THE 7 SECRETS OF PUMP RELIABILITY

by ***Ross Mackay***

1. Why the pump doesn't do what it was designed for.

Contrary to popular opinion, a centrifugal pump is not designed to develop a specific head at a certain capacity as requested by the pump purchaser. In fact a pump is designed and built to produce a whole range of head-capacity conditions as identified by it's performance curve. The pump will operate on that curve if it is driven at the designated speed.

The specific point at which the pump will operate however, will be determined by the back-pressure on the discharge flange as created by the system.

The operation of the system under a variety of conditions can be shown by the system curve, and the back pressure on the pump discharge flange will be represented by the point at which the system curve intersects the pump curve.

The slope of the system curve will be changed by the static head in the system or the friction losses in the system.

Therefore, for all practical purposes, the system controls the pump, and will operate that pump at whatever conditions it sees fit, regardless of what conditions it was bought to accomplish.

2. The vital piece of information missing from your supplier's IOM manual.

The vast majority of pump manufacturers installation instruction advise that "the pump should be located as close to the suction source as possible". This is an important consideration as it will minimize the amount of losses in the suction line which, in turn, maximizes the NPSH available to the pump. Unfortunately, many will carry that instruction to the extreme and bolt one side of the suction isolating valve to the pump, and the other side to the tank. This creates an excessive amount of turbulence in the liquid as it enters the pump suction nozzle and the impeller eye. The result is Air Entrainment and reduced reliability.

The piece of information that is missing from the IOM manual is that "the pump should be located as far away from the suction source in order to permit the necessary piping practices for sound operation".

Every pump should have a smooth flow of liquid entering the suction nozzle. Ideally this comes from a suction line that is at least one size larger than the suction nozzle and with no valves, elbows or other fittings within 5 to 10 diameters of the suction nozzle. The pipe diameter should also be reduced to the pump flange by an eccentric reducer located with the flat side on top.

3. The most important troubleshooting question.

Regardless of the details provided when trying to unearth the basic cause of a pump breakdown, the single most important question to ask is, "How long has this been going on?".

The answer to that question can immediately change the impact of all the other information. The answers will range from, "It's been that way since Day one." to "It just happened yesterday afternoon.". Somewhere between these two, you may hear, "It started a while ago and has been getting steadily worse.". Obviously the real cause will be determined from these responses. Some immediate considerations might be:

"…. since Day one"	— Wrong pump!
"…. getting steadily worse"	— Normal wear and tear!
"…. yesterday afternoon"	— Something went wrong!

Some years ago, I was invited to investigate a problem of excessive packing leakage from a pump in a paper mill. I spent many hours interviewing the plant engineers and maintenance staff, and pouring over the maintenance records, before I finally asked the question, "How long has this been going on?". It then transpired that they had been living with this problem for over 15 years.

It was immediately obvious that, although the real problem was the method they were using to pack that pump (quite different from the way they packed every other pump in the mill), it was highly unlikely that the condition would change because it was now ingrained in the department culture. Consequently, an immediate change to a mechanical seal was both inevitable and essential.

4. The most important troubleshooting tool.

Many thousands of older end suction centrifugal process pumps are still operating with shaft diameters that are no longer adequate for the more arduous service conditions now being experienced. The symptoms of this condition include repetitive and regular seal failure and excessive packing leakage.

Confirmation of the shaft problem can be identified by the Shaft Slenderness Ratio. This is a comparison of the shaft diameter and it's overhang length. It is identified by the relationship of L^3/D^4 where 'L' is the axial length between the centerline of the radial bearing and the centerline of the impeller, and 'D' is the diameter of the shaft under the sleeve. As it is not a true ratio, it is important that the measurements be in inches.

Many older pumps will have a value in excess of 100 which indicates a pump that is not able to handle a variety of stresses at the shaft. Under adverse conditions, excessive deflection will take place and frequent seal and packing failure results.

The normal solution is to remove the shaft sleeve and make a new shaft with the diameter at the stuffing box at the same diameter as the discarded sleeve. This will significantly reduce the Slenderness Ratio and minimize the deflection of the shaft, thus permitting longer life from the seal and packing.

5. Your best mechanical seal supplier.

All the major mechanical seal suppliers manufacture a wide variety of seals that will handle an even wider variety of applications. If any one supplier is limited in any important area, they can be eliminated from the list of possible suppliers. Otherwise, the actual product should not be the main focus when identifying the best supplier. As the seal industry is also highly competitive, you can be assured that the pricing level of the seals are going to be very similar from one supplier to the next, and will be determined largely by your own negotiating and purchasing skills.

The most significant area of differentiation is in the competency of service you can expect from the local representative. The difference from one to another can be huge in any one area. In fact, if I ask any of my clients, “who is the best seal rep in the area?” they are able to give me one name without hesitation. The sad part is when they tell me they’re not able to use him or her because their head office — in another part of the country — has decided on the exclusive use of another supplier. The importance of the local supplier is underscored by the fact that the two main areas of seal problems is in the selection of the correct seal for a particular service (pump and liquid), and the accuracy of installation. In both these areas, a willing, competent and local representative is essential.

6. What cavitation is and what it’s not.

More papers and books have been written on this topic than on all other pump questions put together. The main reason is that there are exceptions to almost every rule identified in this area. However, there are still some basic conditions that apply to the vast majority of pump applications, and these are identified here.

When a pump is vibrating and exhibits that unique rumble/rattling noise, most people will identify the problem as cavitation. This is not necessarily the case! There are two other conditions that will result in almost the same symptoms, but are caused by different conditions.

Cavitation is caused by insufficient pressure at the eye of the impeller. Air Entrainment is caused by turbulent conditions or boiling or fermenting liquids entering the pump. Recirculation is caused by operating the pump at too low a capacity. These differences are also reflected in the general location of the pitting damage that takes place on the impeller. Cavitation and Air Entrainment causes the damage to occur at the eye of the impeller while Recirculation generally causes the damage to take place further along the impeller vanes and often at the vane tip on the outside diameter of the impeller.

If any of these conditions becomes excessive, the damage will spread throughout the impeller and even on to the casing.

7. The simple way to extend your bearing life.

In most process pumps, bearings and their environment are protected against the ingress of dirt and water by lip seals which are not suited to the purpose. Lip seals are designed to operate in an environment where they are constantly lubricated. This does not take place in a pump bearing housing. Consequently, they run dry, fret the shaft and wear out prematurely. When we consider the fact that these seals are only supposed to operate for a period of about 1,000 hours under ideal, lubricated conditions, they are obviously an inappropriate selection to protect pump bearings.
The non-contact labyrinth type of seal has been recommended for this purpose in the petroleum industry for over 50 years. It is now gradually being introduced into the process pump industry, but is even slower in being supplied as a retrofit for pumps already in the field.

More commonly referred to as a bearing isolator, these items are available from a variety of sources and are extremely effective in protecting the environment of pump bearings.

Ross Mackay specializes in helping companies reduce pump operating and maintenance costs by conducting training courses in person, and through a self-directed video program.

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