White Paper

Progressive Cavity Pump Health Diagnostics

ATLANTIC PUMPS

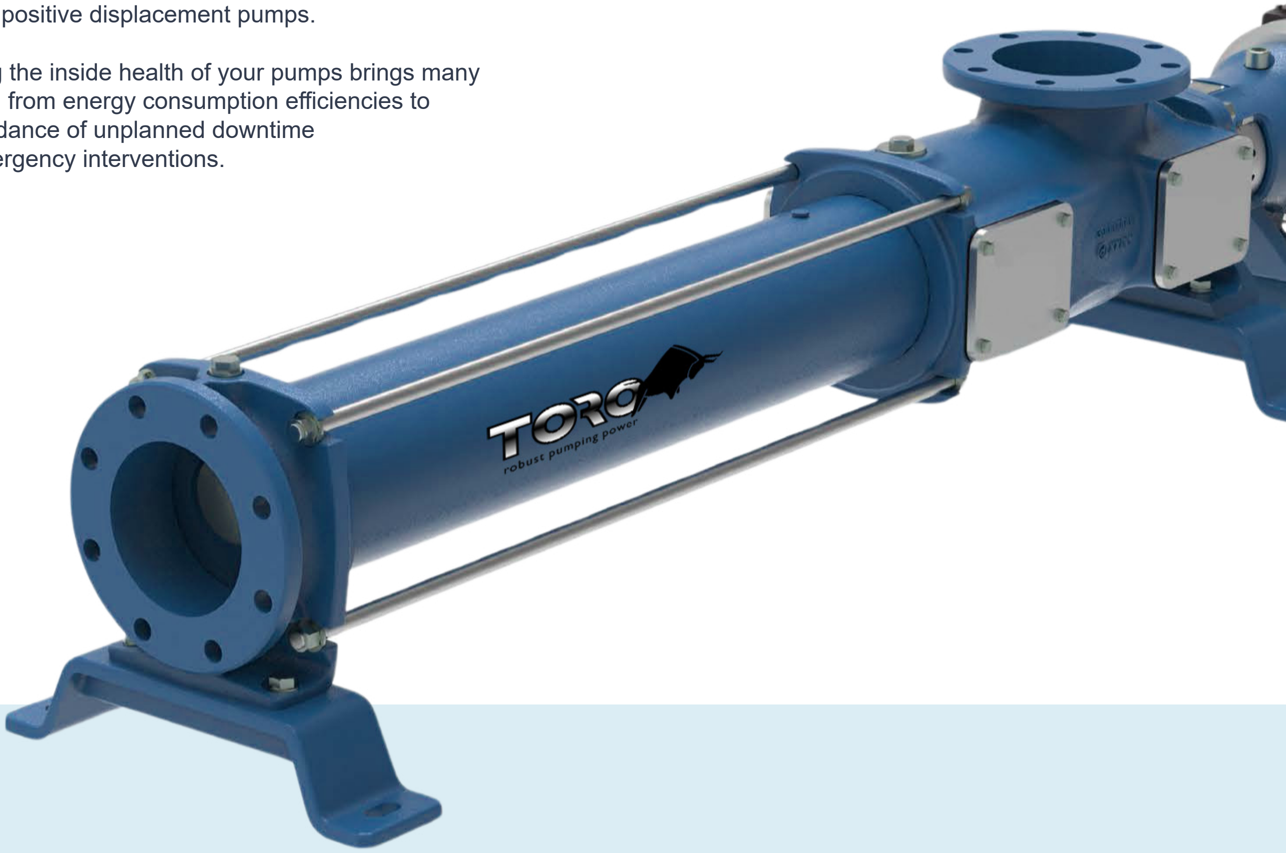
What’s wrong with my pump?

Understanding what’s going on inside your pump system is possible, even without opening it up. With the right tools, and the tips we share in this white paper, you’ll know what to look (or listen) for, from your progressive cavity (PC) pump.

Focusing on PC pump characteristics, we show you how to diagnose and even predict a future maintenance issue, with little to no downtime.

Although this white paper is about progressing cavity (also known as progressive cavity or PC pumps), some of the concepts can be usefully applied to other types of positive displacement pumps.

Knowing the inside health of your pumps brings many benefits, from energy consumption efficiencies to the avoidance of unplanned downtime and emergency interventions.



Progressing Cavity Pump Health Checks – Without Disassembly

Being able to monitor your pump’s performance (and hence its internal condition) while it remains online offers many benefits. Certain performance tests can be done while the pump is running, and others need just a quick isolation and operational pause.

Ongoing condition monitoring allows spare parts to be ordered ahead of time, engineering and maintenance people booked, and downtime planned around work shifts and seasonal demands. “Never assume”, Martin Gillman, a “pump Doctor” at Atlantic Pumps reminds us. “You don’t want to be writing out purchase orders for spare parts you might never need, or calling in specialist engineers when the issue lies elsewhere” he says.

On the other hand, breakdowns and emergency repairs can prove very costly. So how do we get the balance right? How can we move from reactive to proactive without spreading ourselves too thin?

1 Condition-based Maintenance

Regular condition monitoring tests provide data that is useful in predicting performance issues and planning maintenance ahead of breakdown. It can both save unnecessary part replacements, and avoid surprise breakdowns that lead to emergency work and costly downtime.

2 Pump Technical Data Sheet

Every pump should come with its specific data sheet, outlining what the pump was designed to do. “The first point of reference, when you have any sort of issue or concern with a pump, is to map it against its data sheet”, says Martin. “Is it doing what it should be doing?” If you don’t have this data sheet, reach out to the manufacturer.

If the pump duties haven’t changed dramatically, for example, the head height or pipework friction hasn’t increased, and the fluid characteristics remain within design parameters, then it points to a pump issue.

Time for gauges. If you’re not fortunate enough to have the benefits of permanently fitted instrument gauges, you’ll need to fit a temporary one for diagnostic purposes.

The best place to fit a pressure gauge for a pump condition test is on a straight section of discharge pipe, between the pump and the first isolation valve. Ideally, straight and unrestricted pipework (at least 3 x the pipe diameter) on either side prevents turbulence affecting the readings. Bear in mind that gauges need calibrating, and are not immune to failure themselves.

3 The Closed Valve Test

With the right setup, the closed valve test can be performed without lengthy downtime or system disruption. It indicates what level of wear the pump is at, using inline gauges to measure an individual pump's performance.

The more knowledge you have of your pump system and fluid characteristics, the easier it is to make a diagnosis and take remedial action. The three most helpful things are:

- Pump specification/capability (technical data sheet).
- Fluid gauges – pressure gauges, and if possible, a flow meter.
- Ability to isolate pumps and connected processes.

Pilots never take off without a working instrument panel, but not every working environment has the same high-stakes criticality. We frequently see systems that lack both isolation valves and inline gauges. Isolation valves allow for inspections and repairs without draining the system, and in many cases, a pressure gauge makes a worthwhile investment. They are relatively inexpensive and provide a lot of useful data.

Flow meters, on the other hand, typically cost £1k plus, due to the complexity of measuring inline flow without introducing turbulence, an issue that decreases the very factor you want to measure. A low-cost workaround is to measure the flow rate periodically using a basic stopwatch and bucket (or the connected tank). So long as you know the volume transferred and in what time frame, you have all you need.

If you have previously fitted pressure gauges, then you'll likely know what good operation looks like and can spot deviations promptly.

Tip: mark the gauges with green/red labels or paint to show where the normal operating ranges and the critical points are. This makes it easier for anyone in the future to spot a problem.

The best position for a pressure gauge to measure pump performance is between the pump discharge and an isolation valve.

TIP

Mark the gauges with green/red labels or paint to show where the normal operating ranges and the critical points are.

4 Check Dynamic Discharge Pressure

With all valves fully open and the pump running, note the discharge pressure gauge reading. This informs us of the actual system/duty pressure as it is currently running.

Now, slowly begin to close the valve on the discharge pipe (downstream from the pressure gauge). You want to restrict the flow gradually until it ‘dead-heads’ – but be careful not to shut it off too quickly to avoid ‘water hammer’ and shock damage.

Observe what is happening to the pressure reading; this should be rising if the pump is healthy. In theory, it should attain its rated pressure, e.g. 6 bar for a single-stage 6 bar-rated pump.

If the pressure doesn’t build smoothly, or fails to reach anywhere near its rated pressure, then it indicates worn wet parts. What is happening is that the pumped media is slipping back rather than resisting the pressure as it should.

The more worn a pump is, the less pressure it will be able to attain. While it is still delivering enough for the system, you won’t likely notice the growing issue, so running this closed-valve test can provide an earlier indication that maintenance is due.

For example, a pump is rated at 6 bar maximum pressure but only requires 2 bars to work the system. Performing this test periodically will enable you to map the wear rate; 5.5 bar, 4 bar, 3 bar etc - and even predict when it will begin impacting operational duties.

The closed valve test can also be done on the suction side of the pump, although you’ll need a gauge that measures negative pressure rather than zero upwards. If the pump doesn’t display a strong suction as the intake valve is slowly closed off, there is likely a sealing issue within pump.

With progressive cavity pumps, this is typically caused by wear on the rotor and stator, although it could also be a failed shaft seal bearing that’s allowing air to be sucked in (which you might be able to hear).

TIP

If the pressure doesn’t build smoothly, or fails to reach anywhere near its rated pressure, then it indicates worn wet parts.

5 Excessive Wear

There are only two basic reasons for a consistent, excessively high wear rate; the wrong pump for the media, or the pump running too fast for the level of abrasion. Operating the pump outside of its specified design parameters (off “data sheet”) is the most common reason for failure.

Other common issues that contribute to, or cause premature failure include:

- Too fast running, highly abrasive pumpage, impact damage from large solids.
- Chemical incompatibility. Misuse, or accidental/unknown chemical contamination.
- Cavitation – restriction or blockage on the suction side, insufficient NPSHa.
- Over-pressure – system restriction or blockage, valve failure, high viscosity, or misuse.
- Dry running – fluid starvation.
- Temperature damage – lack of lubrication, thermal expansion, too much ‘clamp’, or extreme temperature fluids (outside of the pump’s rated range).

Faults and Failure Indications of Progressive Cavity Pumps

Noise

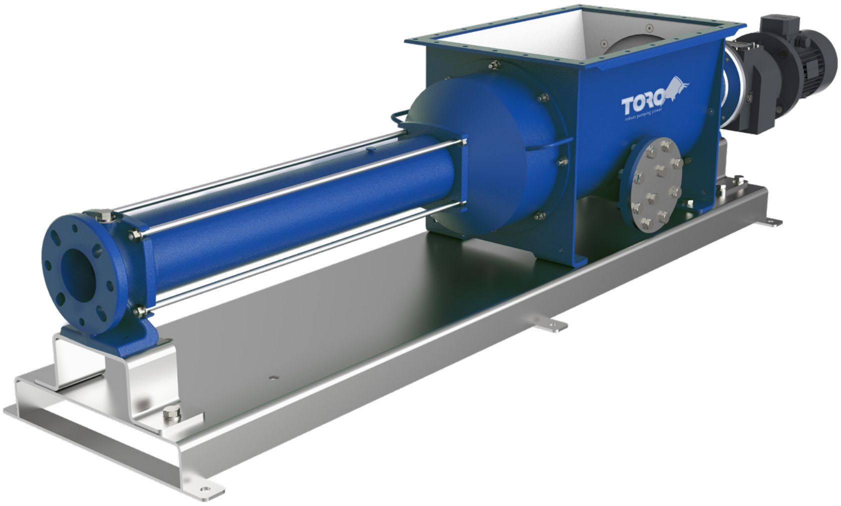
Some faults in pumps are accompanied by vibrations and noise. Know what to listen for and how to interpret the likely cause with this list:

Noise	Emitting From	Probable Cause
Heavy banging sound	Anywhere along the hydraulic pathway	Cavitation – stop the pump immediately!
Swishing, accompanied by a thumping/slapping sound	Stator	Over-pressure
Swishing/spitting noise, with no thumping sound	Stator	Worn rotor and/or stator
Rhythmic knocking	Suction casing	Failing universal joint
Air sucking	Seal area	Failed mechanical seal (will suck air in or leak fluid out depending on pressure differential)
Fast clicking sound	Gearbox	Chipped gear teeth
Squealing/grinding/squeaking	Gearbox, bearing house or motor	Failed bearings

Engineer’s Tip:

If you want to amplify sound coming from equipment, a long screwdriver can act as a stethoscope. With the metal tip touching the suspected failure point, put your thumb on the top of the handle and press the knuckle against the side of your head, between the ear and the top of your jaw. This can help pinpoint where the noise is coming from.

Of course, most of these noises are a result of vibration, which can be felt or seen if particularly advanced. Better still, it can be picked up earlier by regular testing with a vibration monitor at key points, such as mounts and shaft housings.



Heat

Excessive heat generation is a strong indicator of pump trouble, and an infra-red thermometer is a useful tool for early warning during routine maintenance, as well as finding the (literal) “hot-spot” of the trouble!

Unusual levels of heat coming from electrical parts (wiring or motor) indicate excessive power draw. If the wiring system is rated correctly for the pump, then it is likely that the pump is being overworked by too high a head height, blockage or fluid viscosity increase. Friction heat coming from the chamber is a clue to dry-running (insufficient supply), dead-heading (head height too high or a blocked/partially blocked discharge pipe), or impeller misalignment/damage.

Visual Observations

Zero flow, yet the motor and shaft are clearly spinning: it could be a break or disconnect in the joint or coupling rod.

Low flow from the pump discharge end, with pump shaft and rotor spinning OK. If this happens with PC pumps, it’s likely that the sealing line has eroded away causing slippage to occur. This could be caused by pumping abrasive fluids, or a melting of the stator from dry-running. In the latter case, you might smell rubber and see a crocodile skin pattern where the surface is breaking up. Fine abrasives can cause a polishing effect.

Other things to check in this situation include:

- **The flow meter itself.** Check the flow meter is calibrated and fitted correctly. Time to fill a vessel of known capacity is a sure-fire way to calculate the actual flow rate, either in place of a meter or to check it’s calibration.
- **Shaft and joints.** Are they intact and positively transferring? Inspect for fractures and disconnected rods.
- **Rotor and Stator.** Check for signs of wear or damage.
- **The motor powers up but fails to run, or trips after a second.** A mechanical blockage or seizure of the moving parts is a common cause of this. Alternatively, it could be a problem on the power supply, such as if one phase of the 3 phase system is down, or an inverter is failing.

If the pump has a variable speed drive (VSD) or frequency inverter, check the condition and setting on this. Will the pump start OK on a low speed, then allow you to speed up once it has overcome the starting torque resistance? Are you able to run the pump direct-on-line (bypassing the VSD)?

Running these tests can help isolate the issue and provide a solution, whether that involves a replacement part or adjustments to start-up settings.

Conclusion

Pumps can fail to run, or display reduced performance for a variety of reasons. Taking a step-by-step checkup of vital readings, and performing the tests described in this white paper can help take the stress and guesswork out of troubleshooting your PC pump.

Atlantic Pumps can assist you with servicing, repair, condition monitoring, and rapid delivery of spare parts for most progressive cavity and many other industrial pumps. Contact us for pump performance improvements and maintenance-saving upgrades, or follow us on LinkedIn for news of upcoming pump training programs, events, help articles and webinar invitations.

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Moving What Matters

Get in touch

T: 01246 284 420
E: hello@atlantic-pumps.com
W: atlanticpumps.co.uk