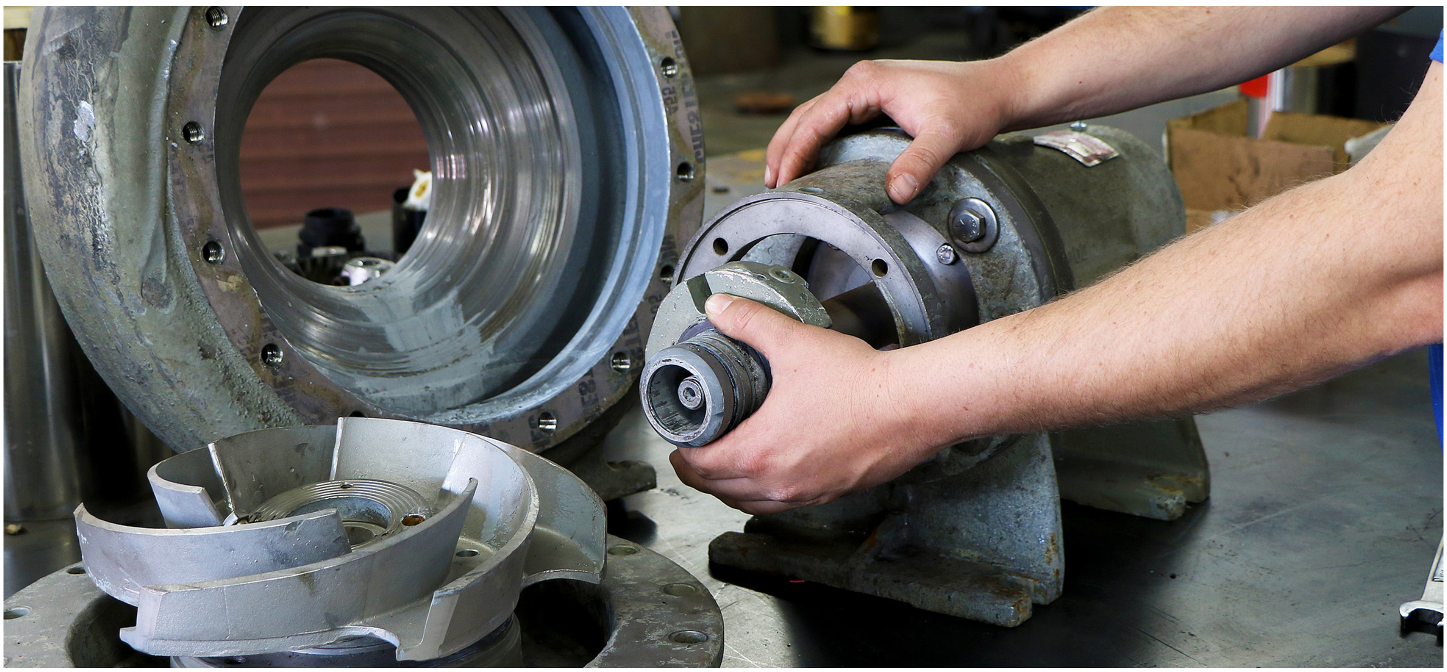
RUTHMAN
Engineering Pump Solutions™

WHITE PAPER
Identifying Causes of Pump Failure

Guide to Seals, Bearings and Couplings

A pump rarely fails without warning; there are usually clear signs that a failure is imminent. Excessive vibration, noisy squealing, increased operating temperature, off-curve pressure readings, and process fluid leaks are all symptoms of problem pump operation. Identifying the root causes of these pump issues can avert further damage to the pump and downstream equipment, and avoid costly repair downtime.

Seals, bearings, and couplings are the most common pump components underlying pump performance troubles. Without proper maintenance of these items, processes are at risk of considerably increased operating expense. The true cost of neglecting these items encompasses not only the repair and replacement of equipment damage but also resources and production downtime. This guide helps users identify signs of impending failure, uncover the root causes, and prevent them from happening again.



MECHANICAL SEALS

Signs of Failure

Field technicians estimate that up to 85% of pump failures are caused by mechanical seal problems, making them a likely place to start. Fortunately, this issue is also pretty easy to spot. Failing seals will often present as a slow drip or steady stream of process fluid originating from the seal gland. While seals account for most rotating equipment failures during the life of the pump, they are seldom the root cause of failure.

Incorrect material for the process where a seal is being put into service is a common mistake. This can cause the seal's O-rings to swell or crack, or cause corrosion of the seal's face. Proper selection takes into account not only the process fluid of the service, but also the operating conditions. For example, water would be considered a pretty non-reactive fluid that wouldn't require specialty seal selection. But that previously inert fluid can cause flashing and damage at the seal face when extreme temperatures are part of the operating conditions.

Likewise, operating procedures can also impact seal health. Taking a stopped pump from ambient temperature up to immediately running extreme high heat or super cooled fluids can thermal shock the seal and cause cracking.

Viscous fluids such as paint can cause build up along the faces and edges of the seal. Over time, this can cause failure. See ***Figure 1*** for an example of a seal that failed due to paint buildup.

Figure 1 Failed mechanical seal exhibiting cracked seal faces and paint buildup

The final major cause of seal failure is dry running of the seal, which can result in thermal shock or burn up the seal's elastomers. Any number of systemic problems can cause dry running. A low level of fluid from the source, blockages to the suction side of the pump, or running with closed discharge (deadheading) can all cause temperature to spike and lead to seal failure.

Preventative Steps

The first step in avoiding mechanical seal failure is to select the proper seal for both the process fluid and operating parameters. Instead of defaulting to selection by fluid type, review process conditions in detail with an application sales engineer.

If a process runs extreme temperatures–either supercooled or superheated liquids–changes to startup procedures should be made to avoid thermal shock to the seal. Gradually introducing the process fluid into the pump will bring all components up to full temperature more slowly. The addition of external heating or cooling elements is another possible solution.

For applications like paint and other viscous fluids, an external seal flush system can be added to minimize buildup on the seal. If an external flush system is present on a pump, it should be maintained in good working order and checked if seal build up and failure occurs.

After selecting the proper seal material for an application, focus should shift to preventing dry running of the pump. A level control switch prevents low supply levels and should be installed if fluid at the source regularly runs low. Discharge flow and pressure drops are signs that the intake should be checked for blockages.

Finally, a pump should never be run with a closed discharge. The only exception to this rule should be very brief amounts of time during pump performance testing. Signage and lockout procedures should be implemented to prevent this from happening during regular running of the process.

One way to completely avoid seal problems is to retrofit the process with a sealless pump that eliminates the need for a mechanical seal altogether. Vertical enclosed column designs reduce leakage across the throttle bushing, collect any incidental leakage within the pump column and discharge it back to the suction or supply tank.

BEARINGS

Signs of Failure

There are a number of indicators that could signal bearing problems: increased noise during operation, higher than normal vibration readings and temperature spikes around the bearing housing should be treated as the red flags that they are. These little signs could foreshadow big pump problems. Acting immediately on these warnings can head off major issues. Even minor rattling should be checked out. Once that noise progresses to loud squealing, it's usually too late. The bearings are probably already damaged and the pump is in danger of locking up.

Bearings are initially lubricated at the factory, and then require regular lubrication as preventative maintenance. The schedule for this varies and should be based on the pump's application and operating schedule. Skipping this required maintenance can lead to overheating and early failure.

(The one exception to this maintenance is for sealed bearings; see Preventative Steps.)

Care should also be taken to keep bearing lubricant free of grit and other contaminants. Even the smallest debris can damage the bearing surface, causing inconsistent operation and significantly shortening bearing life.

Finally, shaft misalignment and pump vibration should also be closely monitored and promptly remedied. Both can cause spalling and damage to the bearing surface over time.

Preventative Steps

The most important step in ensuring bearing health is to regularly lubricate them according to the best practices outlined below. Set a regular lubrication schedule and keep a log.

Apply the appropriate amount of lubricant, according the operator's manual. Over lubrication can be just as damaging as under lubrication. Severe heat buildup and premature bearing failure can result from overgreasing.

Note that sealed bearings do not require additional greasing, if grease is added to sealed-type bearings this could force the seal out of position.

Periodically inspect the lubricant. If it appears to be contaminated, have it analyzed to determine what type of contaminants are infiltrating the bearing housing. Once the type of contamination has been determined, take corrective action to prevent reoccurrence.

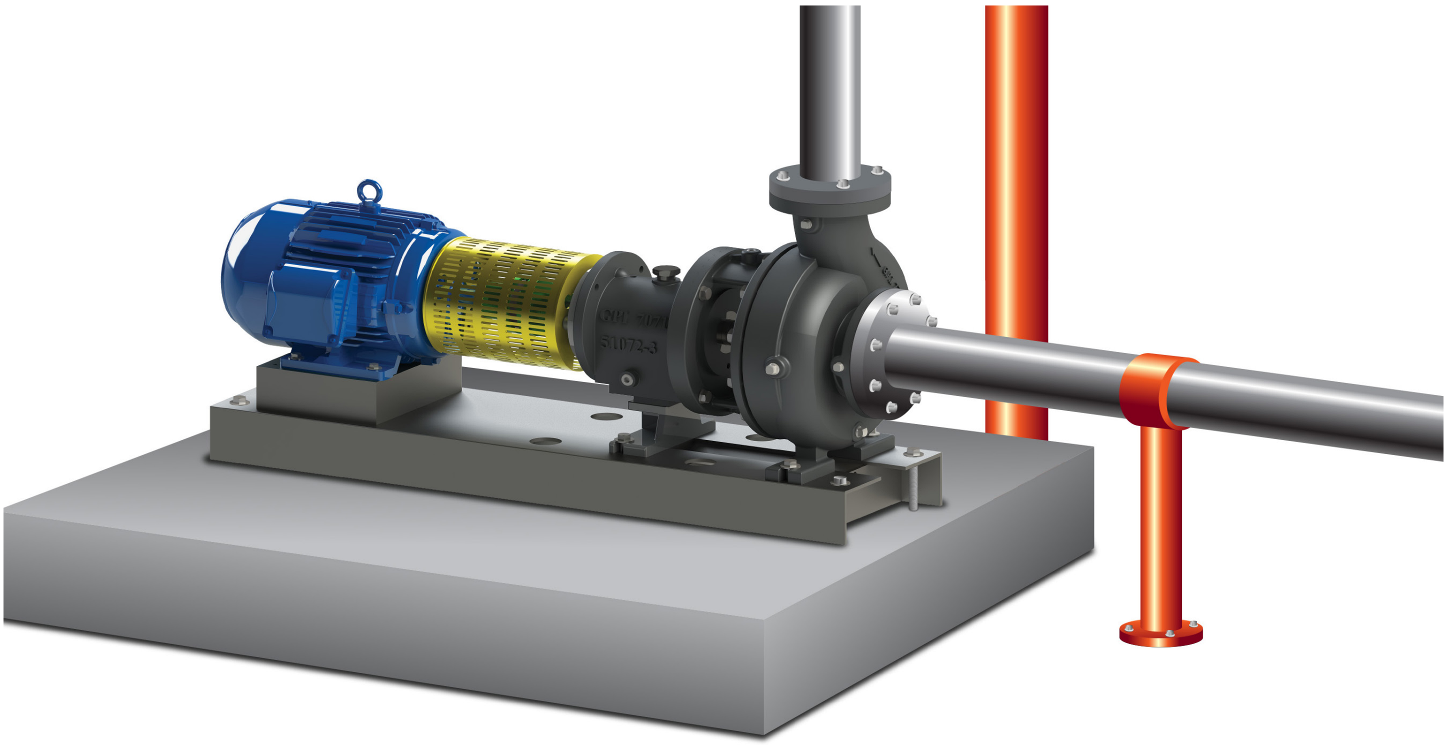


Figure 2: Properly aligned and supported pump installation

Always fully shut down a pump before performing this maintenance. If lubricant is added while the pump is running, the grease will not reach the rolling elements and the bearings will run dry.

Use the same grease type every time; never mix grease types. Different grease thickeners can be incompatible and cause starvation or hardening.

Good system design and solid installation should prevent the excessive vibration that can lead to bearing spalling or pitting. Pumps should be mounted securely on a level base, with extreme care taken to support intake piping to avoid any strain on the pump. A pipe hanger installed on the discharge pipe should support all weight, not the pump or the casing. See ***Figure 2*** for proper installation and support. Regularly monitor equipment for changes in vibration and temperature to identify changing conditions.

COUPLINGS

Signs of Failure

When the pump shaft and motor shaft are out of alignment, couplings will fail. The misalignment may be present from pump commissioning due to improper installation. It is also possible for a properly aligned pump to become misaligned over time due to system vibration.

Black debris under the coupling area of the pump is a sure sign of coupling misalignment. This pile of shavings is from the coupling insert that is placed between the coupling flanges. On a misaligned coupling, the faces of the flanges rubbing together will grind down the insert over time.

Vibration is the other key indicator of misaligned couplings. Any increase in vibration above what is normally observed during the regular operation of the pump should be investigated as described below.

Preventative Steps

Whenever trouble is suspected–either due to spotting the aforementioned shavings or increase in vibration–couplings should be inspected. Regular inspection should be part of a routine maintenance schedule as well. Any time repairs are made to the pump, proper alignment should be verified both prior to startup and after the pump is at operating temperature (called 'hot alignment').

The parallel coupling alignment should be checked first by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling. If the maximum offset exceeds what is specified by the coupling manufacturer, the coupling should be realigned.

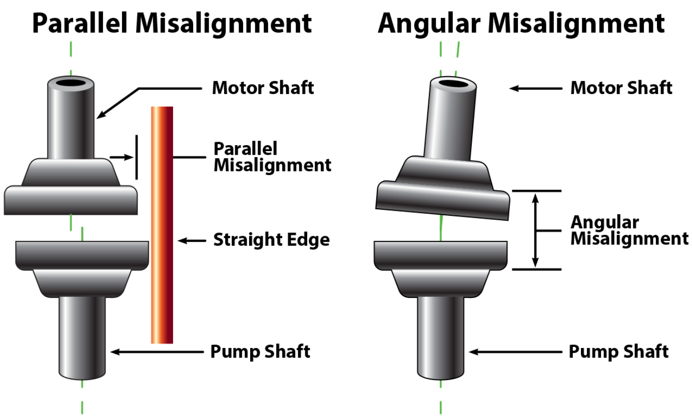


Figure 3 Parallel and Angular Coupling Alignment

Once satisfied with the parallel alignment, the angular alignment of the coupling should then be verified with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. If the difference between the maximum and the minimum exceeds the tolerance specified by the coupling manufacturer, the coupling should be realigned. If correction is necessary, the parallel alignment should be rechecked. See ***Figure 3*** for proper coupling alignment techniques.

DOCUMENT MAINTENANCE AND REPAIRS

Keeping good maintenance logs can identify future pump problems and help diagnose the cause of future pump failures. Once a pump is up and running again, this important step is often neglected as other tasks take precedence. Documentation should be given the same level of importance as the physical repair of the pump.

The more detailed the documentation, the easier it will be to pinpoint unusual pump conditions. Note the pump's location in the process and the reason the pump was identified for repair (stoppage, performance, leakage, noise, amps, etc.).

Repair notes should also include the diagnosis and steps taken to repair the pump. When a pump requires frequent repairs and is identified as a "problem" pump, it can be flagged for closer inspection of the installation, piping, operation, and repair procedures. This closer inspection should result in identifying the "root cause" of the failures.

Maintenance logs should also include any unusual operating conditions around the timing of the repair issue (e.g., a period of shutdown for a holiday, exceptionally high temperatures, etc.).

Using historical data to eliminate recurring problems will significantly extend pump life and prevent process downtime.