Early detection pays off

Improved pump monitoring can help protect your operations from failure and downtime, says **Cranford Johnstone**

PETROCHEMICAL plants have a large number of pumps that are continually in use for functions that range from feedstock supply to product distribution. Pump repairs typically consume up to 7% of the total maintenance budget and therefore must be carefully considered within an overall maintenance programme. It's not unusual for petrochemical plants to invest in online protection systems for the most expensive pumps as well as those which are critical to continuous operations (usually 5% or less of the total number of pumps). However, the remaining 95% includes many pumps which, should they fail, could also damage profits.

The initial decision as to which pumps are monitored online is typically made during plant design, but with age and changes in process configuration, previously non-critical pumps can become essential assets. Loss of an essential pump may cause a process upset and increase maintenance costs, but more seriously, could lead to fugitive emissions and a vapour cloud, culminating in a fire or explosion. As a worst case, the end results could be catastrophic, with damage to plant equipment and potential injury or loss of life.

why pumps fail

Many causes contribute to pump failure. According to author Ron Moore in his book *Making Common Sense Common Practice*, up to half of all failures are process induced and are therefore preventable. For example, when changes in operating conditions induce pump cavitation (a result of insufficient net positive suction head), this can grossly accelerate impeller wear and lead to seal failure. Despite the clear cause and effect, these types of problems continue due to the lack of a feedback mechanism for the operators – they are simply unaware that they are shortening equipment life.

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Another leading cause of failure is mechanical wear. This can manifest itself through conditions like imbalance, poor shaft alignment, loose pump mounts, broken bolts, foundation cracks, and damaged impellers. These defects gradually

common threats to pump health

- Restricted suction caused by a plugged suction strainer or loss of level in the suction drum then leads to cavitation.
- Poor valve control may cause the pump to operate at less than the minimum recommended flow, resulting in cavitation.
- Blocked-in discharge can result in fluid stagnation, raising the temperature, resulting in cavitation.
- Cavitation – regardless of the cause – disrupts the process flow and induces internal damage to the pump case and impeller, leading to whole host of problems, including imbalance, bearing failure, and premature or even sudden seal failure.
- Inadequate monitoring of auxiliary seal flush levels can result in missed low-level conditions causing a loss of flush resulting in seal failure. Conversely, a high-level condition may be an indication of mechanical seal leakage.
- Improper installation such as shaft misalignment can cause excessive vibration that leads to bearing or seal damage and possible failure.

don't overlook your valves

For petrochemical companies, many process valves are just as important as pumps and should share their status as critical assets. For example, failure of a control valve in a process line that has no by-pass would result in shutdown of the unit.

Valve health can be monitored using digital valve controllers, which are based on microprocessor technology. Performance indicators such as friction are collected over time and used to better predict or plan maintenance activities.

Accessing such information needs to be simple, and software can be used to quiz a digital valve controller for additional information or to run advanced diagnostic tests. For example, if the control valve has not moved to its required position within a certain period of time, an alert would be generated and automatically directed to the appropriate personnel, allowing more informed decisions to be taken.

By analysing performance diagnostics from the digital valve controller and its software in advance of a scheduled process shutdown, plant maintenance teams can accurately determine which of the valves on a priority fix list actually need to be pulled and repaired. By only repairing valves that need attention, costs are reduced and turn-around times are minimised.

decrease the integrity of the machine and can lead to coupling, seal and bearing failures.

spotting the signs

While pump failures often appear to be sudden and may not become apparent until revealed by spills, vapour clouds, fires, or explosions, they rarely occur without warning – if you are listening, they're almost always announced well in advance. One key way to 'listen' for developing problems is by monitoring vibration, commonly by manual measurements on a periodic basis – typically every 30–90 days. Assuming that a trained analyst is available to review the data, these periodic checks can be used to detect many faults in advance; even then, however, they still leave the plant vulnerable to unplanned outages in between measurements.

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Online monitoring can report vibration levels on a continuous basis, thereby removing the opportunity for problems to go unnoticed between periodic checks. This information can be archived too and made available to the maintenance department as well as operators in the control room. In theory, the operator could track how quickly a fault is developing, so that maintenance could be scheduled and performed before a failure takes place. However, this has not been widely adopted because traditional online monitoring, which relies on raw vibration data, provides little or no advanced warning about an impending outage. In many cases, the condition alert about the health of the asset and the resulting equipment failure occur in the same shift – providing almost no time to plan the remediation.

Improved methods to determine pump health are needed, and this new technology needs to provide the control room with:

- real-time feedback when the current process configuration is harmful to the production equipment;
- a clear indication of when a machine is in distress – while there's still time to correct the problem; and
- a reliable gauge of fault severity.

monitoring impacting

One way these goals can be accomplished is by monitoring impacting in addition to raw vibration. High frequency impacting faults – such as where metal comes into contact with metal – create short duration stress waves, which can be monitored using proprietary technology to identify problems earlier. This impacting level – measured in acceleration, g – can determine if a pump is operating problem-free, or in distress.

For a typical process pump operating between 900 and 4,000 RPM, an operator can thus evaluate its condition as follows:

Level of impacting (in g's acceleration)	Machine condition	Action
0	Problem-free	-
10	Abnormal situation present	Put pump on watch list
20	Serious abnormal situation present	Draft action plan
40	Critical abnormal situation present	Implement action plan

Emerson Process Management

SABIC olefins plant

SABIC Olefins plant in Teesside, UK (*pictured above*), is using a wireless pump health monitoring system from Emerson Process Management to monitor critical pumps on its olefins cracker. The company previously collected and analysed vibration data for these pumps manually, but this led to higher maintenance costs and reduced plant availability.

In addition to measuring overall vibration and temperature, the system includes PeakVue technology, which detects key indicators such as impacting, friction, and fatigue, particularly in gearbox and rolling element bearings. The system takes basic readings every 30 minutes and an in-depth, full spectrum analysis daily. By tracking rising vibration levels, SABIC detects developing faults and improves maintenance scheduling.

The system has identified multiple defects, including a chipped tooth on a gearbox gear and an impending bearing failure. Without early detection, these faults would have likely resulted in equipment failure.

the rise of wireless

Despite the simplicity of monitoring the level of impacting to determine pump health, the vast majority of essential pumps remain unmonitored. This is primarily due to the high cost of retro-fitting. However, with the advent of wireless technology this now becomes more cost-effective to implement, as it reduces or eliminates the costs of engineering, trenching, and cabling. It also allows measurements to be obtained from places where there is no supporting cable infrastructure. A well-designed wireless infrastructure is cost-effective, expandable and easy to configure, and can be integrated into an existing control and asset management network.

Wireless also makes it feasible to gather multiple types of data that affect pump health. For example, for a total picture of pump health we also need pressure monitoring to check for clogged suction strainers as well as pre-cavitation. If these values are not already being monitored, wireless pressure transmitters can be added easily and affordably.

Early warning can help improve condition-based maintenance and mitigate asset failures. Repairing pumps at the onset of fault detection is much less expensive than repairing pumps after they have failed.

Readings for vibration, impacting and pressure can all be broadcast over the same wireless network, and the system can be easily expanded to include temperature, level, flow and many other parameters. Users can monitor online for the conditions that are of greatest concern, including cavitation, bearing temperature, vibration, process leakage, suction strainer differential pressure, discharge pressure, seal reservoir level and pressure. Diagnostic data is chronicled and analysed to alert operators or maintenance staff to potential issues that can contribute to failures before they arise.

Users can also choose which pumps to monitor and customise accordingly. For example, for the pumps that have previously experienced cavitation, users can install pressure and vibration sensors to monitor the condition online, and expand monitoring to include leak detection or seal flush reservoir level measurement to watch for seal failures. Detecting and predicting equipment problems while there is still time to take corrective action significantly reduces repair costs and helps avoid unplanned slowdowns or shutdowns.

conclusion

Impact monitoring technology such as PeakVue represents a new and reliable parameter for monitoring pump health. In addition, wireless technology means it can be quickly and cost effectively installed within a plant.

Early warning can help improve condition-based maintenance and mitigate asset failures. Repairing pumps at the onset of fault detection is much less expensive than repairing pumps after they have failed. Timely pump health alerts also help to avoid production slowdowns or process shutdowns, which generally result in much greater savings. **tce**

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Chemical Engineering Matters

The topics discussed in this article refer to the following lines on the vistas of IChemE's technical strategy document *Chemical Engineering Matters*:

Energy
Line 20

Health and wellbeing
Lines 11, 19

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