BX07 - Strategic Application of a Wireless Tool on Dozers Maintenance in a Bauxite Mine

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Abstract

The replacement of a tractor bar clearance measuring equipment with a wireless tool is a solution that offers several advantages over the previous method. Measuring the clearance of tractor bars is a critical activity for maintaining heavy equipment used in mining operations, such as tractors and other vehicles. However, performing this task can be dangerous as mechanicals often need to enter hazardous areas to perform measurements, such as the tracks where tractors are operating.

Implementing a wireless tool to measure tractor bar clearances offers a safe and effective solution to minimize the risk of fatality during inspection activities at a bauxite mine in northern Brazil. With the use of this technology, precise and reliable measurements can be made without the need to enter hazardous areas, significantly reducing the likelihood of serious accidents.

The wireless tool consists of a proximity sensor that is attached to the end of a measuring rod, allowing the measurement of tractor bar clearances at a safe distance. This tool can be operated remotely through a mobile device or computer, eliminating the need for wires and cables that could easily become entangled or a hindrance.

Furthermore, the wireless tool is more convenient and easier to use than the previous measuring equipment, as it is portable and can be easily transported from one location to another. The tool is also capable of collecting real-time data, allowing operators to monitor equipment conditions and take necessary measures to maintain worker safety.

In summary, replacing the tractor bar clearance measuring equipment by a wireless tool is an innovative solution that offers numerous advantages for conducting inspection activities in bauxite mines and other mining operations. This technology minimizes the risk of fatality during inspection activities and improves the efficiency and convenience of maintenance operations.

Keywords: Bauxite, Maintenance, Predictive, Inspection, Wireless.

1. Introduction

In the realm of heavy machinery used in the dynamic and demanding environments of mining operations, ensuring safety and maintaining operational efficiency stands as an unceasing challenge. Among the critical components of these colossal machines, the equalizer bars of D11 tractors bear paramount significance. These bars play a pivotal role in stabilizing and distributing forces across the vehicle, enabling seamless movement over varied terrains and loads. However, this pivotal function necessitates meticulous attention, regular maintenance, and accurate measurements to ensure their optimal performance and prevent potential hazards.

This introduction embarks upon a comprehensive exploration of the crucial aspects surrounding the measurement of clearance in D11 tractor equalizer bars, contextualizing its paramount importance in the broader spectrum of mining machinery maintenance and operation. The discussion delves into the multifaceted dimensions, underpinning the significance of precise clearance measurements and the inherent risks entailed in the process within hazardous work areas.

Within the intricate labyrinth of heavy machinery that constitutes a mining site, the D11 tractor stands as an embodiment of power and functionality. Serving as the workhorses of excavation and transportation, these tractors perform under strenuous conditions, relentlessly driven by the demands of mineral extraction. At the heart of their intricate design, the equalizer bars harmonize the colossal forces and stresses generated during operation, ensuring stability and controlled movement. The dynamic interplay between these components not only affects the machine's performance but also the safety of the operators and the longevity of the equipment.

Maintenance, a cornerstone of efficient mining operations, becomes a paramount endeavor to preserve the integrity of these massive machines. A central aspect of this maintenance regime is the measurement of clearance in the equalizer bars, a task inherently tied to their optimal functioning. Ensuring that the clearances are within designated specifications guarantees the appropriate distribution of forces and stresses, thereby preventing undue wear, imbalanced loads, and potentially catastrophic failures. Consequently, precise measurement of clearance emerges as a critical process to safeguard both the equipment and the personnel operating near it.

Moreover, the mining environment is characterized by its unforgiving nature, as it juxtaposes advanced machinery with rugged terrains and harsh conditions. The implications of neglecting or inaccurately measuring clearance in D11 tractor equalizer bars could reverberate far beyond mere mechanical inefficiency. It could culminate in compromised stability, unexpected breakdowns, and dire safety concerns for operators and bystanders alike. Thus, the contextualization of the importance of clearance measurements in these high-performance machines transcends the realm of maintenance, intertwining it with the overarching goal of cultivating a secure and productive mining ecosystem.

The act of measuring clearance in D11 tractor equalizer bars, while inherently essential, unfolds within a web of challenges and potential hazards. The locations where these measurements are conducted often intersect with hazardous areas within the mining environment. The intertwining of precise measurement requirements and perilous work zones underscores the inherent risks associated with this pivotal maintenance task.

Hazardous areas within mining sites encompass a spectrum of elements that can imperil the well-being of personnel and the integrity of equipment. These areas might encompass uneven terrain, restricted spaces, exposure to moving machinery, and the presence of potentially harmful substances. As mechanics and operators venture into these perilous territories to carry out clearance measurements, they expose themselves to a heightened probability of accidents, injuries, or even fatalities.

The act of measurement itself can amplify these risks. Traditionally, measuring clearance in equalizer bars often necessitated direct physical access to the machinery, placing personnel near moving components and confined spaces. This physical presence significantly elevates the chances of accidental contact with moving parts, entanglement with machinery, or exposure to detrimental conditions like excessive noise, vibration, and airborne contaminants.

Furthermore, the exigencies of the mining industry often dictate that measurements be performed under time constraints, intensifying the pressure on personnel to swiftly execute tasks within hazardous areas. This time-sensitive scenario augments the likelihood of oversight or errors, as the rush to complete measurements may overshadow adherence to stringent safety protocols.

In summary, the discussion of risks associated with measuring activities in hazardous areas within mining environments underscores the critical importance of devising innovative and safer methodologies for clearance measurements in D11 tractor equalizer bars. The convergence of intricate machinery, demanding work conditions, and stringent measurement requirements necessitates a paradigm shift in approach to ensure the well-being of personnel and the longevity of equipment. This exploration seeks to unravel the complexities and intricacies of these risks while advocating for the integration of advanced technologies to transcend traditional limitations and mitigate potential hazards.

2. Literature Review

The precise measurement of clearances in heavy equipment holds pivotal significance for ensuring operational efficiency, maintenance, and, above all, the safety of personnel in diverse industrial sectors. Over time, a spectrum of methodologies and technologies has been harnessed to execute accurate and reliable clearance measurements, contributing to the seamless functioning of heavy machinery.

Traditional approaches have encompassed the utilization of mechanical measuring instruments such as dial indicators and gauges. These instruments, known for their robustness and accuracy, facilitate a direct assessment of clearances between vital components. However, their usage necessitates operators to physically engage with the machinery, often placing them in perilous situations within hazardous environments like mining sites and construction zones. The inherent risk of physical proximity to moving mechanical parts and complex equipment is an ever-looming concern that demands innovative solutions.

In response to these challenges, pioneering technologies have emerged to revolutionize the clearance measurement landscape in heavy equipment. Laser proximity sensors have garnered attention as a contemporary solution that obviates the need for physical contact during measurements. These sensors emit laser beams, which interact with the machinery's components and provide data for the precise calculation of clearances. By eliminating the requirement for direct human-machine interaction, laser sensors mitigate risks and enhance operator safety, especially in confined spaces or areas with restricted access.

Another vanguard advancement lies in the domain of imaging technologies, where sophisticated cameras and computer vision systems come into play. These systems capture intricate images of components, subsequently subjecting these images to intricate algorithms that decipher the clearances present. This approach, devoid of direct physical involvement, introduces an unprecedented level of safety and accuracy. Imaging technologies have a potent role to play, particularly in intricate spaces where physical measurements are a challenge.

The contemporary industrial landscape has undergone a profound metamorphosis, fueled by the relentless march of technological innovation. Within this realm, wireless technologies, notably Bluetooth, have emerged as transformative tools, orchestrating a symphony of efficiency, safety, and seamless communication within industrial settings.

Bluetooth, hailed as a paragon of wireless connectivity, has carved an indelible niche in the industrial domain. Its virtues encompass unparalleled connectivity, steadfast reliability, and a range conducive to dynamic industrial environments. Leveraging the prowess of Bluetooth in the context of clearance measurements signifies a quantum leap toward safer and more streamlined industrial operations.

The application of Bluetooth technology, seamlessly integrated with measuring instruments like dial indicators, has bestowed a newfound agility upon the clearance measurement process. The quintessence of this fusion is apparent in scenarios such as measuring the clearances in D11 tractor equalizer bars. By enabling remote measurements via wireless communication, Bluetooth liberates operators from the confines of hazardous zones, redefining the tenets of safety. The operator, equipped with a Bluetooth-enabled device, can orchestrate measurements from a safe distance, negating the need for physical presence near potential hazards.

Furthermore, the marriage between clearance measurement and Bluetooth unveils a realm of data-driven intelligence. The technology empowers the storage and dissemination of measurement data, rendering it accessible for analysis, reporting, and informed decision-making.

The fusion of wireless communication and precise measurements not only augments safety but also instills a new echelon of operational efficiency.

In a world characterized by the imperative of worker well-being and equipment reliability, the application of Bluetooth and wireless technologies in the realm of clearance measurement stands as a testament to the progressive spirit of industrial evolution. It not only recalibrates the parameters of safety but also heralds an era of digital prowess, where data, connectivity, and ingenuity converge to redefine industrial paradigms.

3. Methodology

This article delves into the innovative application of a wireless tool designed to assess the condition of equalizer bars in D11 dozers. The implementation of this tool was carried out through a comprehensive experimental process, surpassing the mere transition from the dealer's conventional tool to the wireless counterpart.

At its core, the tool takes the form of a dial indicator meticulously engineered to capture data. This data is then seamlessly transmitted via Bluetooth technology to a variety of mobile devices capable of accommodating this advanced communication protocol. The maintenance methodology employed in this study revolves around the principles of Predictive Inspection, a strategy that allowed the maintenance team to conduct frequent assessments across the entire fleet of dozers, totaling 17 units.

In contrast to the conventional approach, which necessitated the inspection team to laboriously employ the old tool, involving the intricate setup of cables and a protracted process of routing them to the cabin, the newfound wireless tool has ushered in a transformative change. The application of the wireless tool entails a remarkably simplified procedure. The inspection team can now seamlessly attach a magnetic plug to the dozer's structure, thereby bypassing the cumbersome cable setup, and directly proceed to the cabin to collect the essential data.

This advancement not only streamlines the inspection process but also significantly expedites data collection, thereby contributing to enhanced operational efficiency and reducing potential downtime. The utilization of the wireless tool underscores a paradigm shift in maintenance practices, exemplifying how cutting-edge technology can seamlessly integrate into established workflows, yielding tangible benefits in terms of accuracy, time savings, and operational effectiveness.

Figure 1. Equalizer bar after 500 hours in operation since inspection.

The process of measuring clearance in the equalizer bars of D11 tractors assumes an indispensable role within the mining milieu. Failures within this pivotal component reverberate through hours of operational downtime, culminating in substantial financial setbacks for the company. These repercussions encompass not only lost machine productivity, but also potential profits left unattained, compounded by the incurred costs of component repair. The manufacturer‘s schedule doesn’t identify a period to inspect the equalizer bar, but suggers 1,5mm as the limit for the clearence. Consequently, owing to its indisputable significance as a linchpin in the machinery's longevity, the inspection team undertakes this mission with unwavering frequency.

In its embryonic state, the task entailed an operator navigating the underside of the tractor, methodically applying an analog dial comparator. As the operator commenced the motion, the skilled mechanic conducted meticulous measurements beneath the tractor, positioned directly within the line of operational action.

Progressing to the second phase, an approach adopted universally across mining operations worldwide, personnel were furnished with a tool proffered by the dealer. This iteration, however, presented an assortment of assembly challenges stemming from its sheer magnitude. The compulsion to intricately install an array of cables throughout the tractor's architecture rendered the process intricate and prone to potential cable damage during the clearance measurement maneuvers.

Advancing to the third stage, which constitutes the focal point of this study, a pivotal transformation emerged. The dealer's tool was supplanted by a wireless-enabled dial comparator, thus ushering in a paradigm shift in approach. This innovation introduces a myriad of advantages, rendering it not only a more cost-effective alternative but also endowing it with swift assembly procedures, enhanced precision, and simplified calibration procedures.

This transformative progression embodies a testament to the evolution of maintenance practices within the mining sector. From the rudimentary under-tractor inspection to the dealer-provided tool and culminating in the adoption of a cutting-edge wireless dial comparator, each phase of this journey underscores a relentless pursuit of efficacy, precision, and efficiency. The current innovation, anchored in wireless connectivity, epitomizes a culmination of years of refinement, infusing the clearance measurement process with a newfound dimension of streamlined accuracy and operational fluidity.

In summation, the trajectory of measuring clearance in D11 tractor equalizer bars narrates a saga of continuous improvement, a saga driven by the imperative to optimize efficiency, economize resources, and enhance overall performance. The implementation of a wireless-enabled dial comparator stands as a testament to the mining industry's unyielding commitment to embracing technological advancements and propelling maintenance methodologies into the realm of exceptional proficiency.

While the dealer’s tool, whether in its wired or wireless version, offers several significant advantages for maintenance and inspection of construction and mining equipment, it's also important to consider its drawbacks for a comprehensive assessment. Some of the negatives of the tool could include:

1. Mobility Restrictions: The wired version of the tool might be limited by the need for physical connections to measurement or data collection devices. This can restrict technicians' mobility during the measurement process, especially in hard-to-reach areas or on large equipment.
2. Setup Complexity: The need for physical connections can make the tool's setup more complex and time-consuming. This could result in longer preparation times before measurements, impacting overall maintenance team efficiency.
3. Potential Cable Damage: In wired versions, the presence of cables connecting the tool to measurement or recording devices might increase the risk of cable damage during use in challenging industrial environments. This could lead to unplanned interruptions and the need for cable repairs.
4. Dependency on Connections: The functionality of the wired tool could depend on the availability and quality of physical connections. Connection issues, such as poorly connected cables or accidental disconnections, could affect data collection and measurement accuracy.
5. Limitations in Harsh Environments: While the tool is designed for durability, particularly harsh environments, such as mining sites with high levels of dust, humidity, or intense vibrations, may present additional challenges to its operation and longevity.
6. Maintenance Costs: Ongoing maintenance and calibration of the tool could represent an additional cost over time. This includes replacing worn components, calibration adjustments, and potential repairs.
7. Compatibility and Updates: Compatibility with different equipment models and measurement devices could be a challenge. Additionally, technological advancements could lead to obsolescence, requiring updates or replacements of the tool to maintain integration with emerging systems and technologies.

Figure 2. Tool that was used before and sent by machine's dealer.

4. Results and Discussion

The application of the dial indicator wireless was a significant improvement, reducing the tool's acquisition cost on almost 10 times. The more effective way to measure the equalizer bars has ended the catastrophic cases (Fig. 1), after that, just one bar has been substituted and it was in a preventive job.

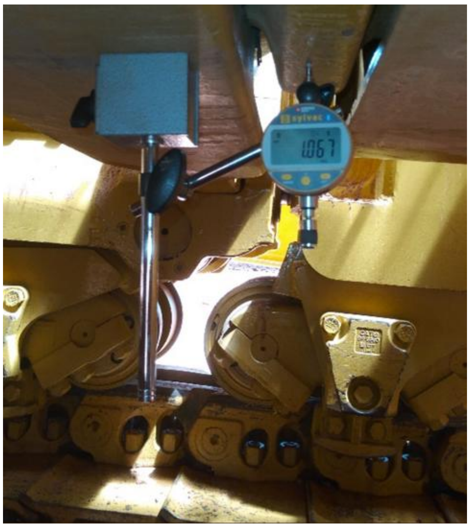

Figure 3. Dial indicator installed down the dozer.

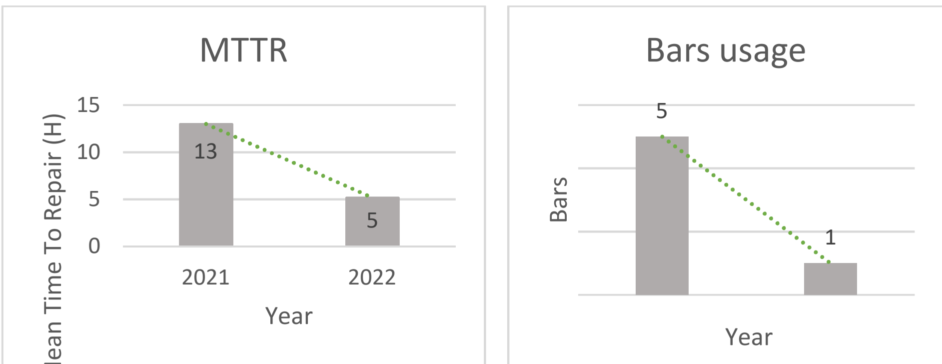

Figure 4. Comparative between Mean Time to Repair in 2021/2022 and bars use in the same period.

5. Conclusions

In conclusion, the strategic application of a wireless tool for dozer maintenance in a Bauxite Mine represents a transformative advancement that holds immense promise for optimizing maintenance practices and operational efficiency. The integration of wireless technology addresses several critical challenges faced by traditional maintenance approaches, ushering in a new era of streamlined and data-driven maintenance processes.

By harnessing the power of wireless communication, this innovative approach minimizes downtime, enhances data collection accuracy, and empowers maintenance teams with real-time insights into equipment health. The wireless tool's ability to transmit crucial data seamlessly to mobile devices enables technicians to swiftly identify and address issues, reducing the risk of equipment failures and maximizing overall productivity.

Moreover, the application of wireless technology mitigates safety concerns by minimizing the need for physical access to machinery during inspections, safeguarding personnel from potentially hazardous environments. This not only improves worker safety but also contributes to a more efficient workflow.

The strategic implementation of the wireless tool in dozer maintenance demonstrates a commitment to embracing technological progress within the mining industry. As operations become more complex and demanding, this tool exemplifies the industry's adaptability and dedication to staying at the forefront of innovation.

In essence, the utilization of a wireless tool in dozer maintenance within a Bauxite Mine not only exemplifies a prudent investment in efficiency but also underscores a visionary approach to sustaining long-term success in a competitive and dynamic sector. This strategic shift towards wireless-enabled maintenance sets a precedent for future advancements and solidifies the Bauxite Mine's position as a leader in progressive and effective equipment management practices.

6. References

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