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Industrial operators that take advantage of the latest digital and automation asset performance management (APM) tools can look forward to improved operational efficiency, reduced downtime, and a proactive maintenance culture. **Stacey Jones, ABB Energy Industries,** explains.

Like most aspects of modern industrial production, asset performance management (APM) has been transformed by a new generation of digital and automation tools. Industry 4.0 solutions like artificial intelligence (AI), machine learning (ML) and data analytics can now be easily integrated into established operational technology (OT) and information technology (IT) environments, giving operators unprecedented visualisation and control of critical assets.

Central to this revolution is real-time IT and OT data gathered in the operational domain by wired and wireless sensors and then analysed to accurately assess the health of equipment, enabling personnel to make informed decisions around maintenance and repair to drive efficiencies and avoid costly downtime.

'APM 4.0' can be of particular value in large resource and emission-heavy facilities housing multiple devices, often in remote or hazardous environments. For example, a condition monitoring solution and sensors for rotating equipment can be deployed through a Bluetooth network: personnel are given an overview of the health of plant assets via a user-friendly dashboard, including proactive alerts of potential issues, avoiding the common problem of applications and data running in silos.

The overarching goal of APM 4.0, of course, is to help customers predict process failures way before they occur, thus improving the reliability, availability and maintainability of their critical equipment.

This article will explore the added-value elements of APM 4.0 in terms of sustainability, long-term reliability and costs, and company culture; the evolution of condition monitoring, from time or usage-based strategies to today's quantitative risk analysis and current-state-of-machine solutions; and how ABB's APM solutions are helping to modernise a refinery in Kazakhstan.

Wake up to the benefits of APM 4.0

Despite the many benefits of 'APM 4.0', there remains a lack of traction for APM in many industries, for a variety of reasons. One is the misconception that asset failures are 'rare' events, when in fact they happen on a regular basis, with 82% of asset failures actually taking place at random intervals.[1]

This leaves many companies in an unfortunate position: the unlikely nature of these events does not incentivise capital investments in continuous condition monitoring, while time-based maintenance does not catch all potential problems. There is also the cost factor, of course, with many operators believing that new-generation wireless sensors are still more expensive than their traditional wired counterparts. In reality, the recent decrease in the cost of technology that uses connection protocols such as Bluetooth or WirelessHart means that adding the ability to continuously monitor industrial assets has finally become a cost-effective alternative to manual, infrequent condition monitoring.

Despite this, maintenance continues to be done on a fixed time interval or through machine hours rather than based on current data, leading to higher maintenance costs: maintaining assets only when needed can decrease maintenance costs by 20 - 30%, and machine downtime by 20 - 50%.[2]

The current standard for most small-to-medium sized rotating equipment, therefore, is little to no condition monitoring. For equipment deemed medium to high risk, vibration monitoring is carried out using manual techniques during regular operating rounds. The data may be discarded once the values are deemed to be within 'normal' range, preventing the ability to trend and learn from it.

Shockingly, less than 20% of data generated by industrial companies is actually utilised – even less is analysed. This means that up to 80% of what is arguably a company's most precious resource is lost.

A new era of data-driven APM

Thankfully, the Industrial Internet of Things (IIoT) is changing this. As mentioned, APM has evolved in the past two to three decades from run-to-failure reactive – meaning equipment had to be shut down at short notice for unplanned maintenance – to today's advanced data-driven technologies.

The next step up from reactive APM was usage or time-based maintenance, where a schedule was used to assess when equipment was about to fail with a view to addressing the issue before it had occurred; however, this failed to take into account that industrial assets are of varying importance leading to high maintenance backlogs with varying return on investment (ROI).

Next was risk-based maintenance, which uses innovations such as failure modes and effects analysis (FMEA) and reliability-centred maintenance (RCM) to prioritise critical assets. While this constituted a significant step forward, it too had its limitations in that maintenance is based on how an asset has behaved in the past, rather than using real-time data to prevent assets from failing across the board.

Let us use the analogy of a doctor's examination. If the physician only asks how the patient is feeling rather than taking their temperature and blood pressure, etc, that is only half the picture. With more quantitative information comes better decision making – and, ultimately, a more accurate diagnosis.

Enter APM 4.0, which employs data-driven and statistical models including AI and ML techniques – algorithms are taught what optimum asset performance is across multiple variables – and then sends an alert when equipment, machinery or instrumentation violates these conditions.

Figure 1. Minimise on-site personnel and safety risks by reviewing machine health remotely from a computer or mobile device.

A layered, hybrid, standardised approach

ABB adopts a pragmatic, layered approach to APM, in recognition of the fact that its customers are at different stages of their digital journey, and may therefore benefit from a hybrid APM solution.

This simply means that less critical assets may only need rules-based, or derived or calculated, monitoring: this may be a sensor that sends a notification if the temperature or pressure exceeds a pre-defined threshold. An example is taking raw vibration data and calculating the root mean square (RMS) velocity (how the vibration is increasing over time). This is a baseline layer of APM protection.

However, there are more complex layers that can be deployed to maximise protection around the asset using physics and engineering design-based 'first principles' models that tell the company how a specific piece of equipment performs. In addition, pure data-driven models leveraging AL/ML can also be deployed to create a nonparallel level of protection for the most critical assets.

ABB also operates a standardised or 'data agnostic' strategy whereby all assets – electrical, rotating, instrumentation, IT, and fixed equipment, etc – are combined. Using adapters to convert data from non-ABB historian and computerised maintenance management systems (CMMS) so that it can be understood by ABB technology and brought together in one location, ready for analysis using advanced APM tools.

Case study: Shymkent oil refinery, Kazakhstan

In Kazakhstan, the ABB Ability™ platform – a unified, cross-digital offering comprising software, hardware and services – was deployed to help modernise a major oil refinery.

The Shymkent site was commissioned in 1970 and it is located in the Sayramskiy region of Kazakhstan Shymkent. It is operated by PetroKazakhstan Oil Products (PKOP), a joint venture (JV) between the China National Petroleum Corp. and KazMunayGas, the national oil and gas company of Kazakhstan.

Sensors, data and advanced analytics all monitor and assess the health of the refinery's assets in real time, providing PKOP with critical, real-time insights into equipment and production processes. At Shymkent, digital transformation is expected to increase productivity and lower operational costs, empowering staff to make better-informed decisions based on accurate and live data and reporting.

The project is a compelling example of how the benefits of integrating Industry 4.0 technologies into existing operations can form part of a company's or country's wider digital transition – in this case the government-led 'Digital Kazakhstan' programme, which focuses on accelerating growth and elevating economic sectors such as oil, gas and chemicals throughout the Republic using digitalisation, with a goal of creating a sophisticated digital economy.

PKOP's maintenance strategy has evolved from an hourly-based system to a prescriptive or predictive-based one. ABB extended the maintenance annual turnaround intervals at the refinery to a three-year plan to ensure early identification of when assets might need repair or replacement – supporting operators to prioritise maintenance based on actionable insights.

ABB provides a business consultancy service to PKOP to support the project lifecycle and promote culture change in adopting digital practices at the Shymkent plant. This includes assessing current work processes, leveraging opportunities to increase efficiency and resilience, recommending improvements, and providing expert staff training.

Valued-added benefits

The residual benefits of effective APM are also important. Implementing data-driven rather than reactive condition monitoring helps to establish a robust reliability culture, where personnel are empowered to take control of asset health, instead of simply reacting to failures after the event. Maintaining equipment and machinery in peak condition also helps reduce asset life cycle costs.

Figure 2. ABB APM 4.0 technology proactively alerts users of potential issues, and on-site maintenance personnel can be deployed ahead of unplanned downtime.

Using ABB's APM application, for example, key data, along with information gathered from other rotating, electrical, instrumentation and IT equipment, can be monitored in a single location. This enables operators to prepare interventions, short and long-term planning and predictive maintenance, maximising asset usage in terms of productivity, safety, quality, efficiency and cost optimisation.

In addition, this information can also be utilised further by enterprise resource planning (ERP) tools and CMMS, avoiding the need for manual interventions, facilitating integration with existing service scheduling, including the replacement of equipment, and ultimately contributing to an autonomous business process. APM can also contribute directly to improve sustainability, since critical assets in large, resource-heavy industry sectors tend to be the largest consumers of energy.

In summary, APM 4.0, including innovations such as AI, ML and advanced analytics, represents a unique opportunity for oil and gas operators to take full control of asset health and maintenance, improving production efficiency and sustainability, limiting unplanned or forced downtime, fostering a proactive maintenance and repair culture – and helping them maintain competitive advantage.

References

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