Innovative Re-Engineering of Semi-Automatic Compressor Engine Oil Make up

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ABSTRACT

In the upstream oil and gas industry PT Pertamina EP Regional 2 Zone 7 Tambun Field carries out oil and gas production activities. In the natural gas processing unit, one of the most important equipment is the gas compressor which functions to increase gas pressure so that gas can be flowed to consumers at a distance through a pipeline. The problem in current compressor operations is the occurrence of unplanned shutdowns caused by uncontrolled lubricating oil levels, this occurs due to late filling or addition of lubricating oil when the compressor unit is operating. In addition, the way of filling lubricating oil in the compressor is also a challenge because it still uses a manual method by climbing the deck on the compressor by passing through an unsafe pressure pipe. This research aims to solve the problem of unplanned shutdown caused by the lack of control of the lubricant level in the compressor engine and improve a safer way of filling lubricating oil. The observation shows that by using a new innovation of filling lubricating oil in the compressor has a real impact that the lubrication level on the compressor engine is better maintained so as to eliminate unplanned shutdowns from this factor and safer to use. Data analysis there is a change in work speed when filling oil from 30 minutes to 10 minutes, so that work becomes more efficient.

Keywords: unplanned compressor shutdown, lube oil level, efficient

INTRODUCTION

Background of the Problem

PT Pertamina EP (Exploration and Production) is a subsidiary of PT Pertamina (Persero) that focuses on oil and gas exploration and production in Indonesia (Firdaus, 2016). PT Pertamina EP was established in 2005 as part of the restructuring of PT Pertamina (Persero). This establishment aims to separate oil and gas exploration and production activities from Pertamina's downstream business, so that it can be more focused and efficient (Saputra, 2020). Through exploration and production activities, the company has contributed good financial performance with the awarding of the 'AAA' predicate based on the affirmation of the private rating of Fitch Rating Agency Indonesia in 2023 (Ibrahim, 2024)

Figure 1. Working area of PT Pertamina EP Regional 2 Zone 7 Tambun Field

In figure 1 it is explained working areas of PT Pertamina EP Regional 2 Zone 7 Tambun Field which is headquartered at Jalan Raya Pertamina, Kedung Jaya Village, Babelan District, Bekasi Regency. The working area covers Bekasi Regency and Karawang Regency. PT Pertamina EP Tambun Field has 4 gathering stations including Tambun Gathering Station, Pondok Tengah Gathering Station, Pondok Makmur Gathering Station and Rengas Dengklok Gathering Station. The largest oil production is at Tambun Gathering Station with a production of 500 Bopd (barrels of oil per day) and gas of 4.5 MMSCFD (million standard cubic feet per day) in April 2024.

Despite its good track record so far this year, the company still faces challenges. Common challenges faced by an oil and gas company may include fluctuations in global oil prices, government regulations, and the need to maintain sustainable energy resources (Maulani, Nizmi, & Olivia, 2024). However, with the right strategy and technological support, the company is expected to continue to play an important role in the oil and gas industry in Indonesia. PT Pertamina EP continues to strive to increase its production through various innovations and improvements in operational efficiency, as well as maintaining a commitment to sustainable and responsible business practices (Sholikin & Hudi, 2022). Therefore, optimizing the production process for this company is very important.

The gathering station is a place on the surface that functions as a place where the first fluid separation process occurs after the production fluid is lifted and flowed through the flowline from the well. This gathering station is usually used by companies engaged in oil and gas as a place to collect crude oil produced from drilling wells. At the tambun gathering station there is a separation process between petroleum, water and gas which will be processed with different systems, the following flow diagram at the Tambun Gathering Station.

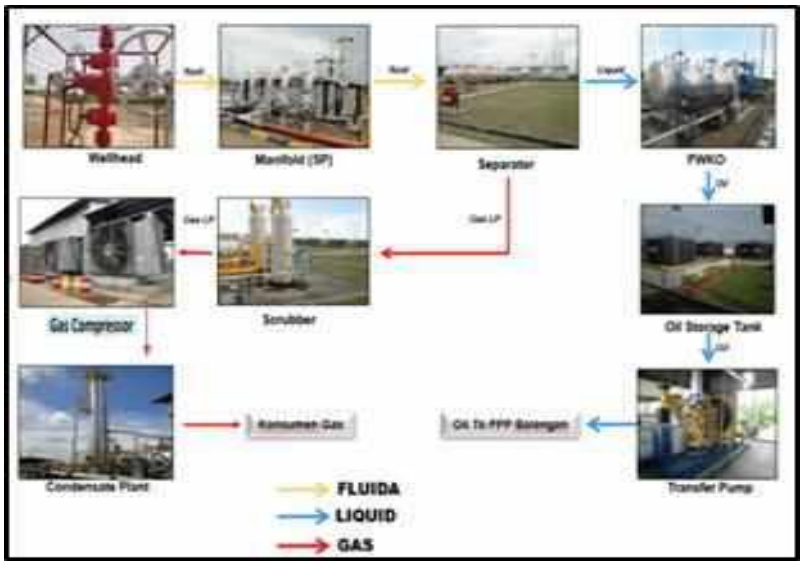

Figure 2. Flow diagram of Tambun Collecting Station

In the figure 2 Flow diagram of Tambun Collecting Station explained about production process, the fluid (a mixture of oil, gas and water) from the production well (well) flows through the manifold and then flows to the separator to be separated between the liquid (oil and water) and the gas contained in it.

From the results of the separation, the gas will then flow to the scrubber which functions as a separation if there is still water or petroleum included in the gas, the gas will flow to the gas compressor to increase the pressure from low pressure (20 Psig) to high pressure (300 Psig) so as to reverse the gas to be flowed to gas consumers who have a considerable distance from the Tambun Collecting Station.

In natural gas processing units, one of the most vital pieces of equipment is the gas compressor. A compressor is a machine used to compress air or gas (Sularso & Tahara, 2006:167). By using a compressor, gas can be easily flowed to consumers in places with long distances through pipes so as to increase revenue for the company. Therefore, compressor reliability is needed to support the production process at PT Pertamina EP Regional 2 Zone 7 Tambun Field, with the right compressor unit maintenance schedule, competent human resources and also innovation to support the operation of the compressor unit.

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LITERATURE REVIEW

Compressor Definition

A compressor is defined by Sularso and Tahara (2006:167) as an instrument that can be used in compressing gas or air. This tool can be divided into air compressors that draw air from the atmosphere or at a pressure that is much higher than the atmosphere. This is intended to increase its suction capability or as a booster. Another type is a gas compressor (vacuum pump) that has the ability to draw gas at a lower pressure than the atmosphere.

Figure 3. Gas Compressor

Figure 3 it is explained the booster compressor is the type used at PT Pertamina EP Regional 2 Zone 7 Tambun Field.

Definition of Lubricating Oil

Lubricant or oil is a thick liquid that serves as a lubricant, protector, and cleaner for engine components. Oil identification codes use the SAE (Society of Automotive Engineers) system, where the number following the code indicates the viscosity of the oil. The larger the number, the thicker the oil. The letter "W" behind the initial number stands for "winter", which means that the oil has a viscosity level suitable for cold and hot temperature conditions. As such, the oil will provide optimal protection when the engine is started under extreme conditions. Under normal temperature conditions, the ideal oil works in the range of SAE-40-50 viscosity numbers according to SAE standards. An example of the use of this code is as follows, if this code is present. SAE15W-SAE50 This indicates that the oil used in the production process has a viscosity of SAE 15 under low temperature conditions and will increase to SAE 50 under high temperature conditions.

Problem Formulation

Gathering Station located at the Tambun has 6 compressor units with natural gas as the main driving fuel. Oil and gas operational systems generally require optimal lubrication to maintain optimal performance, especially in the compressor section. However, the problem that often occurs at the Tambun Gathering Station is the uncontrolled lubricating oil level due to negligence or delays in filling/adding lubricating oil during the production process. This causes frequent unplanned shutdowns. In addition, filling oil or lubricating oil in the compressor engine is also a challenge because it still uses a manual method, namely by climbing the compressor engine deck and there are pressurized pipes, of course, this is very unsafe.

Therefore, it is necessary to optimize the compressor unit system and assist the operator in the lubricating oil filling process so that the process becomes safer and can facilitate work so that the compressor unit operations run well. From the background description, the problem formulation from the description above is how to improve the system or how to fill the lubricating oil in the compressor unit better and safety?

Research Objectives

The objectives of this study are:

a. Innovating the design of a semi-automatic engine oil make- up tool on compressors that previously used manual methods to eliminate unplanned shutdown problems that occurred due to uncontrolled compressor engine lubrication levels.
b. Analyze the positive impact caused after the use of semi- automatic engine oil make-up tools on compressors on the time required to fill engine oil (lubricating oil) on compressors as well as on safety and the work environment.

RESEARCH METHODS

This research was conducted through several stages, starting from problem identification, setting research objectives, collecting and processing data. Direct observations were made to evaluate the improvements that occurred after the application of a semi-automatic compressor engine oil make-up tool in compressor operations at PT Pertamina EP Regional 2 Zone 7 Tambun Field.

RESULTS AND DISCUSSION

Compressor Lubricating Oil Filling Method Before Innovation

Before using the innovation of semi-automatic engine compressor oil filling, compressor lubricating oil filling at PT Pertamina EP Regional 2 Zone 7 Tambun Field was done manually.

Figure 4. Filling oil into jerry cans

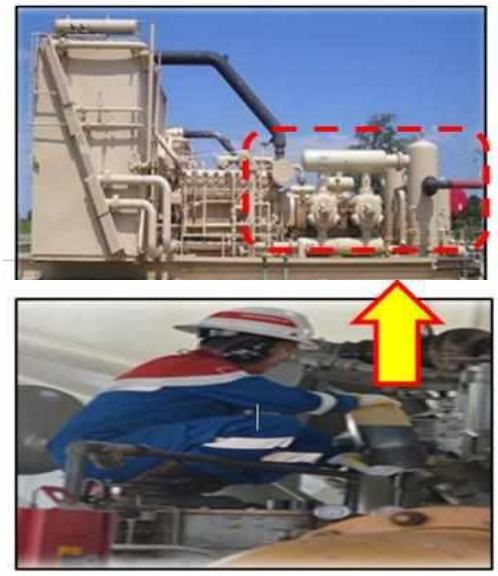

Figure 5. Filling the oil into compressor manually

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In the figure 4 the operator carries out the oil filling process manually using an oil pump into a 5 liter jerry can, then the oil will be used to fill the compressor engine.

Figure 5 explains that the operator is required to climb the deck with a height of approximately 1 meter to filling the oil into compressor engine. When filling lubricating oil manually, the level on the machine cannot be controlled, this is because filling lubricants is difficult and takes a long time when filling, which is 30 minutes. The following is data on unplanned shutdown of compressors due to uncontrolled lubricant levels.

Figure 6. Graph of Unplanned Compressor Shutdown Events Due to Lubricant Level in 2024

Based on the figure 6 it can be concluded that the occurrence of unplanned shutdowns that occurred in compressors before the implementation of semi-automated compressor engine oil make-up tools with an average of 11 events per month caused by uncontrolled lubricant levels. The use of 5-liter jerry cans to transport oil also increases the risk of spillage, especially when the jerry cans have to be lifted to the height of the compressor deck. This situation can cause environmental issues and safety hazards at the worksite.

Solution for Improving Compressor Lubricating Oil Filling Method

According to Total Quality Management (TQM) theory, comprehensive quality control in all operational processes of a company is essential (Anggraini, 2023). In the context of oil filling, inadequate control of oil levels can result in a decrease in the operational quality of the compressor and ultimately affect the company's overall performance. With the implementation of a more convenient and automated system, PT Pertamina EP Regional 2 Zone 7 Tambun Field can improve quality control in the oil filling process, reduce the risk of unplanned shutdowns, and increase machine reliability.

To improve the method or way of filling lubricating oil which was previously manual, ineffective and lacking in safety, innovation is carried out re engineering make up oil engine compressor by making a tool that serves to fill or add compressor lubricating oil that operates semi-automatically.

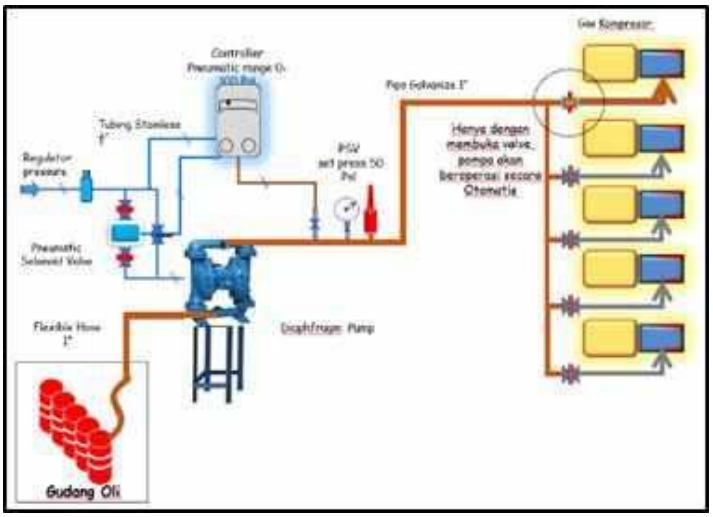

Figure 7. Layout Design of Re Engineering Make Up Oil Engine Compressor Semi Automatically

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In the figure 7 explains that innovation will utilize a type of diaphragm pump that is able to drive positive displacement based on a combination of alternating diaphragm movements. This pump has valves located on both sides to pump the fluid. In addition, this pump also has a diaphragm made of rubber, thermoplastic, or Teflon material.

By connecting the diaphragm pump with the oil drum and compressor and using pneumatic controls and pneumatic solenoid valves set at the required pressure. The diaphragm pump uses air supply power as its driving force.

In its operation to drain the lubricating oil from the storage drum to the compressor only by opening the valve on the oil delivery pipe so that the pneumatic control will read the pressure down so that it will order the pneumatic solenoid valve to open so that the air supply to the diaphragm pump flows and the pump drains the oil from the oil storage drum to the compressor. To stop the flow of oil, simply close the valve on the pipeline that was previously opened, when the valve is closed, the pressure in the oil pipeline will rise so that the pneumatic control will work to order the pneumatic solenoid valve to close the flow of air supply to the diaphragm pump so that the pump that drains oil from the storage drum will stop operating.

According to Grossel (2008), diaphragm pumps tend to be safer to use for the transfer of hazardous or toxic liquids as there is no risk of contamination from air or other liquids into the system, thanks to their closed design and operating without mechanical friction that produces sparks. According to Zhao et al. (2023), this type of pump has the ability to cope with the high viscosity of lubricating oil without difficulty, thus making it a good choice for liquids with such properties. In addition, this system can be operated with pneumatic controls, which makes it easier to organize and integrate with a wider automation system. The use of pneumatic solenoid valves and air pressure to drive the diaphragm pump makes its operation more flexible and reliable (Holloway et al., 2012).

Budget plan for making semi-automatic oil filling innovation

The following is the cost budget plan required for the manufacture of the Semi-Automatic Compressor Engine Oil Make Up.

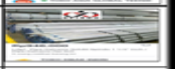
No.	ITEM	Vol/Sat		Harga		Jumlah Harga		Referensi Harga
A. MATERIAL								
1	Pressure Controller	1	Pcs	Rp	615,000	Rp	615,000	
2	Solenoid pneumatic	1	Pcs	Rp	1,500,000	Rp	1,500,000	
3	Diafraghm pump	1	Pcs	Rp	48,900,000	Rp	48,900,000	
4	Galvanize pipe 1"	25	Jts	Rp	690,000	Rp	17,250,000	
5	Pressure safety valve	1	Pcs	Rp	3,500,000	Rp	3,500,000	
6	Pressure gauge 0-100 Psi	1	Pcs	Rp	600,000	Rp	600,000	
7	Regulator pressure	1	Pcs	Rp	1,800,000	Rp	1,800,000	
8	Male connector 1/2 x 1/2"	12	Pcs	Rp	180,000	Rp	2,160,000	
9	Ball valve 1 inch	6	Pcs	Rp	435,000	Rp	2,610,000	
10	Tubing stainless 1/2"	6	Jts	Rp	1,610,000	Rp	9,660,000	
B. JASA								
1	Instalasi	1	Ls	Rp	5,000,000	Rp	5,000,000	
Total						Rp		93,595,000

Figure 8. RAB Making tools Re Engineering Make Up Oil Engine Compressor Semi-automatically (Price in 2024)

Figure 8 shows the equipment needed to manufacture a Semi-Automatic Re Engineering Make Up Oil Engine

Compressor along with the purchase price of the equipment. This is necessary so that you can find out the costs required to make the tool.

According to Rozee (2016), the budget cost will depend on the size and material of the pump. However, the installation of this system is considered relatively inexpensive as the pump can be placed anywhere with enough space, even in liquids if compatible with the pump material. A point to consider is the cost of regular maintenance, spare parts, and labor for maintenance and diaphragm replacement. However, the proposed system is considered easy to disassemble for maintenance or diaphragm replacement.

Installation of semi-automatic oil filling innovation

The following is the installation process of the tool that will be used for semi-automatic filling of compressor lubricating oil.

Figure 9. Diaphragm Pump Repair Process

Figure 9 explains the initial stages of installing the semi-automatic oil filling innovation, namely preparing the diaphragm pump. To make savings from the RAB that had been prepared, the team decided to repair the diaphragm pump that was already available in a damaged condition at the workshop so that nothing else was damaged. There is no need to buy a diaphragm pump to install the required compressor lubricating oil filling equipment. According to Rozee (2016), the costs that need to be considered later for this type of system are the energy costs obtained from the consumption of compressed air needed to operate the pump. Because compressed air is relatively expensive, this component is a major cost in operating an AODD pump.

The diaphragm pump used has specifications as in Figure 10 below.

Maximum Delivery	530 ltrs/min (140 gal/min)
Max. Working Pressure	8.6 bar (125 PSI)
Max. Solid Particle Size	6 mm. (0.24")
Air Inlet	3/4" NPT
Temperature Limits	Determined by Elastomers
Suction Lift (Dry)	6.1 metres (20 feet)
Suction Lift (Wet)	7.6 metres (24.9 feet)
Fluid Inlet / Outlet	2" BSP / NPT
Installation	Surface mounted
Accessories Included	Exhaust Air Silencer
Shipping Weight	38 kg. (83.8 lbs) aluminum 63 kg. (138.9 lbs) cast iron / aluminum 90 kg. (198.4 lbs) cast iron
Shipping Dimensions	540 x 350 x 750 mm 12.3" x 13.8" x 29.5"

Figure 10. Diaphragm Pump Specifications

After the diaphragm pump has been repaired, the next stage is to install it at a predetermined place, namely in the oil storage area adjacent to the gas compressor station.

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Figure 11. Installation process of semi-automatic compressor oil filling equipment

In figure 11 is the process of connecting a diaphragm pump with pneumatic controls and lubricating oil delivery pipes. After the piping installation, a pressure test is also carried out up to 155 Psig to determine whether there is a leak in the lubricant filling line or not. Leak testing is very important so that when operating there is no splashing of lubricating oil into the environment due to poor installation.

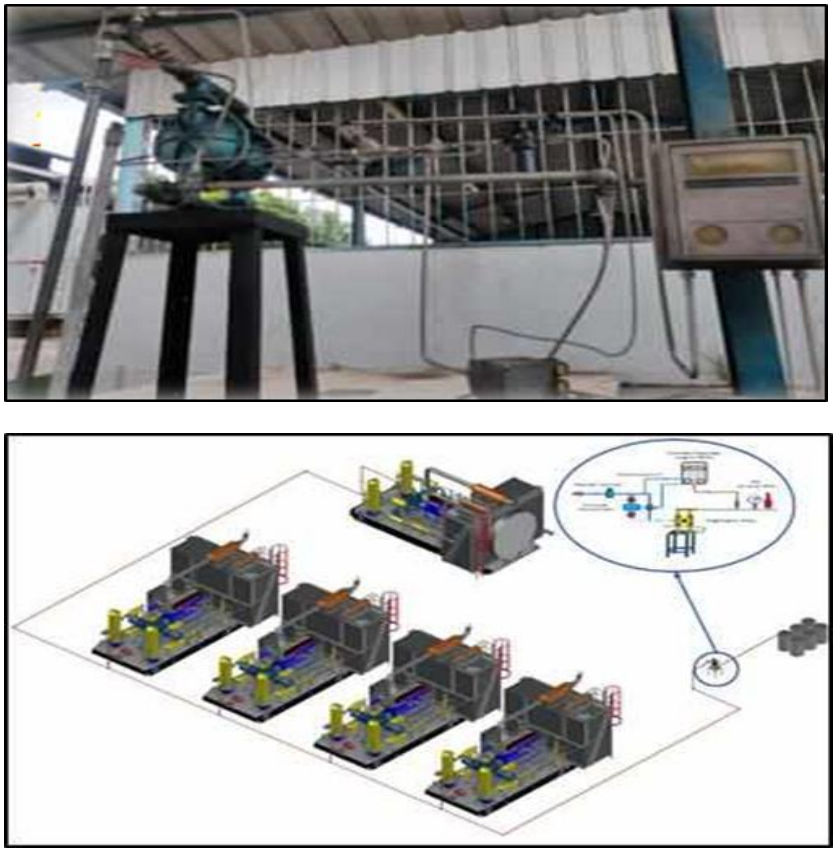

Figure 12. Installation results of semi-automatic compressor oil filling equipment

Figure 12 is the installation results of semi-automatic compressor oil filling equipment. This tool is used to fill engine oil semi-automatically on compressor engines at PT Pertamina EP Regional 2 Zone 7 Tambun Field.

Vantages gained after the Implementation of the Semi Automatic Compressor Engine Oil Make Up Tool

After the implementation of the Semi-Automatic Compressor Engine Oil Make Up tool, there are several advantages obtained, among others:

Eliminate the incidence of unplanned shutdown of compressors caused by low oil level.

Figure 13. Graph of Events Before and After Implementation of the Semi-Automatic Compressor Engine Oil Make Up Tool

In figure 13 it is known that from January to March (Before Implementation of the Semi-Automatic Compressor Engine Oil Make Up Tool) compressor shutdowns occurred due to low oil levels on average 11 times a month. and in April and May after the implementation of the Semi-Automatic Compressor Engine Oil Make Up Tool, compressor shutdown events due to low oil levels could be eliminated. So that gas distribution to consumers will be better maintained and maintain customer satisfaction.

After the implementation of the tool, the work of filling lubricating oil in the compressor engine becomes more efficient, which was previously done manually with several work steps such as filling lubricants into jerry cans and then filling them into the compressor engine by climbing the compressor deck to only open and close the lubricant channeling valve automatically lubricating oil will fill into the compressor engine. Before the implementation of compressor lubricating oil filling took 30 minutes for 6 compressor units, after implementation it only took 10 minutes for 6 compressor units.

The constraints of filling lubricating oil that were previously done manually by climbing the deck can be replaced with an easier and safer method without climbing the compressor deck.

Reducing oil splashes that occur in the compressor area because there is no manual filling, supporting the implementation of 5K2S housekeeping (Orderly, Neat, Clean,Sustainable and Disciplined, Service and Safety).

Recommendations for the Company after the Implementation of the Semi Automatic Compressor Engine Oil Make Up Tool.

Based on the benefits that have been obtained in terms of efficiency and effectiveness of this system innovation, it is possible to keep making innovations in the system to ensure efficiency. Some recommendations that can be given are as follows:

Implementation of sensors and monitoring systems can be done to monitor oil levels in real-time. Research by Zhu et al. (2020) showed that the use of integrated sensors can reduce unplanned shutdown events by enabling early detection of oil shortages. This not only improves compressor availability but also maintains stable gas distribution, supporting better customer satisfaction.

According to Bongcales, Cabral, & Chua (2024), the use of automation technology to improve the efficiency of the oil filling process. By adopting advanced automated systems, such as the use of PLC (Programmable Logic Controller), the time required to fill oil in compressor engines can be significantly reduced. This not only saves time but also reduces human error that may occur in a manual process

CONCLUSIONS

Based on the research results and descriptions that have been presented in the previous chapter, it can be concluded that the results of the implementation of the "Semi Automatic Make Up Oil Engine Compressor at PT

Pertamina EP Regional 2 Zone 7 Tambun Field" tool are as follows:

a. Unplanned compressor shutdown caused by low oil level can be eliminated. Before Implementation of the Semi-Automatic Compressor Engine Oil Make Up Tool, compressor shutdowns occurred due to low oil levels on average 11 times a month. After the implementation of the Semi-Automatic Compressor Engine Oil Make Up Tool, compressor shutdown events due to low oil levels could be eliminated.
b. Time efficiency of oil filling work on 6 compressor units from 30 minutes to 10 minutes (66.6% down time).
c. The compressor lubricating oil filling work becomes safer because there is no need to climb the compressor deck.
d. Supports 5K2S good housekeeping activities because it reduces oil splashes caused by compressor lubricating oil filling activities.

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