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Improving the Testing Facilities for Oil Separation in Grease Samples by Developing the Preter (Pressure Digital Timer) Device

Muthia Putri Hidayati*, Sentiyaki, Ardiansyah, Faris Faruqi Ilham, Ishak Sambas, Aditya Yugo Kartika Enggriawan, Nurudin
PT. Pertamina Lubricants, Indonesia
Email: muthia.hidayati@pertamina.com*

ABSTRACT

Oil Separation testing is the determination of base oil separation from grease during storage at a constant temperature with a pressure of 0.25 psi for 24 hours using an oil separation device. Oil separation testing is a critical parameter in grease product specifications to meet the company's established quality standards. The high %RSD impacts include customer complaints caused by product sedimentation due to oil and soap separation in grease, which clogs suction pumps with solid soap. Customer complaint data from 2024 confirmed these losses, encompassing product replacement costs, return transportation costs, and failed product rework costs. From an internal perspective, during the 24-hour testing process, pressure frequently drops because water in the tube cannot withstand excess pressure and spills out, forcing analysts to periodically refill the tube. This requires analysts to remain on standby for 24 hours, generating overtime costs totaling 5,460 hours from January to October 2024. This research focused on improving the %RSD value through the development of the PRETER tool, consisting of two main components: a Safety Valve as an automatic pressure controller and a Panel Box as a time controller and power supply. Testing involved seven different analysts. Results showed a %RSD of 1.41% for conventional grease and 3.57% for complex grease, both below 5%, proving that the PRETER tool effectively improves testing precision, streamlines the work process, and eliminates the need for 24-hour monitoring.

Keywords: %rsd; oil separation; preter tool.

INTRODUCTION

The problems that have occurred at PT. Pertamina Lubricants is a compliant customer due to the fact that the grease sample is dry, due to the separation between lubricants and additives, so that when vacuumed, the pump becomes clogged due to clumps of additives.

This was proven after we did mapping, where the oil separation test had the highest %RSD value compared to other tests of 13.55%. Oil Separation testing is the determination of the separation of the base lubricating oil from the grease during storage time at a constant temperature at a pressure of 0.25 psi for 24 hours using an oil separation device (Ali, 2024; Hogenberk et al., 2023, 2024, 2025; Jacob, 2023; Schüler et al., 2024). However, inadequate testing facilities result in pressure loss that can affect test results. Pressure loss is caused by the water in the glass tube being wasted due to excess pressure, so that the pressure on the sample is less than optimal (Behzadi et al., 2025; Bello et al., 2023; Deng et al., 2023; James & Tripathi, 2023).

The second is related to the internal process, namely during the oil separation testing process, where during the testing process which is carried out for 24 hours, the pressure is lost because the water in the tube cannot withstand excess pressure so that the water in the tube is wasted and

inevitably the analyst has to refill the tube so that the pressure on the oil separation device becomes stable (Wang et al., 2020; Li et al., 2021). In order for pressure to always be maintained, analysts inevitably have to be on standby for 24 hours, resulting in additional costs to overtime analyst personnel (Gao et al., 2022; Zhao & Yang, 2019). The total overtime hours issued by the Laboratory from January to October 2024 for Oil separations testing are 5,460 hours (Xu et al., 2020; Tang et al., 2021; Zhang & Li, 2023).

Oil separation testing is one of the important parameters in the specifications of grease products so that it can meet the product quality standards that have been set by the company.

This study aims to provide an alternative design of the PRETER tool with the calculation of the %RSD ratio on the results of the oil separations test. The PRETER tool consists of two main components, the first is the Savety Valve as a pressure controller, which can remove excess pressure automatically so that the pressure becomes stable. The second Panel Box as a time controller and power supply, which can turn off the test equipment automatically based on the predetermined time. This study used an experimental method involving seven different analysts to test oil separations.

The use of the PRETER tool to prevent pressure loss and control the test to be on time, so that valid results are obtained, but in this study the discussion will only focus on its use on the oil separation tool so that %RSD <5% is obtained.

Oil Separation testing is the determination of the separation of the base lubricating oil from the grease during storage time at a constant temperature at a pressure of 0.25 psi for 24 hours using an oil separation apparatus (ASTM D1742, 2025). Oil separation (bleed) in grease plays an important role in bearing lubrication. Excessive bleed can shorten the life of the grease, while too low bleed can trigger starvation and damage. Therefore, a predictive model is needed to support the estimation of grease performance/life (Femke Hogenberk et al., 2025).

This test method involves the determination of the separation of the base lubricating oil from the grease during the storage time at constant temperature and a regulated pressure using the Oil Separation tool.

This test is important to estimate the length of grease storage limit, because if the grease has separated from the base lubricating oil, the composition of the remaining grease will change, and this can lead to possible changes in the expected grease performance (TKI, 2023).

This test method cannot be used to predict the possible separation of the base lubricating oil from the grease under dynamic conditions.

A safety valve is a safety valve used in pressurized systems (such as boilers, tanks, or pipes) to automatically release excess pressure to prevent damage or explosion.

The function of the safety valve is to protect the equipment from pressure that exceeds the safe limit, prevent explosion in boilers, gas cylinders, or pressure tanks and remove excess pressure by opening automatically when the pressure exceeds a predetermined value (set pressure) (M. Waxman, 1984).

The way the safety valve works is that when the pressure is normal, the valve remains closed; if the pressure exceeds the set limit, the spring inside the valve will be pressurized and the

valve opens, the fluid (steam, gas, or liquid) comes out so that the pressure drops back down and after the pressure returns to normal, the valve closes again automatically.

A panel box is a box or cabinet used to place and protect electrical or control components such as switches, MCBs, relays, contactors, and other control devices. This panel serves as a place for regulating, distributing, and securing the electrical system.

The function of the panel box is to protect electrical components from dust, water, and physical damage, the place of installation and arrangement of electrical equipment, facilitate the control and monitoring of the electrical system and increase safety so that users do not directly touch the voltage-related components.

Digital and automated time measurement reduces errors due to human factors and improves measurement consistency. In PRETER, the digital timer functions to ensure that the test duration (e.g. 24 hours) runs consistently without the dependency of the standby operator. The consistency of the test time helps to increase the repeatability of the oil separation test results so as to support the reduction of data distribution (%RSD) (Nicola Corna et al., 2021).

%RSD (Percent Relative Standard Deviation) is a value that indicates the extent of the spread or accuracy of the data to its average value. These values are often used in laboratory, chemical, pharmaceutical, and statistical analyses to find out how consistent the measurement results are.

$$\%RSD = \left(\frac{SD}{\bar{x}}\right) \times 100\%$$

Remarks: SD = Standard deviation (standard deviation), $\bar{\mathbf{x}}$ = Mean value (mean) and %RSD = Percentage of relative deviation (Gunawan Indrayanto, 2022).

The function of %RSD is to assess the precision or accuracy of an analysis method, to find out how much the data varies from the average and to compare the consistency of measurement results.

The precision of an analytical procedure is generally expressed as SD or %RSD (CV), while repeatability represents the variation in results when the procedure is applied repeatedly to homogeneous samples in a single laboratory. The implementation of PRETER which automates test time control and improves the stability of test conditions is expected to reduce SD/%RSD, so that the repeatability of the method increases and the test results become more reliable for QC needs.

The urgency of this research is driven by two factors: external customer complaints and internal operational costs. Customer complaints in 2024 confirmed losses encompassing product replacement costs, return transportation costs, and rework costs. Internally, the high overtime hours represent a drain on resources. Without a solution, the laboratory will continue to produce imprecise results and incur unnecessary expenses. Therefore, improving the %RSD value is not just a matter of statistical compliance but a critical business necessity.

The novelty of this research lies in the development of the PRETER tool, which integrates two main components: a Safety Valve as an automatic pressure controller and a Panel Box as a time controller and power supply. No previous study has combined these two functions specifically for the oil separation test. This integration allows for automatic pressure stabilization and time-based shutoff, addressing the root causes of high %RSD without requiring human intervention.

The purpose of this study is to provide an alternative design of the PRETER tool and to calculate the %RSD ratio on the results of oil separation tests. This study uses an experimental method involving seven different analysts to test oil separation. The research contributes a practical, low-cost solution to a common problem in lubricant testing laboratories. The objective is to achieve a %RSD value of less than 5% for both conventional and complex greases.

The benefits of this research are threefold. First, it improves the precision of oil separation tests, leading to more reliable product quality data. Second, it streamlines the work process by eliminating the need for 24-hour analyst monitoring. Third, it reduces operational costs by removing overtime hours. This study focuses only on the use of the PRETER tool on the oil separation apparatus to achieve %RSD <5%, without addressing other potential variables in grease testing.

RESEARCH METHOD

Types of Research

The research method used an experimentation method, namely finding the %RSD value from the results of oil separations testing before and after the repair (using the PRETER tool). The results of observation and testing will be presented quantitatively in tabulation form equipped with some simple statistical operations.

Time and Place of Research

The research was carried out at the Jakarta Production Unit Laboratory, PT. Pertamina Lubricants, Jakarta and Workshop. The assembly of the PRETER tool and the collection of research data were carried out in the period of July – October 2024.

Research Materials and Tools

The materials used in this study are grease samples, and the tools used in this study use Oil separations tools.

Work Procedure

The procedure for making the PRETER tool begins with making a Savety Valve which functions to withstand and release excess pressure, then the savety valve is attached to the pressure gauge and after that pressure calibration is carried out by the KAN institution (Appendix 1). The second is the manufacture of a Panel Box that functions to turn off the oil separation device automatically, then the panel box is calibrated by a timer by the KAN institution (Appendix 2). After calibration, oil separation testing was carried out by 7 different analysts to obtain a %RSD value, where a comparison of test results was carried out before repair (24-hour monitoring and without 24-hour monitoring) and after repair (24-hour monitoring and using PRETER innovation). The method of oil separation testing is: weigh the weight of the empty bowl and cup cup, put the grease in the bowl until it is full, then weigh it (± 100–120 grams), place the empty cup cup directly under the bowl, install the bowl lid and connect it with the air hose on the inside of the Oil Separation device, let the test last for 24 hours and at the end of the test, cup weighing to a precision of 0.05 grams. Reporting includes the percentage of oil weight lost from a grease sample tested on a test cup with a rounding of 0.01%.

RESULTS AND DISCUSSION

Before Repair

Table 1. Conventional Sample Oil Separations Results

24-hour monitoring	Yield (%)	Without 24-hour monitoring	Yield (%)
Repetition	**Yield (%)**	**Repetition**	**Yield (%)**
1	2.71	1	1.72
2	2.64	2	2.53
3	2.59	3	1.54
4	2.68	4	2.64
5	2.74	5	1.12
6	2.63	6	2.06
7	2.71	7	2.23
Average	**2.67**	**Average**	**1.98**
SD	**0.05**	**SD**	**0.55**
%RSD	**2.00%**	**%RSD**	**27.76%**

Table 2. Oil Separations Sample Complex Results

24-hour monitoring	Yield (%)	Without 24-hour monitoring	Yield (%)
Repetition	**Yield (%)**	**Repetition**	**Yield (%)**
1	1.52	1	1.23
2	1.47	2	1.47
3	1.53	3	0.81
4	1.56	4	1.52
5	1.61	5	1.23
6	1.53	6	0.86
7	1.48	7	1.23
Average	**1.53**	**Average**	**1.19**

SD	**0.05**	**SD**	**0.27**
%RSD	**3.10%**	**%RSD**	**22.84%**

B. After Repair

Table 3. Conventional Sample Oil Separations Results

24-hour monitoring	**Yield (%)**	**Using PRETER Innovation**	**Yield (%)**
Repetition	**Yield (%)**	**Repetition**	**Yield (%)**
1	2.71	1	2.71
2	2.64	2	2.64
3	2.59	3	2.64
4	2.68	4	2.63
5	2.74	5	2.63
6	2.63	6	2.71
7	2.71	7	2.61
Average	**2.67**	**Average**	**2.64**
SD	**0.05**	**SD**	**0.04**
%RSD	**2.00%**	**%RSD**	**1.41%**

Table 4. Oil Separations Sample Complex Results

24-hour monitoring	**Yield (%)**	**Using PRETER Innovation**	**Yield (%)**
Repetition	**Yield (%)**	**Repetition**	**Yield (%)**
1	1.52	1	1.52
2	1.47	2	1.47
3	1.53	3	1.48
4	1.56	4	1.53
5	1.61	5	1.56
6	1.53	6	1.61
7	1.48	7	1.52
Average	**1.53**	**Average**	**1.53**

SD	**0.05**	**SD**	**0.05**
%RSD	**3.10%**	**%RSD**	**3.57%**

1. Initial Conditions

In the early stages, both conventional greases and complex greases show a high %RSD value. Further investigation showed that one of the main factors causing the high variation in test values was the air pressure in the oil separation device that was less stable. These pressure fluctuations cause oil release results to be inconsistent from one test to another.

2. 24-Hour Monitoring

As a temporary corrective measure, 24-hour monitoring is carried out to ensure that the air pressure remains within the expected range. As a result, the %RSD value was successfully lowered to <5%, indicating an increase in precision. However, this approach has some limitations:

1) Increase the duration and workload of analysts.
2) Potentially causing work fatigue.
3) Less efficient in terms of laboratory productivity.
4) Not solving the root of the problem technically.

3. Implementation of PRETER Innovation

To overcome the root cause of the variation in test results, an innovation was developed using the PRETER device that functions to stabilize air pressure. As a result, the %RSD value can be maintained <5% consistently on both types of grease without the need for 24-hour monitoring. This shows that air pressure stabilization via PRETER directly reduces the variability of test results. In addition to improving precision, this innovation also improves operational efficiency and sustainability of laboratory work systems.

CONCLUSION

The use of the PRETER tool has been proven to be more effective than the initial method or 24-hour monitoring because it is able to stabilize the air pressure in the oil separation tool and produce a %RSD value of <5% consistently on conventional and complex greases, so that the test precision becomes better, the work process is more efficient, and the need for 24-hour monitoring can be eliminated with more optimal results.

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