WORLD FERTILIZER®

MAGAZINE | JULY/AUGUST 2025

Enhancing safety and operational continuity

Kjeld Boersma, Istec, the Netherlands, highlights the positive impacts of safety and operational continuity in fertilizer plants with speed and vibration monitoring.

In fertilizer production plants, rotating equipment is fundamental to nearly every process step. Equipment such as steam turbines, ammonia and nitric acid compressors, rotary granulators, and gear-driven pumps are required to run continuously, often at high speeds and under heavy loads. These machines are subject to extreme mechanical, thermal, and chemical stress. If not monitored and maintained carefully, their failure can lead to unplanned shutdowns, disrupted chemical reactions, loss of product batches, and hazardous situations involving flammable or toxic substances such as ammonia, urea, or nitric acid.

To reduce these risks and ensure consistent plant performance, the integration of predictive maintenance solutions is essential. Speed monitoring, vibration analysis, and overspeed protection systems enable operators and maintenance teams to maintain control over machine health and behaviour. These systems form the foundation of predictive maintenance strategies, allowing teams to identify developing mechanical or operational issues before they evolve into critical failures.

Rather than relying solely on scheduled inspections or reactive maintenance, fertilizer plants benefit from a condition-based approach. Data gathered through speed and vibration monitoring

provides insights into system dynamics, load conditions, and early indicators of faults. Vibration monitoring, in particular, is used to determine the condition of the machine by analysing its dynamic behaviour, making it possible to detect if something is wrong before it escalates into serious damage. Speed monitoring ensures operational conditions remain within expected parameters and detects issues such as reverse rotation, standstill, or underspeed. Overspeed protection systems, in contrast, serve as safety-critical systems that automatically prevent machines from operating in unstable regimes. Together, these technologies improve equipment reliability, ensure safe operating conditions, and increase overall plant availability.

Vibration monitoring: early detection of mechanical degradation

All rotating machines generate vibrations during normal operation. However, when vibration amplitude, frequency, or pattern changes over time, it can indicate the early stages of mechanical wear or structural imbalance. In fertilizer plants, such changes may result from misalignment between rotating and stationary components, loosened bolts or couplings, shaft imbalance, progressive bearing wear, gear tooth damage, or cracking in rotors or impellers. Left unaddressed, these conditions often lead to more severe damage, including mechanical seizure, excessive heat buildup, or component failure.

By continuously or periodically monitoring vibration signatures, maintenance personnel can detect these patterns and schedule corrective interventions in a planned manner. This approach avoids the risks associated with running machines to failure, such as emergency shutdowns, uncontrolled chemical releases, or pressure build-up in process lines. In environments with hazardous or regulated substances, predictive intervention is also an essential component of safety compliance.

In addition to real-time condition monitoring, historical vibration data plays a key role in asset management and reliability improvement. By storing and analysing vibration trends over extended periods, engineering teams can identify recurring fault signatures, evaluate the effectiveness of maintenance actions, and refine equipment maintenance intervals. Comparing long-term data across similar machines also supports standardisation of best practices and can inform purchasing and design decisions for future equipment upgrades or replacements. This structured use of vibration history transforms isolated sensor data into strategic insights that support continuous improvement and reduced lifecycle costs.

While vibration monitoring is often focused on critical machinery due to the high risk of failure and operational impact, there is a growing emphasis on sustainability and lifecycle management across all plant assets. As a result, fertilizer producers are increasingly seeking solutions that can extend the operational life of less critical machinery in a cost-effective way. Systems like Istec VibSys® offer cloud-enabled vibration monitoring capabilities that support both online and periodic measurement strategies. As a modular system, it is also well-suited for less critical machinery, offering flexible deployment and seamless integration with existing monitoring structures.

Speed monitoring: detecting abnormal machine conditions

Rotational speed is a key operational variable in fertilizer plants. Speed monitoring systems are not intended to maintain optimal operating speed, but to detect abnormal and potentially hazardous conditions that can affect rotating machinery. These systems identify issues such as reverse rotation, standstill, or underspeed conditions that may not be detected through vibration monitoring alone but can still lead to safety risks or process disruptions if left unaddressed.

Reverse rotation is one such abnormality. If a turbine or compressor starts rotating in the opposite direction, it can cause mechanical damage to couplings, seals, and gear systems, and may even reverse the flow of process chemicals. This is particularly critical in units such as feed pumps or centrifuges, where flow direction is tightly linked to system safety and functionality.

Standstill detection, also known as creep monitoring, is another important condition to identify. It occurs when a machine, typically in a standby or shutdown state, continues to rotate slowly due to process backflow or residual mechanical force. Even minimal movement can pose a danger to personnel working nearby or preparing the machine for maintenance. Speed monitoring allows operators to confirm that the machine is at a true standstill before issuing safety clearance.

Underspeed events, in which a machine runs below its minimum functional threshold, can cause pressure drops, insufficient mixing, or improper chemical reactions. For example, in an ammonium nitrate production line, an underspeed fan or pump may result in suboptimal cooling or flow rate changes, ultimately leading to off-spec product or process instability.

By continuously tracking rotation speed, speed monitoring systems help detect operational anomalies like reverse rotation, standstill, and underspeed that may otherwise go unnoticed. These systems are not intended for process optimisation but for identifying unsafe or abnormal conditions. Their role is relevant for both high-speed critical assets and lower-speed supporting machines, providing an added layer of safety oversight.

Overspeed protection: preventing catastrophic acceleration events

Overspeed conditions arise when rotating equipment exceeds its maximum rated speed. This may result from a sudden loss of load, malfunction in the speed control system, software errors, or unintended control logic execution. At excessive speeds, the kinetic energy of rotating parts increases rapidly, exerting extreme centrifugal forces on all internal components. This can lead to deformation, bearing destruction, coupling separation, or rotor fragmentation.

In fertilizer plants, these events pose severe risks. A failed steam turbine or high-speed compressor located near flammable or toxic chemicals can trigger secondary failures in nearby equipment or release hazardous gases into the atmosphere. The consequences of such events include asset damage, production losses, environmental harm, and safety regulation breaches.

Overspeed protection systems are specifically designed to detect and react to these high-risk events with extremely short response times. Upon detecting a breach of a critical speed threshold, the system initiates a shutdown sequence that includes actions such as isolating the fuel supply, disabling the electrical drive, actuating mechanical brakes, and opening bypass valves to relieve internal pressure. These shutdown actions are configured to function reliably, even in the event of a component failure.

A robust overspeed system operates independently of the machine's main control system and is often built with dual or triple redundancy. This ensures that detection and shutdown will occur even if the primary controller fails. Fail-safe logic, hardware diagnostics, and regular functional testing are vital for ensuring ongoing reliability. System designers must also account for environmental conditions such as temperature, vibration, and electromagnetic interference, especially when equipment is installed in classified or corrosive areas. Implementing such systems is not just a protective measure but an operational necessity for compliance and risk management in modern fertilizer facilities. The Istec SpeedSys® line includes both compact, SIL 2-certified overspeed detection systems for safety-critical applications and tachometers for speed monitoring. These systems integrate seamlessly into both new and retrofit applications, providing a comprehensive solution for both protection and monitoring of rotating equipment.

Strategic implementation in fertilizer operations

Implementing speed and vibration monitoring, along with overspeed protection, starts with a clear focus on the most critical assets in the plant. These are typically the machines where their failure could cause significant downtime, financial impact, or safety concerns. Over time, this monitoring can be expanded to other machinery to further enhance reliability and availability.

Beyond the technology itself, it is important that plant staff are trained to understand what the systems monitor and how to respond to alarms or abnormal readings. Clear procedures for follow-up and escalation help ensure the monitoring systems support safe and effective operations.

Monitoring systems must be selected for compatibility with existing plant infrastructure. For example, data outputs must integrate with distributed control systems (DCS), safety instrumented systems (SIS), or centralised asset health platforms. The ability to configure alarms, automate trip responses, and export historical trend data should also be considered.

By combining strong technical implementation with organisational readiness, plants position themselves to extract maximum value from monitoring investments. The result is a more resilient operation with improved decision-making, higher uptime, and reduced maintenance-related uncertainty.

Advancing operational safety and reliability through intelligent monitoring

In fertilizer production environments, unplanned equipment failures are more than just operational setbacks. They can endanger workers, damage valuable assets, and interrupt supply chains that serve essential industries, such as agriculture. Rotating machinery, due to its complexity and central role in production, requires proactive monitoring to ensure both safety and performance.

By applying vibration monitoring, speed measurement, and overspeed protection, fertilizer plants gain the ability to detect emerging issues early, prevent dangerous scenarios, and extend the lifespan of critical equipment. These systems provide essential visibility into machine behaviour and process conditions, enabling informed decisions and more efficient maintenance.

Implementing these technologies supports continuous production, compliance with safety regulations, and better risk management. In an industry where reliability directly supports global food security, these investments represent a practical and strategic commitment to excellence. WF