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The Performance Evaluation of a Horizontal Capstan in the Lori Pulling System at Bah Jambi Palm Oil Mill

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Abstract: *This study evaluated the performance of a horizontal capstan used in the lori pulling system at Bah Jambi Palm Oil Mill. The study focused on the operational relationship among gearbox pulley rotation, lubricant viscosity, gearbox/oil temperature, and lori pulling time as indicators of capstan effectiveness. Field observations were conducted from 11 to 25 May 2026 by measuring motor speed, pulley dimensions, wire rope diameter, shaft spacing, oil viscosity, gearbox/oil temperature, and lori pulling time. Gearbox pulley speed was calculated from the pulley ratio, while changes in viscosity, temperature, and pulling time were analyzed descriptively to assess the operating condition of the capstan system. The results showed that the gearbox pulley rotated at 13 rpm, indicating an effective speed reduction mechanism for generating the torque required to pull sterilizer lorries. During the observation period, oil viscosity decreased from 30.71 cSt to 21.63 cSt, equivalent to a reduction of 29.57%, while gearbox/oil temperature increased from 41.77°C to 45.47°C. Despite lubricant degradation, lori pulling time remained relatively stable within 137.33–143.67 s, indicating that the capstan continued to operate effectively. Overall, the horizontal capstan at Bah Jambi Palm Oil Mill remained operationally reliable during the study period, although the decline in lubricant condition suggests the need for periodic monitoring and maintenance to preserve long-term transmission performance.*

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INTRODUCTION

Palm oil mills rely on a series of interconnected mechanical systems to ensure the smooth transfer of fresh fruit bunches and sterilized fruit during processing. One important supporting unit in the sterilization station is the horizontal capstan, which is used to pull lorries along the rail line toward or away from the sterilizer. The operational reliability of this equipment directly affects process continuity because any disruption in the lori pulling system may delay sterilization, disturb production flow, and reduce mill efficiency. For this reason, evaluating the operating condition of the horizontal capstan is important not only from a maintenance perspective but also from the standpoint of process performance in palm oil mill operations.

In practical operation, the performance of a horizontal capstan is influenced by the transmission system that transfers power from the electric motor to the gearbox and finally to the pulling mechanism. Parameters such as motor speed, pulley dimensions, transmission alignment, lubricant condition, and gearbox operating temperature determine how effectively the system can convert rotational motion into the pulling force required to move the lori load. Among these parameters, lubricant viscosity plays a critical role because it determines the ability of the oil to form a protective film between interacting surfaces such as gears, shafts, and bearings. A reduction in oil viscosity may decrease lubrication quality, increase friction, accelerate wear, and eventually reduce transmission efficiency (Adebogun et al., 2020; Baumann & Bertsche, 2022).

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Gearbox and oil temperature are also closely related to capstan performance because temperature changes influence lubricant properties and tribological behavior. An increase in operating temperature generally lowers oil viscosity, which can reduce the thickness of the lubricant film and alter frictional behavior in the transmission system (Douglas & Thite, 2015; Lu et al., 2021). In industrial applications, prolonged operation under elevated temperature and degraded lubrication conditions may reduce the reliability of gears and rolling bearings (Hammami et al., 2018). However, a reduction in viscosity does not always lead to an immediate decrease in machine performance, especially when the system is still operating within an acceptable mechanical range and the transmitted load remains manageable.

Previous studies have discussed lubricant behavior in gearbox systems, the influence of oil temperature on transmission efficiency, and the role of transmission elements such as pulleys and gearboxes in industrial machinery (Ismon et al., 2015; Mahmudi, 2021; Putra et al., 2023). Nevertheless, studies specifically examining the operational performance of a horizontal capstan in a palm oil mill lori pulling system remain limited, particularly those linking gearbox pulley rotation, lubricant viscosity, gearbox/oil temperature, and lori pulling time within one operational evaluation. This gap is important because capstan performance in palm oil mills is not only a matter of transmission design but also a practical maintenance issue affecting production continuity.

The novelty of this study lies in the integrated operational evaluation of a horizontal capstan under actual working conditions in a palm oil mill. Unlike previous studies that mainly examined gearbox performance, lubricant characteristics, or transmission components separately, this study simultaneously evaluates gearbox pulley rotational speed, lubricant viscosity, gearbox/oil temperature, and lori pulling time as interconnected operational indicators. By combining these parameters in a single field-based evaluation, this research provides a more comprehensive understanding of horizontal capstan performance and offers practical information to support maintenance planning and improve the operational reliability of lori pulling systems in palm oil mills.

Although horizontal capstans have been widely used in palm oil mills to support the lori pulling system, information regarding their operational performance under actual industrial conditions remains limited. Previous studies have generally discussed transmission systems, gearbox mechanisms, or lubricant characteristics separately, while the relationship among gearbox pulley rotation, lubricant viscosity, gearbox/oil temperature, and lori pulling performance has rarely been evaluated simultaneously in a horizontal capstan system. As lubricant properties gradually change during continuous operation, variations in transmission performance may occur and potentially influence the reliability of lori movement during the sterilization process. Therefore, evaluating these operational parameters is important to provide practical information for maintenance planning and to improve the reliability of horizontal capstan operation in palm oil mills.

Therefore, this study aimed to evaluate the operational effectiveness of the horizontal capstan used in the lori pulling system at Bah Jambi Palm Oil Mill. Specifically, the objectives of this study were to determine the rotational speed of the gearbox pulley based on the transmission ratio, evaluate changes in lubricant viscosity and gearbox/oil temperature during the observation period, and assess the effect of these operational changes on lori pulling performance. The findings are expected to provide practical information for improving maintenance strategies and supporting reliable operation of horizontal capstan systems in palm oil mills.

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RESEARCH METHOD

This research was conducted at Bah Jambi Palm Oil Mill, PTPN IV, on the horizontal capstan used in the lori pulling system at the sterilization station from 11 to 25 May 2026. The observed parameters included electric motor speed, motor pulley diameter, gearbox pulley diameter, wire rope diameter, distance between the motor shaft and gearbox shaft, lubricant viscosity, gearbox/oil temperature, and lori pulling time.

The measurements were performed using several standard measuring instruments. Electric motor rotational speed was measured using a tachometer, pulley and wire rope diameters were measured using a vernier caliper, shaft spacing was measured using a measuring tape, gearbox/oil temperature was recorded using an infrared thermometer, lubricant viscosity was determined using a viscometer, and lori pulling time was measured using a digital stopwatch. Field observations were conducted repeatedly during the study period from 11 to 25 May 2026. Measurements of lubricant viscosity, gearbox/oil temperature, and lori pulling time were recorded during each observation to evaluate changes in the operational condition of the horizontal capstan over time.

The fixed mechanical parameters used as the basis for evaluating the capstan transmission system are presented in Table 1.

Table 1. Fixed Operational Parameters of the Horizontal Capstan System

Parameter	Value	Unit
Electric motor speed	26	rpm
Motor pulley diameter	45	mm
Gearbox pulley diameter	90	mm
Wire rope diameter	12	mm
Distance between motor shaft and gearbox shaft	80	mm

Primary data were obtained through direct field measurements and repeated observations throughout the study period. Electric motor speed was recorded as the rotational input of the transmission system, while pulley diameters, wire rope diameter, and shaft spacing were measured once because these represented fixed mechanical parameters. In contrast, lubricant viscosity, gearbox/oil temperature, and lori pulling time were measured repeatedly during each observation period to monitor operational changes in the horizontal capstan.

The rotational speed of the gearbox pulley was determined using the pulley transmission equation:

$$N_2 = \frac{N_1 \times D_1}{D_2}$$

where n2 is the gearbox pulley rotational speed (rpm), n1 is the electric motor rotational speed (rpm), d1 is the motor pulley diameter (mm), and d2 is the gearbox pulley diameter (mm). Using a motor speed of 26 rpm, a motor pulley diameter of 45 mm, and a gearbox pulley diameter of 90 mm, the calculated gearbox pulley speed was 13 rpm.

The collected data were analyzed descriptively by comparing the initial and final values of lubricant viscosity, gearbox/oil temperature, and lori pulling time over the observation period. Changes in these variables were then interpreted to evaluate the operating condition of the capstan system. The relationship between viscosity decline and gearbox/oil temperature increase was discussed in

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relation to the stability of lori pulling performance and the effectiveness of the gearbox pulley rotation in supporting capstan operation.

RESULTS AND DISCUSSION

Gearbox pulley rotation and transmission characteristics

Based on the observed operating parameters, the electric motor speed was 26 rpm, the motor pulley diameter was 45 mm, and the gearbox pulley diameter was 90 mm. Using the pulley ratio equation, the rotational speed of the gearbox pulley was calculated to be 13 rpm. The calculation details are presented in Table 2.

Table 2. Calculation of Gearbox Pulley Rotational Speed

Parameter	Symbol	Value
Electric motor speed	n_1	26 rpm
Motor pulley diameter	d_1	45 mm
Gearbox pulley diameter	d_2	90 mm
Gearbox pulley rotational speed	n_2	13 rpm

As shown in Table 2, the transmission ratio reduced the motor speed by half, resulting in a gearbox pulley speed of 13 rpm. For a horizontal capstan, the purpose of this speed reduction is to increase torque so that the system can pull lorries effectively.

Changes in lubricant viscosity during operation

The main operational changes observed during the study period are summarized in Table 3. This table presents the core performance indicators used to evaluate the operational effectiveness of the horizontal capstan.

Table 3. Changes in Oil Viscosity, Gearbox/Oil Temperature, and Lori Pulling Time During Observation

Observation item	Initial value	Final value	Change
Oil viscosity	30.71 cSt	21.63 cSt	-29.57%
Gearbox/oil temperature	41.77 °C	45.47 °C	+3.70 °C
Lori pulling time	143.00 s	137.34 s	-5.66 s

As presented in Table 3, lubricant viscosity gradually decreased during the observation period from 30.71 cSt to 21.63 cSt, indicating a viscosity reduction of 29.57%. This decline suggests progressive lubricant degradation during repeated capstan operation. Lubricating oil plays a critical role in forming a protective film between interacting metal surfaces such as gears, shafts, and bearings. When viscosity decreases, the oil becomes less capable of maintaining a sufficiently thick lubricant film, which may reduce surface protection and increase the risk of friction and wear. The observed reduction in lubricant viscosity is consistent with previous tribological studies. Douglas and Thite (2015) explained that prolonged mechanical operation increases thermal stress within gearbox systems, accelerating lubricant degradation and reducing viscosity. Similarly, Lu et al. (2021) reported that continuous operation under elevated temperatures gradually changes lubricant properties, although moderate viscosity reduction does not necessarily cause immediate deterioration in transmission performance when the system is still operating within its design limits. The present

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findings support these observations because the lubricant viscosity decreased throughout the monitoring period while the capstan system continued to operate normally.

During the same observation period, the average gearbox/oil temperature increased from 41.77°C to 45.47°C, representing an increase of 3.70°C. This increase occurred simultaneously with the reduction in oil viscosity shown in Table 3, indicating a clear operational relationship between temperature rise and lubricant thinning. In gearbox systems, temperature changes affect lubrication characteristics, frictional losses, and the ability of the oil to maintain a stable lubricating film.

Lori pulling time was used as a practical indicator of capstan performance. As shown in Table 3, the average pulling time decreased from 143.00 s at the beginning of the study to 137.34 s at the end of the observation period, while the overall range remained within 137.33–143.67 s. These results indicate that the horizontal capstan was able to maintain stable lori pulling performance despite the reduction in lubricant viscosity and the increase in gearbox/oil temperature.

Overall, the study demonstrates that the horizontal capstan at Bah Jambi Palm Oil Mill remained in good operating condition during the observation period. The gearbox pulley rotation of 13 rpm was effective in supporting lori pulling, while the relatively stable lori pulling time indicates that the capstan transmission system continued to function effectively.

Relationship between gearbox/oil temperature and viscosity reduction

During the same observation period, the average gearbox/oil temperature increased from 41.77°C to 45.47°C, representing an increase of 3.70°C. This increase occurred simultaneously with the reduction in oil viscosity, indicating a clear operational relationship between temperature rise and lubricant thinning.

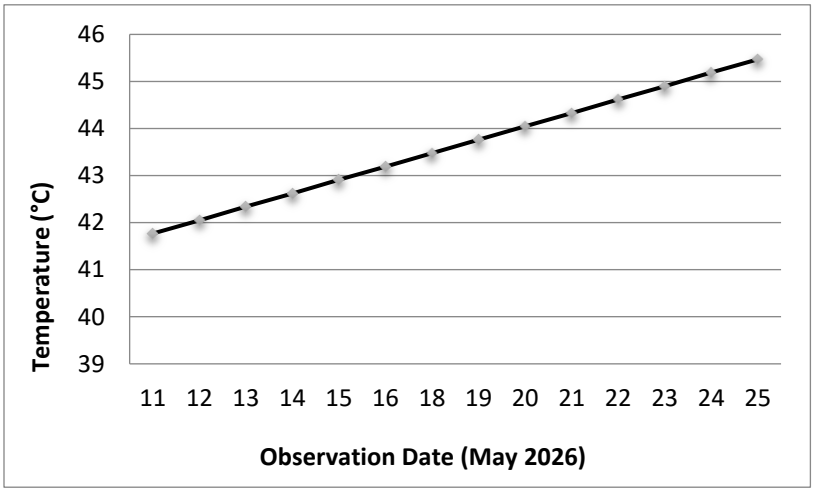

Figure 1. Changes in Gearbox/Oil Temperature During the Observation Period

From a tribological perspective, oil viscosity is highly temperature-dependent. As temperature rises, molecular mobility increases and intermolecular attraction weakens, making the oil flow more easily and reducing its viscosity. In gearbox systems, temperature changes affect lubrication characteristics, frictional losses, and the ability of the oil to maintain a stable lubricating film (Douglas & Thite, 2015). The observed increase in temperature in the capstan system was likely caused by repeated friction among gears, shafts, and bearings, together with continuous mechanical loading

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during lori pulling operations. Similar behavior has been reported in gearbox studies where increasing operating temperature accelerates changes in lubricant properties and contributes to oil degradation (Lu et al., 2021).

Although the recorded temperature remained within a manageable operating range and did not cause obvious failure during the study period, the consistent decrease in viscosity alongside increasing temperature indicates that gearbox/oil temperature is an important monitoring parameter for capstan maintenance. A similar relationship between temperature rise and lubricant degradation has also been reported by Hammami et al. (2018), who emphasized that increasing operating temperature accelerates lubricant ageing and may eventually reduce gearbox reliability if corrective maintenance is not performed. In the present study, the temperature increase was relatively small (3.70°C), indicating that the transmission system remained within an acceptable operating range during the observation period. Nevertheless, periodic monitoring of lubricant condition remains essential to prevent long-term mechanical deterioration. If temperature continues to rise while viscosity continues to decline, the lubricant may lose its ability to adequately protect gears and bearings, thereby increasing the risk of wear and transmission inefficiency (Hammami et al., 2018).

Lori pulling time as an indicator of capstan performance

Lori pulling time was used as a practical indicator of the operational performance of the horizontal capstan. The measured average pulling time ranged from 137.33 s to 143.67 s during the observation period. At the beginning of the study, the pulling time was around 143 s, whereas toward the end it was generally within 137–138 s. This means that the final average pulling time was 5.66 s shorter than at the beginning of the observation period.

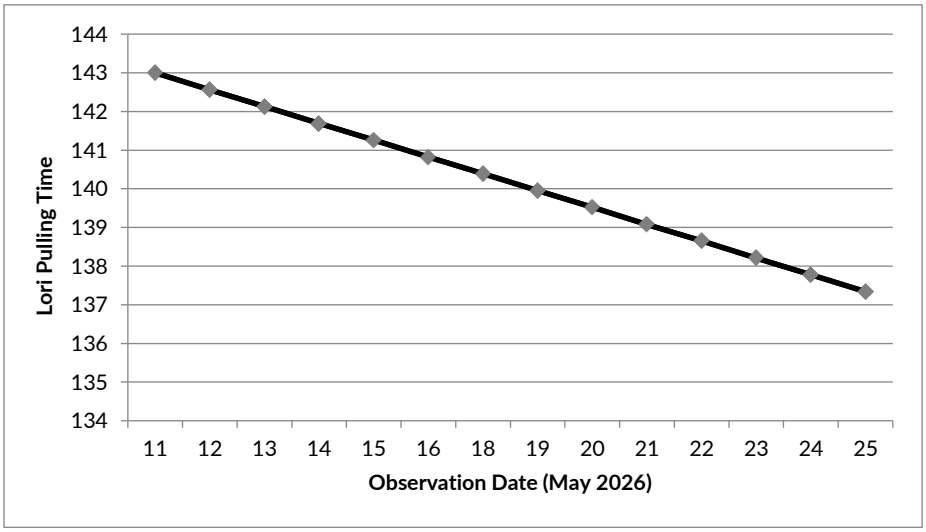

Figure 2. Changes in Lori Pulling Time During the Observation Period

The stable lori pulling time observed throughout the study is consistent with the findings of Mahmudi (2021), who reported that an appropriate transmission ratio contributes to efficient power transmission and stable mechanical performance. In the present study, the gearbox pulley rotational speed of 13 rpm was sufficient to provide the torque required for pulling the lori consistently, despite the gradual decrease in lubricant viscosity. These findings indicate that the transmission system was

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still operating within an acceptable mechanical condition, allowing the capstan to maintain reliable operational performance during the observation period.

These results indicate that the horizontal capstan was able to maintain stable lori pulling performance despite the reduction in lubricant viscosity and the increase in gearbox/oil temperature. In field operation, small fluctuations in pulling time are normal because the pulling process is influenced not only by machine condition but also by lori position, lori load, rail condition, track slipperiness, and operator handling. Nevertheless, the absence of a major increase in pulling time suggests that the capstan transmission system continued to function effectively during the study period.

This stable performance was also supported by the fact that the main mechanical parameters remained unchanged throughout the study. The electric motor speed remained 26 rpm, the wire rope diameter remained 12 mm, the shaft distance between the gearbox and motor remained 80 mm, the motor pulley diameter remained 45 mm, and the gearbox pulley diameter remained 90 mm. The stability of these parameters indicates that no major mechanical disturbance occurred in the capstan system, and that the observed reduction in lubricant quality had not yet progressed to a level that significantly affected lori pulling performance.

Overall performance evaluation of the horizontal capstan

Overall, the study demonstrates that the horizontal capstan at Bah Jambi Palm Oil Mill remained in good operating condition during the observation period. The gearbox pulley rotation of 13 rpm was effective in supporting lori pulling because the transmission system was designed to reduce speed and generate the torque required for hauling. At the same time, the capstan maintained relatively stable lori pulling time despite a 29.57% decline in lubricant viscosity and a 3.70°C increase in gearbox/oil temperature.

These findings suggest that the capstan still possessed acceptable operational reliability during the study period. However, the decline in lubricant viscosity should not be ignored. While it did not immediately reduce lori pulling performance, prolonged viscosity degradation may eventually reduce lubrication quality, increase friction, accelerate wear in gears and bearings, and decrease transmission efficiency. Therefore, the capstan's long-term reliability depends not only on transmission design and pulley rotation but also on regular monitoring of lubricant condition, gearbox temperature, alignment, and the general condition of the pulling components. In this sense, capstan performance is the result of the interaction among lubrication condition, transmission temperature, mechanical stability, and torque transmission capability.

Overall, the present study confirms that gearbox pulley rotation, lubricant condition, and gearbox operating temperature should be evaluated simultaneously when assessing capstan performance. Unlike evaluations that focus only on transmission design or lubricant properties, integrating these operational parameters provides a more comprehensive understanding of capstan reliability under actual mill operating conditions. This integrated approach may assist maintenance personnel in identifying early signs of transmission deterioration before operational failure occurs.

CONCLUSION

The horizontal capstan used in the lori pulling system at Bah Jambi Palm Oil Mill remained effective and operationally stable during the observation period. The gearbox pulley rotational speed of 13 rpm reflected an appropriate speed reduction mechanism for generating the torque required for

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lori pulling. Although lubricant viscosity decreased from 30.71 cSt to 21.63 cSt and gearbox/oil temperature increased from 41.77°C to 45.47°C, the lori pulling time remained relatively stable at 137.33–143.67 s, indicating that the decline in lubricant quality had not yet caused a significant reduction in capstan performance. Overall, the study shows that the horizontal capstan was still reliable under the observed operating conditions, but periodic monitoring of oil viscosity, gearbox temperature, transmission alignment, and pulling components is necessary to maintain long-term performance and prevent future deterioration of the transmission system.

Future studies are recommended to include additional operational parameters, such as actual lori load, electric motor power consumption, wear of transmission components, and laboratory analysis of lubricant condition (e.g., total acid number, water content, and metal particle content). A longer observation period is also recommended to provide a more comprehensive evaluation of the long-term operational reliability of the horizontal capstan system.

REFERENCES

Adebogun, A., Hudson, R., Matthews, A., & Withers, P. J. (2020). Industrial gear oils: Influence of bulk oil temperature and contact pressure on tribological performance and subsurface changes. *Tribology Letters*, *68*(1), 1-20. https://doi.org/10.1007/s11249-020-1287-z

Ariyanto, A., Widodo, S., & Nugroho, H. (2021). Analisis kinerja motor listrik pada sistem penggerak industri. *Jurnal Rekayasa Mesin*, *16*(2), 85-92.

Baumann, A., & Bertsche, B. (2022). Coefficient of friction behavior of gear oils and significance for the meshing process of spur gears: Lubrication for improved properties. *Forschung im Ingenieurwesen/Engineering Research*, *86*(4), 795-805. https://doi.org/10.1007/s10010-022-00589-9

Douglas, C. E., & Thite, A. (2015). Effect of lubricant temperature and type on spur gear efficiency in racing engine gearbox across full engine load and speed range. *Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology*, *229*(9), 1095-1113. https://doi.org/10.1177/1350650115574305

Ghofur, A. A., Zakki, A. F., & Yudo, H. (2017). Analisis penggunaan capstan pada sistem penambatan kapal. *Jurnal Teknik Perkapalan*, *5*(4), 857-864.

Giyanto, G., Damanik, G., & Aisyah, S. (2022). Kajian perbedaan metode aplikasi etephon 60% terhadap efisiensi pembrondolan serta nilai DOBI, beta karoten dan vitamin E pada tandan buah segar kelapa sawit. *Jurnal Agro Fabrica*, *4*(2), 48-59. https://doi.org/10.47199/jaf.v4i2.110

Hammami, M., Martins, R., Fernandes, C., Seabra, J., Abbes, M. S., & Haddar, M. (2018). Friction torque in rolling bearings lubricated with axle gear oils. *Tribology International*, *119*, 419-435. https://doi.org/10.1016/j.triboint.2017.11.018

Hasibuan, Y. M., Zaharuddin, & Sitorus, A. (2024). Perancangan alat bantu dorong lori untuk mengurangi kelelahan karyawan di stasiun capstan pabrik kelapa sawit. *JENIUS: Jurnal Terapan Teknik Industri*, *5*(1), 69-76. https://doi.org/10.37373/jenius.v5i1.865

Ismon, M., Zaman, I., & Ghazali, M. I. (2015). Condition monitoring of variable speed worm gearbox lubricated with different viscosity oils. *Applied Mechanics and Materials*, *773-774*, 178-182. https://doi.org/10.4028/www.scientific.net/AMM.773-774.178

Lu, F., Wang, M., Pan, W., Bao, H., & Ge, W. (2021). CFD-based investigation of lubrication and temperature characteristics of an intermediate gearbox with splash lubrication. *Applied Sciences*, *11*(1), Article 352. https://doi.org/10.3390/app11010352

Lumbantoruan, P., & Yulianti, E. (2016). Pengaruh Suhu terhadap Viskositas Minyak Pelumas (Oli). Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam, 13(2), 26–34.

Copyright © 2026, the author(s). This is an open access article under the CC-BY-SA License.

Mahmudi, H. (2021). Analisa perhitungan pulley dan V-belt pada sistem transmisi mesin pencacah. *Jurnal Mesin Nusantara*, *4*(1), 40-47. https://doi.org/10.29407/jmn.v4i1.16201

Nurdin, I., Arifin, K., Nurdin, I., & Taswin, A. (2023). Analisis Kekuatan Tali Baja (Wire Rope) Dalam Penggunaan Alat Angkat Keranjang (Basket) Peralatan. Jurnal Rekayasa Mesin dan Inovasi Teknologi, 4(1), 235–245.

Pangaribuan, L. V. (2018). Analisis Kecelakaan Kerja pada Mesin Capstan di Pabrik Pengolahan Kelapa Sawit (Skripsi S1). Universitas Atma Jaya Yogyakarta.

Prakos, C. A., Androva, A., & Safi'i, M. (2026). Optimasi Interval Penggantian Oli Hidrolik dan Suhu Operasi untuk Meningkatkan Kinerja Sistem Hidrolik pada Excavator Komatsu PC2000-11. Blend Sains Jurnal Teknik, 5(1), 76–85.

Prasetyo, A., & Assagaf, M. (2023). Analisis sistem transmisi dan gearbox pada peralatan industri. *Jurnal Integrasi*, *15*(2), 101-108.

Putra, D. S., Ariyanto, A., & Feriadi, I. (2023). Pengaruh variasi waktu operasi mesin terhadap perubahan nilai viskositas dan total acid number untuk pelumas gearbox. *Jurnal Inovasi Teknologi Terapan*, *1*(1), 16-23. https://doi.org/10.33504/jitt.v1i1.20

Riswanto, A., Saktiono, M. A., & Awwalin, R. (2026). Analisa Ketidaksesuaian Putaran Ratio Gearbox terhadap Putaran RPM Main Engine yang Mengakibatkan Terjadinya High Temperatur Pelumasan Lubricating Oil Gearbox di Kapal MV. Prakarsa Mas. Jurnal Aplikasi Pelayaran dan Kepelabuhanan, 16(2), 197–207. https://doi.org/10.30649/japk.v16i2.191

Sawong, S., Siahaan, H., & Simanjuntak, R. (2011). Analisis sistem transportasi lori pada pabrik kelapa sawit. *Jurnal Teknologi Perkebunan*, *6*(1), 25-32.

Sutisna, Y., Rachmat, D., & Darma, A. Y. (2018). Kajian penggunaan compact indexer sebagai sistem penunjang operasional di pabrik kelapa sawit. *Jurnal Teknologi Industri Kelapa Sawit*, *8*(2), 45-53.

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