Pumpgear.co.uk

Pump Protection, Monitoring and Control from Epump Ltd.

A SIMPLE GUIDE TO THE PROTECTION AND MONITORING OF PUMPS

Introduction

Industrial pumps are expensive. Many are bespoke and designed for a specific purpose so they generally cannot be mass produced. Parts can be on a long lead time and again very costly.

So it makes sense to ensure your pump gives a long and reliable service life and to protect your investment. To achieve this you need to maximize your mean time between failures (MTBF) and minimise the damage caused by these failures. There are several methods available to protect your pump and these are discussed below.

For most types of pump, the most frequent mode of failure is leakage from the mechanical seal. It is estimated that 90% of pump failures are the result of seal leakage. (The remaining 10% from bearing failure or in a few cases, simply leakage from joints). In most occasions the seal is not at fault. It is very rare that a seal will fail simply because of wear but mostly because the pump is being abused.

The Ten Key Reasons for premature pump failure

- Operating outside performance envelope
- Running pump dry
- Closed valve operation
- Overpressure
- Bearing Failure

} Can be avoided by use of pump accessories

- Water hammer
- Alignment
- Erosion or Corrosion
- Blockage in pump, in pipework or strainer
- Cavitation due to incorrectly designed suction

} Can be avoided simply by use of best practices

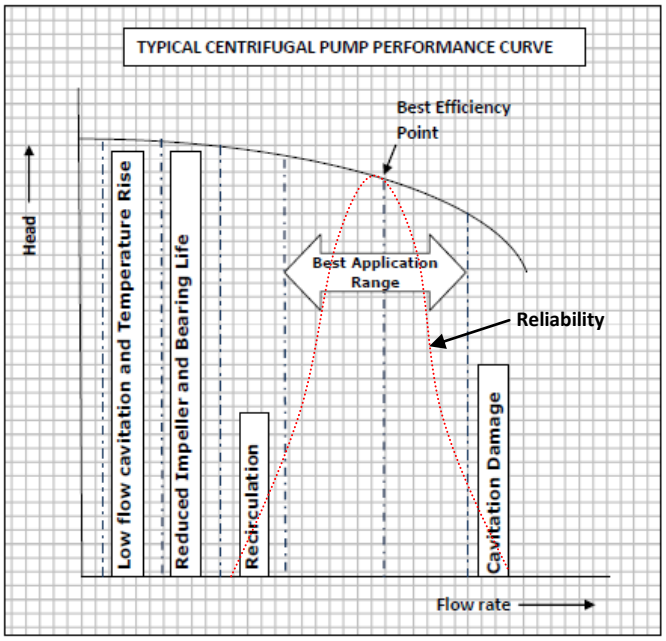
Best practice could also prevent some of the reasons in the first group but experience shows that they still happen – and too frequently.

Operation of pumps outside their design performance envelope

Pump selection should be made as close to best efficiency as possible. This will ensure smooth, trouble free operation throughout the pump's life.

When a pump duty is overestimated, it results in the system curve intersecting the performance curve too far to the right of b.e.p., and may be off the performance curve completely. Flow will be more than that required and there is a danger of cavitation damage which will drastically shorten the life of the pump.

In many cases control valves or orifices are used to bring the duty point back to the performance curve but by restricting the flow, more power is wasted.



If the pump is selected too far to the left of the b.e.p. recirculation will occur, first in the discharge and then in the suction. Efficiency of the pump will fall quickly because of this and there may be accelerated wear – particularly if the pump is handling solids.

As flow is reduced further, internal axial and radial forces increase and the pump might vibrate. Impeller, bearing, shaft and seal life can be reduced substantially.

Finally at very low flows there may not be sufficient cooling of the pump it may overheat and liquid in the casing vaporise. This may damage seals and in some cases lead to pump seizure. NPSH rises towards closed valve and cavitation damage might also occur. For maximum life and mean time between failures, the pump should operate in the range of 80-110% of b.e.p. 70 to 120% is considered fair, but with shortened MTBF. Outside this range considerable reduction in MTBF will be experienced.

Although it is good practice to start a centrifugal pump against closed valve, it should be opened as soon as is practicable to avoid damage.

Control valves, variable speed drive and changing impeller diameter can all be effective in maintaining operation in the best range. Pressure gauges on the suction and discharge of pumps will, by reference to the performance curve, confirm correct operation. Analogue and digital gauges are available from Pumpgear.co.uk.

Running Pumps Dry or with Closed Valve(s)

Tanker unloading and batch transfer are very common applications where dry running can happen, in many cases due to operator error.

In the case of single sealed pumps where sealing depends upon a film of the pumped liquid across the mechanical seal faces, lack of liquid will result in the faces coming together and failing because of friction.

With double sealed pumps the seal is generally cooled using a buffer liquid. This will usually prevent damage to the seals in the short term.

However, only part of the power transmitted through the shaft is converted into useful work by the pump. This defines the efficiency of the pump. The efficiency is a minimum at low or zero flow and the inefficiencies of impeller design and surface finish means the waste energy will be converted into heat by the pump, increasing the pumped liquid temperature. This can result in vapourisation of the liquid in the pump casing. In many cases pumps fitted with double mechanical seals are pumping hazardous liquids – vapourisation therefore can be dangerous so dry running should be avoided.

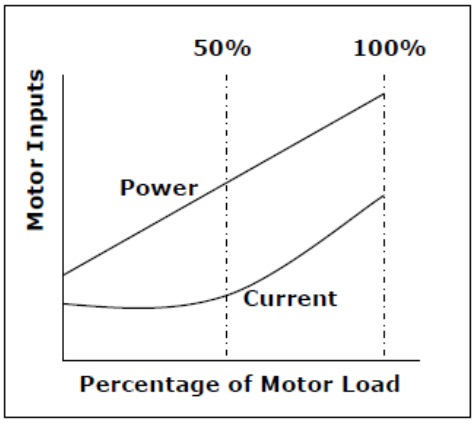
With magnetic drive pumps which have internal bearings, dry running can result in catastrophic failure which always means an expensive repair, or in some cases a new pump. Some magnetic drive pump manufacturers offer coated, low friction bearings and advise short term dry run is OK. Beware!! With non metallic pumps this is possible for a short time, although like sealed pumps, vapourisation is still possible and could be problematic as this type of pump is often used to pump hazardous liquids.

Pumpgear would suggest that metallic magnetic drive pumps should never run dry. Eddy currents crossing the containment shell generate heat. This can build up quickly vapourising any liquid in the bearing area. If heat is allowed to build, damage can occur to O-rings and in some cases the magnets. This would be in addition to vapourisation in the pump casing.

Pumpgear's opinion is that no centrifugal pump should purposely be run dry (would you run your car without coolant or oil?).

Dry run can easily be prevented at low cost and there are several methods available. In order of preference:

1) Power control monitor. This is located in the pump control panel, either DIN rail or panel mounted. This monitors the true power absorbed by the pump.

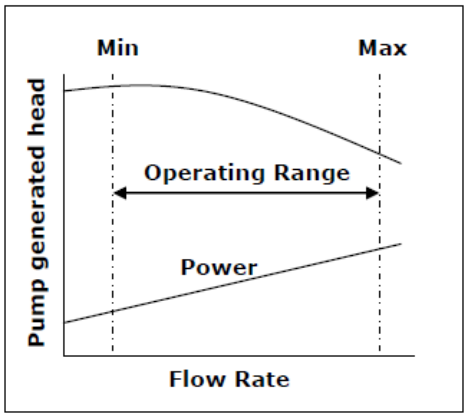


Many users of the first generation dry run monitors (which used to measure phase angle or current) had problems with nuisance trips, and difficulty in setting up.

The reason for this can be explained with reference to this diagram which shows the relationship of motor power and motor current with respect to motor load. The motor current is almost constant up to 50%

of the motor load and so is not a good measure at low pump flows.

The power curve however rises almost uniformly as the load increases, which means that settings are much easier and more reliable. Motor power can be linked to the flow rate using the pump performance curve and the monitor is set to cut out the pump at the power corresponding to safe minimum flow and at maximum rated flow.



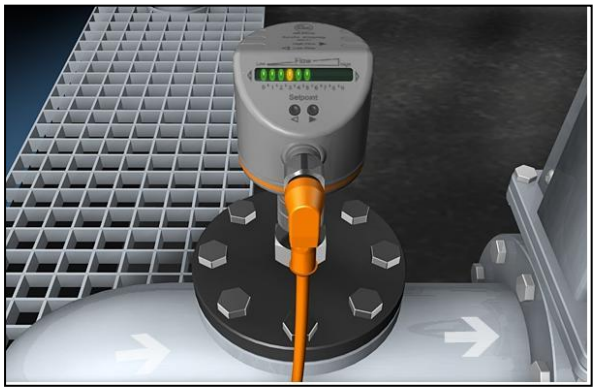
A delay timer is provided so that nuisance trips can be avoided, for instance transient conditions or at start up.

One of the benefits of this device is that it is non intrusive – it does not come into contact with the pumped liquid so is especially suitable for hazardous liquids. There is no expensive mechanical work required – this alone can be more expensive than the unit itself. The unit will also prevent damage occurring because of closed valve operation and ensure that your pump will not operate outside its intended performance range.

380-440 Volt 3 phase Power Monitors for DIN rail mount can be provided either with analogue set up at £ 243.99 + VAT or the digital version at £ 358.97 + VAT. Other voltages available.

A display unit is available for the analogue version and there is also a panel mounted version of the digital unit. See web site for details.

2) Flow sensor



Flow monitoring is an inexpensive way of visually checking flow - locally to the pump and also provides a positive shut off when the flow drops below a set value. This is commonly used on positive displacement pumps where viscous liquids can be pumped and can be

supplied for hygienic applications as well as industrial.

IFM have a range of modular flow monitoring equipment to suit different pipework diameters.

The monitor will generally be mounted on a tee piece on the suction pipework as shown. The sensor will typically measure liquid velocity between 0.03 and 3 m/s.

Easy adjustment by push button means that the application parameters can quickly be set on site using a "teach" mode. Electronic locking will prevent tampering. Flow and switch point are indicated by a multicoloured LED display on the monitor.

Prices start at approximately £ 303.00 + VAT including connector and 5m cable which is less than the price of a good quality mechanical seal!

Overpressure

Pumps are designed for a maximum working pressure. Exceeding this pressure can damage the pump and in some cases be dangerous.

Centrifugal pumps are less prone to this than positive displacement. Closing a discharge valve will not have any short term effect on the pump, indeed for most types it is recommended to start the pump against closed valve.

Positive displacement pumps however will continue to build pressure when a valve is closed or there is some obstruction in the discharge line. This can be extremely damaging. In the case of lobe or circumferential piston pumps overpressure has been known to deflect the shaft so that the two lobes contact and damage each other resulting in costly repairs. In other cases seals are destroyed. Pressurised liquid can be a hazard – especially if hot, corrosive or toxic. So it is better to prevent this from happening.

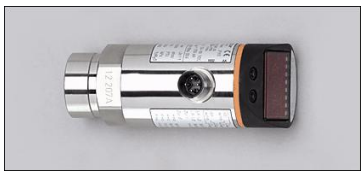
The most common methods are:

1) Pressure relief valve. Either integral with the pump or on the discharge pipework, piped back to suction or source.
2) Pressure switch set at or below the pump maximum pressure rating to cut out the pump in the event of overpressure

Other methods are by using power settings in a variable speed drive (uncommon and only as good as the commissioning person), and bursting discs which have a similar effect to pressure relief but are considered failsafe.

IFM pressure Monitors can provide switching for overpressure and can be supplied suitable for industrial and hygienic use.

The range includes low cost pressure monitors with a single switching output such as the PK5523 pictured at £ 87.20, and the PN50 series with display at £ 257.70 + VAT.



For hygienic use, IFM offer a unique combined pressure gauge with both electronic and analogue display. Switching settings are visible as LEDs with settings carried out simply on an optical touch field.

All common connections are available and the unit is CIP able. FDA and EHEDG certified. Price £ 453.90 + VAT.

Bearing Failure

Around 10% pump failures are due to wear and eventual collapse of pump or motor bearings. The bearings themselves tend to be inexpensive but the damage caused by their failure can result in a costly pump repair bill.

For instance consider a simple close coupled water pump. A bearing collapse will probably mean impeller and renewable ring damage together with a broken seal. Replacing these items can amount to 30 - 50% of the total pump price. If the shaft too is damaged then a new pump might be more economical.

Now consider more expensive engineered pumps with complex mechanical seals or magnetic drive, and wetted parts in stainless steel or more exotic materials. The same failure of low cost bearings now results in major expenditure. Better to change the bearings before they fail?

Failure can usually be avoided by monitoring bearing wear.Portable equipment has been widely used for this purpose, but this requires constant visits to the pump for measurement and comparisons. Low cost permanent measurement has finally arrived.

In its simplest form, a vibration monitor can be mounted on the pump bearing housing, or in the motor lifting bolt hole. The IFM VK monitor will measure r.m.s. velocity. When an adjustable limit value is reached a switching output sets to alarm. In addition a 4-20 mA signal is

provided for process control system. A time delay is provided for transient conditions.
The VE series takes this a stage further. These compact diagnostic units are very easily pre programmed using a PC with the parameters associated with the machine's bearings.

The unit will then constantly monitor up to five bearings and give a visual indication of condition by LED display. Two switching outputs are provided – for warning when the bearing is partly worn and for alarm. Budget cost £500.00 + VAT. Allow for one off costs of software, cable and power supply for programming budget £120.00.

Further equipment is available which will monitor 4 different machines at the same time. So say goodbye to manual monitoring and hello to low cost 21st century diagnostics.

Conclusion

Today's modern cars and commercial vehicles are fitted with a variety of sensors that protect and monitor performance of the engine. This has resulted in much more reliable vehicles with longer service intervals and therefore lower running costs.

Similarly, there are several low cost accessories that can protect, enhance the life, and extend the mean time between failures of pumps. Your pump might have cost the same as a family saloon car, so it would certainly make sense to protect your investment.

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Prices correct at March 2010
More details and pump accessories at www.pumpgear.com

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