BX09 – Online Predictive Asset Monitoring Via Cloud Specialist System

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Abstract

In an industry, physical assets are related to machines and equipment that require Preventive and Corrective maintenance when necessary, aiming at the continuity of the production process for which the asset was specified. Predictive Maintenance has methods, techniques and tools that during a defined periodicity assists maintenance teams in diagnosing failures so that the equipment does not stop operating. However, these techniques depend on the technician moving to the equipment for vibration and temperature collection of critical assets in a pre-established routine, which in the vast majority is not enough for a failure to be diagnosed in advance, before equipment collapses due to occurrences between data collection times. This results in equipment failures and loss of production because we do not have anticipated information of a potential failure, because all physical assets before stopping have warning signs that if monitored and interpreted correctly avoid the collapse of equipment, consequent loss of production and financial loss to the company. Therefore, the present study aims to present the Online Predictive Monitoring of Critical Assets via Cloud Specialist System, which uses vibration sensors and wireless temperature with transmission via SimCard Mult Operator 3G/4G to specialist cloud system with artificial intelligence, installed in critical assets in Hydro Mining Paragominas. With this solution you can receive real-time insights from major equipment failure modes, identifying faults in advance and correcting before the equipment collapses, resulting in avoided losses, maximization of asset operation, increase in life, cost reduction, increased predictability and production control as well as assists decision-making in the data.

Keywords: Assets, Monitoring, Predictive, Cloud, Artificial Intelligence

1. Introduction

The aim of this article is to highlight how online monitoring technology can optimize the industry by enabling real-time monitoring of asset conditions through vibration and temperature analysis. This approach helps in the early detection of anomalies and in the adoption of predictive measures. Furthermore, the differences between online and offline monitoring and the specific advantages of online monitoring will be explored.

Predictive maintenance is associated with preventive and anticipated practices to preserve the proper functioning of the equipment used in industrial operations. This approach usually involves periodic monitoring using vibration analysis, ultrasound and visual inspection. Regular collection of temperature and vibration data is carried out manually, following a schedule (day, weekly or monthly) to identify irregularities in the equipment before they become more serious problems. However, this technique depends on the physical presence of the technician with the equipment for the data collection of critical assets, following a pre-established routine. Unfortunately, this approach is often not enough to diagnose failures early, before the equipment collapses, due to sudden events that occur between data collection periods.

Figure 1. Example of portable vibration collector.

2. The Internet of Things

The Internet of Things (IoT) is rapidly transforming the industrial sector, revolutionizing the way we interact with objects and technology. With the advancement of connectivity and the growing adoption of smart devices, IoT is becoming a tangible reality, bringing with it an unprecedented potential for the reformulation of various industrial segments.

At its core, IoT refers to the interconnection of physical devices over the Internet, enabling real-time data collection, sharing and analysis. In the industry, IoT is revolutionizing manufacturing, logistics and maintenance processes. Smart sensors enable real-time monitoring of machines and equipment, preventing failures and optimizing maintenance. Through data analysis and smart automation, efficiency and productivity are maximized, reducing costs and downtime.

2.1 IoT in Maintenance

The use of the Internet of Things (IoT) in maintenance is radically transforming the way maintenance tasks are performed in various industrial sectors. By interconnecting smart devices and sensors, IoT enables real-time data collection and analysis, enabling early detection of failures, optimizing maintenance processes and reducing operating costs.

With the implementation of IoT in maintenance, equipment and machines can be monitored continuously, providing detailed information about their performance, operating conditions and maintenance needs. Sensors installed on the equipment collect relevant data, such as temperature, vibration and power consumption, which are transmitted to a centralized platform.

These data are processed and analyzed by advanced analysis and artificial intelligence algorithms, capable of identifying patterns, trends and anomalies. Based on this information, it is possible to perform predictive maintenance, anticipating potential failures and scheduling interventions before unexpected shutdowns or significant damage occur.

The adoption and implementation of IoT in maintenance also helps to improve operational efficiency and reduce costs. With a more predictive and proactive approach to maintenance, unscheduled shutdown times are reduced, maximizing the availability of equipment and increasing the overall plant productivity. Also it provides a new perspective, based on real-time data and advanced analytics, to ensure reliable and efficient operation of equipment.

With its ability to monitor, diagnose and act predictively, IoT is revolutionizing the field of maintenance, driving efficiency, reliability and sustainability of industrial operations.

3. Predictive Maintenance

Predictive Maintenance is a maintenance strategy that uses real-time data and information collected to predict failures and perform interventions before problems or unexpected equipment shutdowns occur. Rather than performing reactive or preventive maintenance based on fixed time intervals, predictive maintenance is based on the actual condition of the assets.

There are currently two methods for asset monitoring in predictive maintenance, which are Online Monitoring and Offline Monitoring.

- Predictive Maintenance Offline – This maintenance is a conventional strategy adopted by companies for a long time, which involves the collection of data manually through professionals who are responsible for monitoring assets through these field measurements.
- Predictive Online Maintenance is a strategy that involves continuous monitoring of an asset, receiving real-time alerts and acting before a failure occurs. This methodology is related to the prevention of potential failures that can affect the condition of the machine.

4. Offline Monitoring X Online Monitoring

4.1 Offline Monitoring

In this method, as mentioned above, professionals perform data collection manually using specific instruments, following a predefined maintenance plan for each asset point. However, the execution of these measurements depends on the simultaneous availability of resources such as personnel, personal protective equipment (EPI), collective protective gear (EPCs), stairs, among others. This poses a risk to the safety of employees, especially in hard-to-reach assets such as carrier reducers, which are commonly found in the mining sector.

This data collection process requires a large time investment on the part of predictive maintenance professionals, which delays the analysis of the data itself and the subsequent identification of failures. Due to this prolonged cycle of collection and analysis, the identification of a potential failure may occur late, making it impossible to intervene before the failure actually occurs.

4.2 Online Monitoring

In online asset monitoring, sensors are continuously installed on machines, allowing real-time data collection. This eliminates the need for the professional to move to the asset, as all data collection is carried out automatically and remotely. This approach reduces both the physical effort required in the collection activity and exposure to related risks.

In addition, the data analysis is done using artificial intelligence techniques, and is subsequently deepened by the professional specialized in predictive maintenance. This combination of automated analysis and human expertise increases the effectiveness of diagnosis, ensuring that no symptoms go unnoticed. This way, it is possible to identify potential problems early and take corrective action before significant equipment failures occur.

5. Online predictive monitoring for critical assets in mining

In a bauxite mine there are several equipment that make up the mining industrial park, many of which are essential for production. For these critical assets, there is a need for specific actions to maximize their operation.

With this in mind, the engineering team at Hydro Mining Paragominas implemented Tractian's Predictive Online Monitoring System. This system uses IoT Smart Trac sensors, which connect wirelessly to the Smart Receiver (Receiver) and send the data to a cloud platform dedicated to asset monitoring and management.

The sensors are easily coupled to the equipment through a magnetic base and glue, ensuring a secure fixation. Smart Receivers have their own communication network using 3G/4G cellular network technology, which eliminates the need for an industrial Wi-Fi network or customer's internal network. This approach further simplifies the feasibility of the installation and provides greater cybersecurity by avoiding external connections to the local network.

After installation, the IoT sensors undergo a machine learning process to identify machine operating patterns. This learning enables an automatic comparison of the current health and vibration of the monitored asset with thousands of other assets monitored by the company. Thus, it is possible to set precise limits even in short periods of time.

With monitored assets, it is possible to generate vibration graphs and gain insights that can be viewed by predictive maintenance analysts, maintenance supervisors, engineers and technicians via computers using Tractian's Desktop or Mobile platform. These data can be easily accessed by any authorized person, facilitating real-time decision-making based on information.

Figure 2. Smart Trac (Sensor) and Smart Receiver (Receiver).

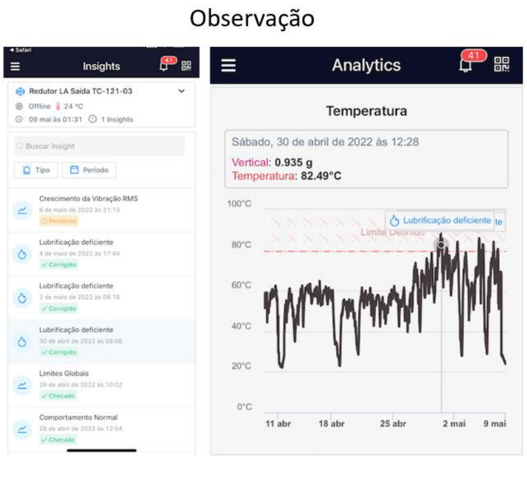
With real-time collection, the data is continuously interpreted by the expert cloud system. In case of detection of any anomaly, the system issues alerts and diagnostics on the condition of the machine. These notifications are sent directly to the smartphone of the responsible professional, allowing for immediate action.

The expert can then conduct an inspection on the asset in the field and validate the existence of the potential failure through the system. This continuous feedback enables the system to become increasingly accurate and adapt to the plant's maintenance culture. In this way, the necessary actions are directed to the maintenance teams for the appropriate measures, making it possible to avoid functional failures or the collapse of the equipment.

At Hydro Mineração Paragominas, the initial project includes the monitoring of 30 active points, which include equipment such as rubbers, carriers, pumps and agitators. This extent provides monitoring of the critical assets of the plant, increasing efficiency and operational reliability.

6. Success Factors of the Project

The images below show the visualization of the platform in the daily life of the maintenance professionals.



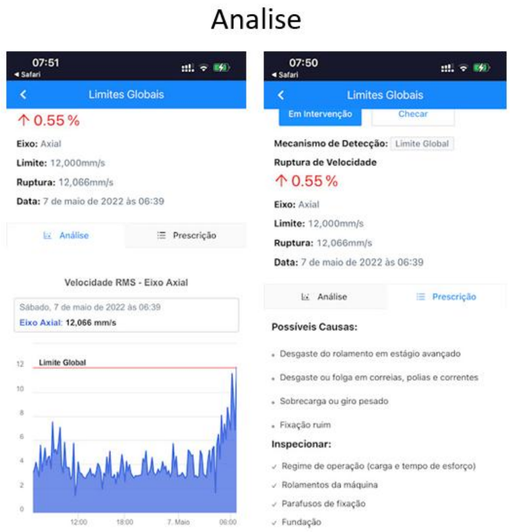


Figure 3a. Example type of insight generated and its treatment – Viewing in the Mobile App.

Figure 3b. Example type of insight generated and its treatment – Viewing in the Mobile App.

Figure 4a. Example of use of the platform – View in the Desktop Application.

Figure 4b. Example of use of the platform – View in the Desktop Application.

7. The Results

The project included several implementation stages of the solution, such as the installation of the sensors, the definition of the responsible maintenance team and adjustments in the machine learning solution and the use of the tool by the predictive maintenance team. After this period, it was possible to reap significant gains for Hydro Paragominas. The following are examples of losses avoided during the use of monitoring.

7.1 Breakdown of the entrance

For example, in the conveyor reducer TC-121-03 an unsatisfactory result was avoided. This asset had a wide history of damage, with incidents resulting in an approximately 13 hour maintenance stop for its replacement. Thanks to the monitoring project, this anomaly was identified in advance, avoiding an emergency stop, which would result in high repair costs, loss of production and overtime.

Figure 5. Reducer of Carrier Driving.

In figure 5 we have the reducer applied in the drive of the conveyor belt of a reclaimer, in this we previously had a breakage of the input pinion which resulted before monitoring a machine stop for 13 hours of corrective maintenance.

In the figure below we can track the trend of global vibration, we identified that from April 26 there was a change in the operational behavior of the reducer and change in temperature, validated in the field, after we have received the alerts via WhatsApp and E-mail, we checked on-site that the reductor was in trouble, this helped the team in the decision-making on the replacement of the reductor in a scheduled stop planned in the annual calendar, avoiding emergency stop.

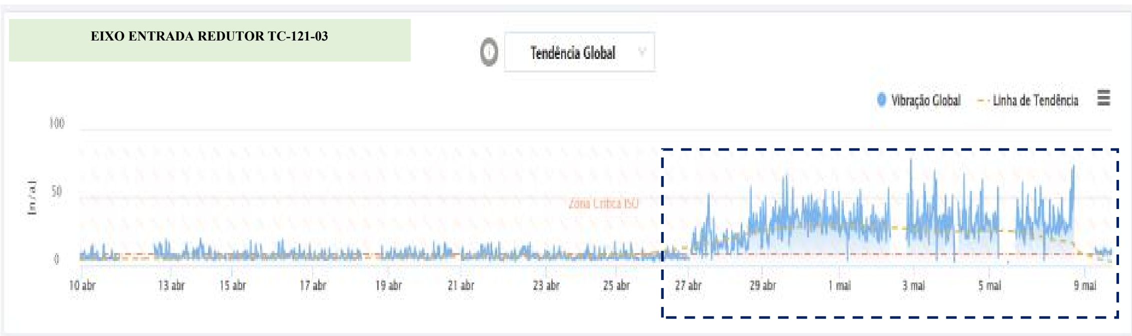


Figure 6. Global vibration trend chart.

Below we have the chart with the temperature trend on the Tractian monitoring platform that sent the alert also of high temperature, with this alert we went to the field and confirmed its elevated temperature at 103 °C as in the photo.

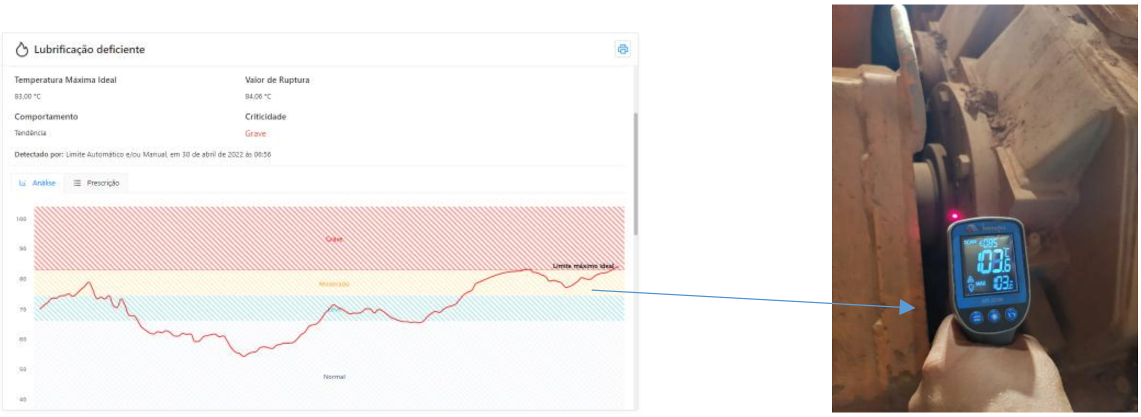


Figure 7. Temperature trend chart and location measurement photo.

7.2 Damage to the Protective Ring of the Coupling Amortisers

On one of the drive engines of a Roll Breaker which is a critical equipment for mining, we had the alert generated by the Tractian platform, where the speed limit RMS(23mm/s) had been exceeded, after receiving the alerts via WhatsApp and E-mail, the predictive technician moved to the equipment for offline measurements identifying misalignment and radial loose in the mancal caused by the breaking event of the protection ring of the coupling dampers. After we have observed the anomaly, the reserve engine was prepared for replacement at scheduled preventive stop, because through monitoring we were able to track the evolution and make the best exchange decision at a scheduled stop, otherwise we would have a corrective stop of approximately 8 hours of repair of the machine resulting in financial losses for the company.

Figure 8. RMS Motor Rolling Speed Graph.

Figure 9. RMS Motor Rolling Acceleration Graph.

7.3 Anomaly in the front and rear bearing of the carrier engine

With Tractian's monitoring via sensors and expert cloud system, we received the RMS acceleration limit alert reached, after the predictive technician did the offline measurements had identified an anomaly in the front and rear bearing of the electric motor, with the monitoring of temperature and vibration trends, the decision was made to prepare the reserve engine and leave near the exchange point in case of emergency, however this was changed only at the preventive stop scheduled in annual calendar avoiding emergency corrective maintenance based on real-time data for the best decision making.

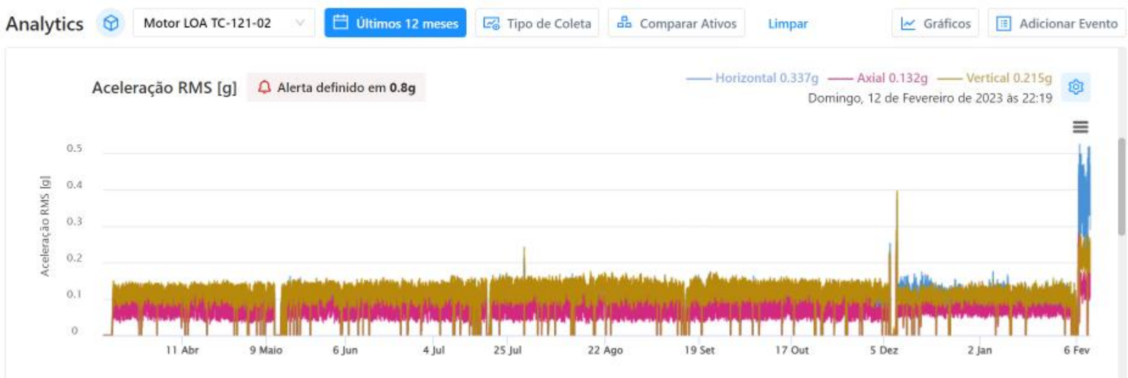


Figure 10. RMS acceleration chart for motor bearings.

7.4 Anomaly in the bearing of the Britador's brewing axles

The model of the breaker present in the plant does not allow for the offline vibration measurement of the bearings installed on the breaking axes to be carried out, i.e. through the inspector, as it poses risks to its safety as the equipment is in operation. For this aggravating reason, despite the online monitoring of the temperature of the bearings, there have been recorded breakout events of bearings resulting in corrective equipment shutdowns, which resulted in long maintenance periods.

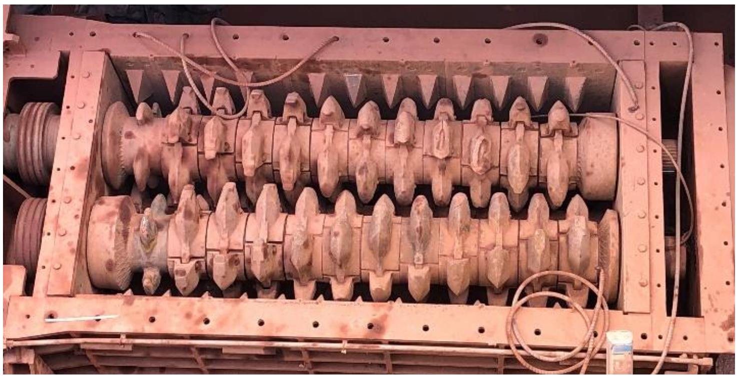


Figure 11. Dental Roll Breaker Model Installed on the MPSA.

With Tractian's monitoring via sensors and expert cloud system, we received the speed limit and acceleration alert RMS reached, on both bearings positioned on the breaking axles, position opposite the drive. From the warnings generated, it was decided to carry out the replacement of the breaker in preventive stop and, at the time of replacement, it has been identified that the cover of one of the folders was damaged and out of position, in addition to the excess fat and contaminants present in the housing of the bearings, which could result in the breakdown of the loads if the breaker remained in operation.

Figure 12. Bridger RMS Rolling M2 LOA Speed Chart.

Figure 13. RMS Rolling M2 LOA Acceleration Chart of the Briter.

Figure 14. Identification of damaged mancal cover and excess contaminant.

In this sense we can say that through online monitoring we had Avoided Losses and to this we exemplify the costs below that in case of corrective by the collapse of the equipment we would have hours of maintenance, as well as a cost with high materials. In the table below we demonstrate the material and production losses avoided in item 7 with this monitoring.

Caption:
- Downtime (Corrective Maintenance Hours)
- RM (Mass Recovery)
- Rate (Average Rate in ton\h of the area)
- BRL/t (2022 value of ton of bauxite)

Calculation Basis
- Ceasing Profit = (Downtime x Rate x RM x BRL/t)
- Material Cost = (Acquisition - Repair Cost)
- N/A - Not Applicable
- Avoided Loss = (Material Cost + Lost Profit)

Item	Material Cost	Loss of profit
7.1	R$109.740,00	N/A
7.2	R$800.000,00	N/A
7.3	R$340.000,00(Aquisição) - R$187.000,00(Reforma) = R$153.000,00	8hs x 2500t/h x 0,67 x R$230,40 = R$ 3.087.360,00
7.4	R$200.000,00(Aquisição) - R$1.903,22(Reforma) = R$198.096,78	8hs x 2100t/h x 0,67 x R$230,4 = R$2.593.382,40
	~ R$1.260.836,78	~ R$ 5.680.742,40
Loss Avoided	**~ R$ 6.941.579,18**	

Figure 15. Avoided Losses Table.

8. Conclusion

Online vibration monitoring allows the predictive team to analyze the data collected by the sensors quickly via the web or the mobility app, handling the alerts generated and keeping the maintenance team continuously informed about the assets and their behavior.

In this way, it is possible to maximize the operation of assets and extend their life by understanding that the equipment is working at the optimal point of operation and making data-based decisions. In the event of any potential failure, it is possible to act and avoid unnecessary wear, thereby reducing costs and increasing the predictability and control of production.

With the results presented in section 7, the decisions to not stop the equipment were based on data and continuous monitoring of the equipment avoiding a corrective stop, bringing the equipment to a preventive stop foreseen in the annual calendar of the plant and in a planned way. If we did not have online monitoring all equipment would have stopped and we would then have corrective and losses for the company.

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