operation of industrial machinery, but most studies only highlight specific equipment, without highlighting the use of modern balancing machines such as the HOFMAN HL-28.

This research offers a new contribution by applying the HOFMAN HL-28 balancing machine specifically to the screw conveyor at PT Petrokimia Gresik. There are not many studies that use this type of balancing machine, especially in the context of the industry in Indonesia. By optimizing balancing using the latest technology, this research not only improves efficiency, but also extends the life of equipment and lowers maintenance costs.

Previous research has focused more on more general machines or processes such as balancing on impellers or line balancing processes in mass production. In this study, the main focus is on optimizing the balancing screw conveyor using HOFMAN HL-28 which has not been studied in depth. The study also emphasizes on vibration reduction and increased operational stability, which is new in the context of Indonesian industry, especially in the fertilizer industry which relies heavily on screw conveyors for the production process.

Based on the background of these problems, the research conducted by the researcher is to optimize the screw conveyor balancing process using a HOFMAN HL-28 type balancing machine to determine the balance of rotation and mass distribution. The purpose of this study is to find out the results of the balancing process, including balancing parameters and initial unbalance.

Method

Stages and processes in machine optimization research to obtain results with maximum precision and efficiency. The following is a flow chart of the research carried out:

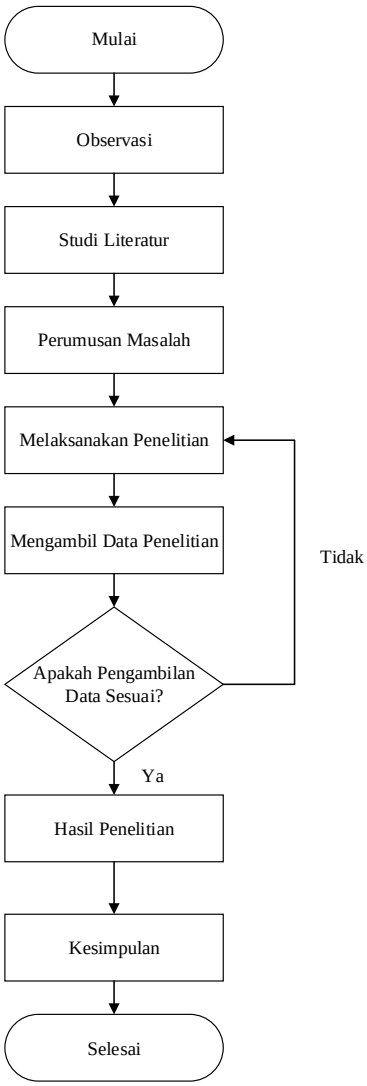


Figure 1. Experimental flowchart

This research was carried out at PT Petrokimia Gresik in the period from October 2024 to January 2024. The machine used for the testing process is a HOFMAN HL-28 type balancing machine. The following are the tools and materials used to support the research:

Table 1
Tools and Materials

No	Tools and materials
1	*Dynamometer*
2	Welding machine
3	Grindstone
4	Digital Scales
5	*Screw Conveyor*

The following are the research procedures that will be carried out:

a. Prepare the tools and materials that will be needed.

At this stage, the author prepares tools and materials such as dynamometers, welding machines, rulers, digital scales, and screw conveyors.

b. Testing and data retrieval

At the stage of testing and data collection using a balancing machine, the following things must be considered:

a) Setting Up the Balancing Machine
b) Setting the screw conveyor to be balanced on the HOFMAN HL-28 machine
c) Data input on the monitor
d) The last step is to turn on the balancing machine

Results and Discussion

Balancing Screw Conveyor Testing

Figure 2. Screw Conveyor Balancing Testing Tools

Previously, testing the data of the equipment to be balanced such as name, dimension (mm), Radius (mm), and Tolerance (g), In the process of working the machine itself by analyzing the vibration that occurs in the machine, during the testing of the unit to be tested previously weighing is carried out to obtain the data required by the balancing machine, then placed on the platform or bearing, after which the unit will be rotated through a belt or end drive, During the process of playing the unit, it will produce vibrations, the vibration is detected by the sensor on the machine, the sensor produces data from the vibration that occurs in the unit and will appear on the digital display screen of the machine, from the results which part of the unit is not balanced with the engine, and later there will be an addition or reduction of mass in that part so that the unit can be balanced again. Parts or components that are often balanced in the fabrication department include screw conveyors from factory II using horizontal balancing machines with balancing grade 2.50G with Std ISO 1940 in the workshop and fabrication department.

Parameter Balancing

Before balancing, several data are needed by the balancing machine regarding the unit such as Weight, Dimension, Radius, Tolerance, etc. The Screw Conveyor itself has the following specifications:

Table 2
Balancing Parameter

Balancing Parameter	
Rotor Weight: 1000.00 Kg	Balancing Grade (G): 2.50G with Std ISO 1940
Balancing Test Speed: 149 RPM	Operation Speed: 300 RPM
Tolerance Plane 1: 125.517 g	Tolerance Plane 2: 125.517 g
Label 08	Label 09

Input Data

This monitor is used to input data before and after finishing the balance, this CAMB balance also stores balancing data that has been done, after the balance data is by the predetermined size, the CAMB balance monitor will store the data and the final finishing, namely the print out of the final balancing data. At the beginning of the balancing screw conveyor process, data input is first to find out the information data before carrying out the next process which is then saved for the preprocessing balancing stage.

Figure 3

CAMB Balancing Monitor (input data balance)

Balancing Screw Conveyor

Screw balancing is carried out by adding or subtracting mass or plates on the side of the degree that is not balanced, on the monitor screen it detects that the screw is added to the mass load with an iron plate on the part that has been detected in the CAMB Balance monitor screen system. Before adding mass, measure the mass using a digital scale.

Gambar 4

Timbangan Digital

Welding

After the mass or iron plate is weighed/measured according to the weight that has been displayed on the CAMB balancing monitor screen, the welding process is carried out on the side of the screw conveyor that has been detected at the level, but in the initial welding, it is only done by dropping on the iron plate/mass.

Figure 5

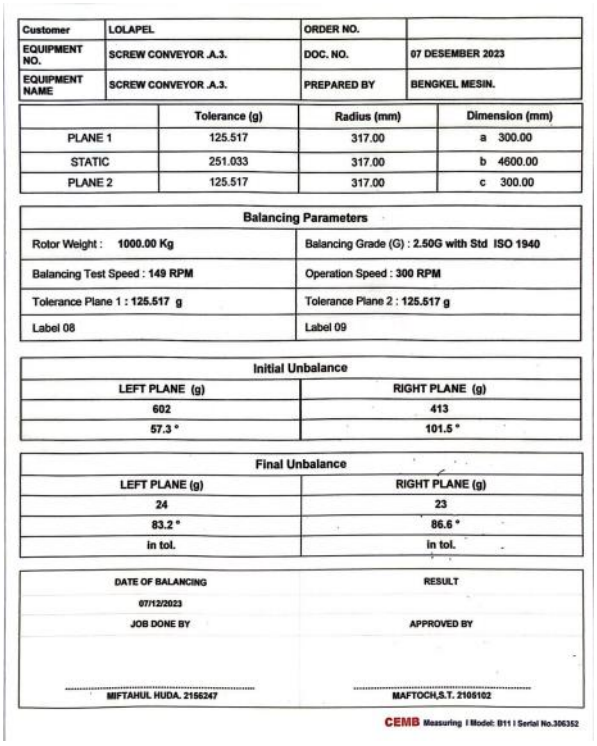
Welding process

In the initial 58 weldings, it was only done by dripping on the iron plate/mass. The result is that after adding mass/load, the screw conveyor is rotated with a belt or and drive with 2 rotations/gears 2 ratios on the spindle, with a speed of 140rpm, in the process of playing the unit, on the CAMB Balance screen, press the start button which will later produce data on mass unbalance and degree of unbalance. Furthermore, the mass/load reduction of the screw conveyor was carried out because the results displayed on the monitor screen were still not sufficiently balanced, then the mass/load reduction was carried out by cutting iron plates using welding with a voltage of 120 volts and using the

NS 8945 electrode type. After adding the load/mass by welding the iron plate on a certain shaft part of the screw, cool it so that the object does not know the expansion, by using a fan that is high enough speed and spraying water on the mass addition part. This is so that during the testing of the object by rotating the balance the data obtained will be accurate with the addition/subtraction of the mass.

Finishing

The finishing or finishing stage after the balancing screw conveyor process involves several important steps to ensure that the balancing process runs smoothly and that the appropriate size can achieve the desired balance. Here are some of the steps that are usually involved in the finishing stage of a screw conveyor. Once the desired balance has been achieved, a final inspection is carried out to ensure that all components are in good condition and that the equipment meets the specified balance tolerances. Also the certificate attached from the CAMB balancing monitor data. Assembly and Testing Components that have been balanced are reassembled, and the entire system is tested to ensure smooth operation without excessive vibration. Detailed records of the balancing process, including before and after measurements, correction methods, and final results, are quupmentated for reference and quality control in subsequent improvements. This documentation is essential for effective maintenance and to meet regulatory requirements or industry standards.



Customer	LOLAPEL	ORDER NO.	
EQUIPMENT NO.	SCREW CONVEYOR .A.3.	DOC. NO.	07 DESEMBER 2023
EQUIPMENT NAME	SCREW CONVEYOR .A.3.	PREPARED BY	BENGKEL MESIN.

	Tolerance (g)	Radius (mm)	Dimension (mm)
PLANE 1	125.517	317.00	a 300.00
STATIC	251.033	317.00	b 4600.00
PLANE 2	125.517	317.00	c 300.00

Balancing Parameters	
Rotor Weight : 1000.00 Kg	Balancing Grade (G) : 2.50G with Std ISO 1940
Balancing Test Speed : 149 RPM	Operation Speed : 300 RPM
Tolerance Plane 1 : 125.517 g	Tolerance Plane 2 : 125.517 g
Label 08	Label 09

Initial Unbalance	
LEFT PLANE (g)	RIGHT PLANE (g)
602	413
57.3 °	101.5 °

Final Unbalance	
LEFT PLANE (g)	RIGHT PLANE (g)
24	23
83.2 °	86.6 °
in tol.	in tol.

DATE OF BALANCING	RESULT
07/12/2023	
JOB DONE BY	APPROVED BY
MIFTAHUL HUDA. 2156247	MAFTOCH,S.T. 2105102

CEMB Measuring | Model: B11 | Serial No.306352

Figure 6
Balancing Certificate

Conclusion

The working efficiency of the Screw Conveyor unit, in the area of Production Department 3B of PT Petrokimia Gresik (coal carrier) has been maximized and with the addition of the balancing indication on the Screw can extend the lifetime of the Screw itself because if there is a disturbance in the Screw motor it will be easily detected by the system and operator, and it will be easy to carry out preventive maintenance. The work efficiency of unit D.5 in the area of the Fabrication Department 11B of PT Petrokimia Gresik has been maximized and with the addition of the balancing indication on the screw can extend the lifetime of the screw itself because if there is a fault in the screw motor, it will be easily detected by the system and operator, and it will be easy to carry out preventive maintenance.

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