WHITEPAPER

Utilizing IIoT to Increase the Success of Reliability Centered Maintenance

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Utilizing IIoT to Increase the Success of Reliability Centered Maintenance

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This paper was originally presented at the Society for Maintenance & Reliability Professionals (SMRP) 25th User Conference in 2017 and reflects the situation and market conditions that sustained at that time. PotashCorp merged with Agrium in early 2018 to form a new company called Nutrien. VIZIYA originally developed the IIoT solution used by PotashCorp before being acquired by Prometheus Group in 2020.

When it comes to selecting the appropriate maintenance strategies for a physical asset, many organizations have a very limited basis for their analysis and selection beyond the OEM manual. This often results in inefficient practices such as doing too much time-based preventive maintenance to try and improve reliability.[1] Throughout the industry, it has been seen that less than 20 percent of failures satisfy age-related characteristics, and more than 80 percent of failures are event-based or statistically random. Time-based maintenance programs have very little effect on overall reliability. For some failures, no effective form of scheduled maintenance exists.[2] Therefore, to be effective, there must be a basis that couples proven methods along with equipment experience to define a maintenance strategy.[3]

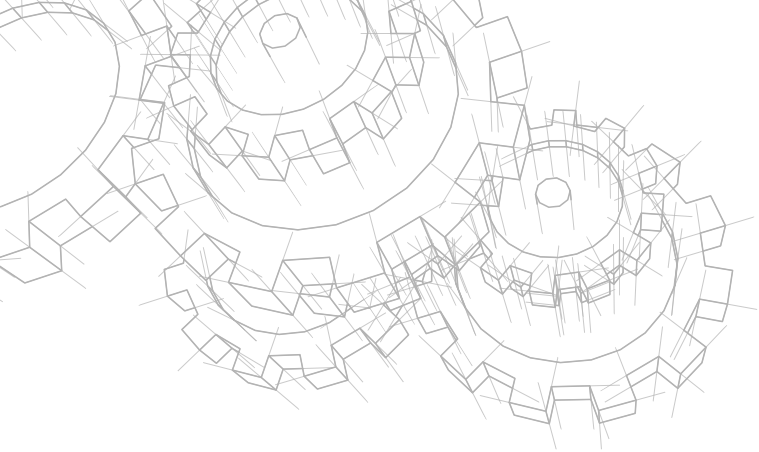
The maintenance leadership at Potash Corporation of Saskatchewan (PotashCorp) recognizes and understand this and have begun the process of instilling the concept of reliability centered maintenance (RCM) across the organization, and specifically at the Allan Division potash mine. This commitment to rigorous and detailed analysis, and the investment in the knowledge, time, and tools needed, have helped PotashCorp determine and ensure the most appropriate maintenance methodology is applied to the compaction circuits at Allan Division. Through RCM analysis, a resulting work plan for each compaction circuit and its failure modes has been identified and documented. This however is an intensive and thorough analysis, and as such, PotashCorp applied it to the compaction circuit and other physical assets as they were deemed critical for operations.

The reliability approach employed by PotashCorp overall allows a more appropriate (and less rigorous) methodology to be applied to other assets that are deemed low criticality to overall effective production and operations. Furthermore, a proper and effective RCM program requires effective communication and the need to connect work plans and actions to documented processes, which is a challenge for most organizations.

[1] Jeff Shiver, “8 Steps to Improve Asset Reliability”, Reliable Plant 2017 Conference

[2] John Moubray, “Reliability-Centered Maintenance”, 1997

[3] Jeff Shiver, “8 Steps to Improve Asset Reliability”, Reliable Plant 2017 Conference



Such documentation and communication enable further analysis towards the improvement of maintenance strategy selection and execution.

This paper will examine how the utilization of the Industrial Internet of Things (IIoT) is changing the options available when deploying RCM results and how the associated tactics are evolving at PotashCorp for critical assets in its operations, such as the compactor. This paper will also look at how this is further enabling the success and effectiveness of the organization's RCM program, the reliability of its assets, and the overall successful operation from the mill.

Background

Potash Corporation of Saskatchewan is the world's largest fertilizer company by capacity, producing potash, phosphate, and nitrogen. Mills are a critical part of the production process.

There are several critical assets in the mill, but the compactor is the focus of this paper. Specifically, we're going to look at the compaction roller assembly bearings. PotashCorp's approach to reliability centered maintenance uses asset criticality as part of its foundation.

Ensuring the compactor is running at an optimal level and with the highest degree of reliability is paramount to ensuring production targets and achieving operational targets. RCM analysis completed on the compactor roll bearings determined that the temperature trending of the bearing was critical to preventing unscheduled shutdowns caused by bearing overheating.

The company has instrumentation to monitor bearing temperature and utilizes OSIsoft PI to collect, monitor, and analyze this data. However, the control system does not act until the bearing temperature reaches 55 degrees Celsius, as the compaction rollers are automatically shut down after six continuous hours of operation at that temperature. Also at 55 degrees Celsius, a notification is created on the alarm page and populates on a banner of the top 10 alarms on the bottom of the alarm page. At 60 degrees Celsius, the control system automatically shuts down the compactor.

The challenge is that creating an alarm at temperatures lower that 55 degrees Celsius would create alarms to operators that may or may not require maintenance and would require the operator to assess the alarm and determine whether a maintenance work request should be created. Analysis has shown that it is the temperature trend of a bearing—relative to the temperature trend of the other three bearings in the compaction roller assembly—that is key to assessing the condition of an individual compactor roller bearing. As such, it is critical to catch any trending temperatures outside of the operating norm and begin to determine what corrective action can be taken and when. The Mean-Time-To-Repair (MTTR) to replace the compactor roller assembly is three days. This would result in significant lost production time as well as the cost of repair. Avoiding this situation is of great importance to the successful operation of the mill. The earlier the bearing failure is identified, the better maintenance and operations can schedule the compactor roller replacement without impacting operations.

> *"The earlier the bearing failure is identified, the better maintenance and operations can schedule the replacement without impacting operations."*

Presently, and with the available technology at the time of the RCM analysis, the decision was made to have operators complete a visual inspection twice per shift. Planners also check the bearing temperature trend on the compactors as part of a monthly preventive maintenance strategy. This manual check of bearing temperature trend utilizes data collected automatically

by the OSIsoft PI data historian. If a manual inspection or a trend analysis shows a failing state, a work request is manually created, and the work management process begins. The compactor is automatically shut down and a manual work order is created for the emergency repair if the bearing temperature reaches 55 degrees Celsius for six hours. In some cases, the roller can be cooled so that operations may continue while the replacement compactor roller assembly is made ready and downtime is arranged with operations. Although the RCM analysis determined these practices to be the best maintenance methods at the time, a few challenges and shortcomings to the current approach exist:

1. **Manual operator inspections are required**
   There is a high degree of procedure adoption and acceptance at the mill and by the operator but, as the checks are manual, they can be prone to error or lack of adoption by operators, resulting in missed inspections.

2. **Operators are inundated with alarms**
   Operators are inundated with alarms from the Delta-V and OSIsoft PI systems, leaving them requiring discernment as well as increasing the likelihood that one or more of these alarms are missed or ignored.

3. **OSIsoft PI and Oracle do not connect**
   The OSIsoft PI system which manages the sensor data does not connect with Oracle eAM, where work orders are generated, and maintenance information is documented.

4. **Historical analysis is completed too late**
   Historical analysis has shown that temperature trending provides an opportunity to trigger planned work that can be done on regular down days, and well in advance of the control system shut down. Unfortunately, this historical analysis is often completed after the bearing assembly has been replaced. Planners who repeatedly see no change in the bearing temperature trend begin to feel that the trend analysis is not necessary, and of course the P-f interval remains the same. So Murphy's law says the month the planner does not review the temperature trend will be the month there is a compactor roller bearing failure.

> *Prometheus IIoT presented an opportunity to leverage the data being collected in OSIsoft PI.*

Implementing full maintenance plans based on RCM analysis may be difficult for several reasons, including getting people to upload the results along with required data of the RCM analysis into the ERP system, and then having maintenance and operations personnel follow the work process as outlined by the RCM analysis. When PotashCorp began the RCM analysis, every effort was taken so that the analysis would not end up as a "nice report on the shelf."

The RCM methodology deployed included the steps required to operationalize the RCM analysis, including updating procedures, data loading, and training. At the end of the RCM analysis, PotashCorp recognized that there were limitations to current condition-based maintenance options that impacted the results of the RCM analysis. IIoT was identified by PotashCorp as an opportunity to enhance their existing suite of condition-based maintenance options.

IIOT presented an opportunity to leverage the data being collected in OSIsoft PI. For example, on Aug. 15, a compactor at the Allan Division was shut down after being at 55 degrees C for six hours, resulting in unscheduled downtime and lost production. If a work order had been created for maintenance to change the compaction roller bearing assembly when the bearing when the temperature exceeded more than 1.3 times the average of the other three bearings on the compaction roller assembly, maintenance would have been notified on June 11 for the first time. This would have provided two months during which the work could be completed on a regularly scheduled down day. Automation of this analysis reduces effort required by the planner while increasing the reliability of the process. At the time the RCM analysis was conducted, there was no ability to automatically trigger work orders from PI data, but the development of the IIoT application by VIZIYA appeared to be a viable option to solve this problem.

IIoT Enabling a More Predictive Company

Most companies have heard about the transformational change that IIoT promises, and many have begun to explore the different options and opportunities available. A recent survey of manufacturing professionals showed there are many deterrents to implementing these solutions, despite optimism for the technology. The top two deterrents cited by respondents in this survey were the high cost of implementation (37 percent) and inadequate infrastructure (37 percent).[4] In the case of PotashCorp, these were key considerations in the selection of an IIoT solution and since PotashCorp already utilized the two primary requirements for implementing Prometheus IIoT, namely that of already having OSIsoft PI as their data historian and a supported CMMS in Oracle eAM, it was a relatively easy step to adopt the IIoT application and the solution architecture.

PotashCorp has been a long-time customer and partner with VIZIYA, being instrumental in the development of products based on specific company and industry needs that seamlessly bolt-on to their existing business infrastructure, Oracle E-business Suite including Oracle Enterprise Asset Management (eAM). The IIoT product again meets this need for the company while also connecting another critical piece of operational software, OSIsoft PI. As official partners of both Oracle and OSIsoft, VIZIYA developed the IIoT product as the most robust and reliable means of connecting these two disparate systems and creating a two-way data integration in which key reliability data could be documented and acted upon in the maintenance system and by the maintenance team.

The product allows the readings to be captured in the same way they are now, but for work orders and work requests to be created automatically based on the operating context of the machine. In the compactor bearing assembly application, if the temperature rises beyond the set parameters, the IIoT application sends out email notifications immediately, rather than waiting for inspections.

Prometheus IIoT can create the correct maintenance object in the ERP system like a work request, work order, or meter reading, and keep everyone up to date along the way. At its core, the IIoT solution seeks to bridge the gap between operational data and maintenance work management. For PotashCorp, the IIoT solution is viewed as a method to augment condition-based maintenance and to better implement maintenance strategies based on the RCM analysis, as a means of achieving greater reliability through a more exacting implementation of RCM.

[4] IoT Institute Research April 2016 as reported in Industry Week May 6, 2016 by Karen Felder (reliabilityweb.com)

Among the key features and benefits of Prometheus IIoT which PotashCorp is utilizing are:

1. **The ability to listen in real time for events and alerts.** With built-in capabilities to listen to OSIsoft PI and other incoming sources, you can continually listen for events based on defined criteria and create actions to perform when they occur. This reduces labor intensive inspection time while increasing awareness of machine conditions.

2. **Create actions and workflows and attach them to events.** When an event is detected, the IIoT solution can push notifications to Prometheus Mobility users and alert Prometheus Planning & Scheduling users that a new work order has impacted the schedule. It can also call any custom stored procedure or web service.

3. **Complete the cycle between maintenance and reliability.** Built-in capabilities to write data such as a work order number back into OSIsoft PI completes the communication channel between reliability and maintenance.

4. **Reduce unexpected failures.** Listen for events from equipment sensors and initiate workflows in your CMMS such as creating work orders, work requests, meter readings, and more.

5. **Complex workflows.** Allows for escalation of events as failures progress, making sure you never create a duplicate work order or object in your maintenance system. For example, assume a work order is generated when a temperature value hits 50 degrees. When the temperature hits 100 degrees, the system will update the existing work order to an emergency, rather than create a new work order.

6. **Integrated dashboards.** These connect reliability and maintenance teams with valuable insight into the status of their assets.

7. **Templated actions.** Makes it easy for a front-end user of SAP, Oracle, Maximo, etc., to manage your integration. It is designed to be created and maintained by front-end users, like configuring a PM schedule, work order, or other routine objects in your maintenance system.

8. **Meter entry.** Automated meter entry into SAP, Oracle, Maximo, etc., of meter readings tracked in OSIsoft PI.

Overall, Prometheus IIoT allows PotashCorp to effectively and efficiently utilize its existing infrastructure and investment while also allowing it to improve its RCM program and actions without unnecessary new infrastructure or the delayed realization of a positive ROI.

PotashCorp – Set Up for Success

The ability to utilize the IIoT solution easily and effectively was made possible by the discipline and effort that PotashCorp – Allan Division has put in place through their commitment to reliability centered maintenance concepts. In addition to their Oracle eAM and OSIsoft PI systems, PotashCorp also already utilizes the Prometheus Planning & Scheduling (VIZIYA) and Prometheus Mobility (VIZIYA) products, which are used to effectively schedule maintenance activities. Maintenance and operations personnel are enabled with Prometheus Mobility so they can receive notifications in the field and identify break-in work and act accordingly, saving valuable time and effort while helping to further prevent or limit costly repairs.

PotashCorp – Allan Division is an excellent example of how with the right initial discipline and approach to maintenance, and with investments in core technology to enable the maintenance and reliability teams like Oracle eAM and OSIsoft PI, an organization can begin to take advantage of the promise and potential of the IIoT in small but tangible ways, seeing benefit immediately and without an outsized effort.

Learn more about how Prometheus Group can help your organization today.

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About Prometheus Group

Prometheus Group is a leading global provider of comprehensive and intuitive enterprise asset management software solutions that work within ERP systems and span the full work management life cycle for both maintenance and operations. Developed jointly with end users, Prometheus software enhances the customer experience for planning, scheduling, and executing work for both routine maintenance and shutdowns and turnarounds, all while protecting the workforce with safety solutions and electronic permit to work. Our straight-forward functionality, graphical visualization, and simple processes enable customers to increase productivity, reduce costs, and improve reporting. For more information, please visit www.prometheusgroup.com.