SEAL FAILURE ANALYSIS RESULTS

The overwhelming reason for a pump to enter the shop is because of failure of the mechanical seal or packing, yet very few companies are regularly troubleshooting these seals. Ten to fifteen minutes spent at this critical juncture can mean doubling or tripling the life of the seal going into service now. It is not difficult to determine the cause of failure in 80% of the applications common in industry today.

Any company buying mechanical seals from a reliable vendor has the right to expect a sensible failure analysis on the majority of their seal failures. The seal rep is seldom at the shop when the pump comes in for repair, but the folks changing the seals can do a very good job of identifying the reason for failure: steps taken at this point can substantially improve the reliability of the application and save the Corporation far more money than the cost of this time invested. Failure to address the problems evident almost certainly dooms the pump to a short service life upon rebuild. For the purpose of this report, I will not discuss packing failures but will focus on the major causes of seal failure.

The following data is compiled from the records kept at two chemical plants on seals I have personally inspected. The totals expressed represent totals for the plant over a two year history and are not application specific. In most cases, the seals were reviewed after the pump was already back in service, but using the form included in this report has allowed these clients to increase the life of the seals used and has increased the Mean Time Between Failure (MTBF) dramatically over the past two years.

CLIENT ONE: a large plant with relatively simple processes and over 600 pumps. This plant has a large powerhouse which it can use for co-generation purposes as well as to supply steam needed for processes in-house. This client uses a wide variety of seal designs and materials of construction. These designs are component seals, split seals, cartridge seals (single and double/tandem).

CLIENT TWO: a medium sized plant that two years ago standardized on cartridge seal designs. This plant does not have a large powerhouse, but runs significantly more involved pump/seal applications (evaporation/condensing/reaction loops/etc.) which lead to other concerns.

SEAL FAILURE TOTALS
CLIENT ONE

I.D./O.D. RUBBING	**106**
O-RING FAILURE	**54**
BEARING FAILURE	**54**
POOR INSTALLATION	**24**
PUMP RAN DRY	**22**
LOST ENVIRONMENTAL CONTROLS	**21**
FACES WORN/OPENED	**19**
CORROSION	**10**

SEAL FAILURE TOTALS
CLIENT TWO

I.D./O.D. RUBBING	**32**
O-RING FAILURE	**25**
BEARING FAILURE	**22**
PUMP RAN DRY	**20**
FACES WORN/OPENED	**16**
POOR INSTALLATION	**5**
LOST ENVIRONMENTAL CONTROLS	**4**
CORROSION	**4**

RESULTS

There is a great deal that can be gleaned from these two plants experience. The largest contributing failure in each case was I.D./O.D. rubbing of the rotary seal member against some object, most commonly the bore of the stuffing box. There have been numerous studies completed and documented that clearly prove the value of large bore stuffing box/seal chambers for mechanical seals. The two plants listed have instituted on-going upgrades for their pump populations; if a seal comes out and shows rubbing as the cause of failure, they immediately return to the previous work order on this particular pump. If that failure report also states rubbing as cause of failure, the stuffing box is replaced with a seal chamber on the spot, prior to seal replacement.

The concept of "Shaft Deflection Ratio" has been discussed at length in previous issues of this magazine and countless others devoted to our industries. The stiffer the shaft ratio, the better the pump is able to perform off its Best Efficiency Point (BEP). A good rule of thumb is that a ratio value less than 60 will guarantee seal life is increased dramatically in "Off BEP" operating conditions. Remember that your pump operates where its pump curve crosses the system curve: systems age and change over time (a gate valve is replaced with a globe valve, long horizontal runs of piping build up solids, etc.). Pumps purchased for design conditions that don't match those given the pump vendor EXACTLY can become headaches for maintenance and operations from Day One.

The second greatest cause of seal failures was related to o-ring failure. The **proper** o-ring for an application must address both the fluid being dealt with AND any fluid used to clean the system. VITON might be the proper material for the normal application: what if your system is cleaned every shut down with a caustic steam solution? You lose the seal a week later and the failure analysis states o-ring failure; is the connection made between the caustic steam washout and the failure of VITON? You are far better off stipulating more expensive o-rings which can survive both conditions than losing seals after your turn-around, when the plant and system are up and have to run.

Please also note the drop in seal failures due to poor installation when comparing Plant One and Plant Two. With the decrease in maintenance budgets and personnel, the increasing utilization of "multi-craft" people demands simpler seal designs for installation by off-shift personnel. Component seals can be very difficult to install and are sensitive to dimensional information often unknown and/or unavailable to "back-shift" employees. "The road to Hell is paved with good intentions"; if your plant has downsized in the maintenance department (and whose plant hasn't?) cartridge designs may justify their additional cost because of their ease of installation. Don't blame an electrician for shortened seal life when complicated seals are being installed!

Note also the frequency that bearing problems cause seal problems; the two are inextricably intertwined. Lip seals were designed around the time of the Second World War; they were designed for automotive water pumps. They have a limited design life which is far short of bearing design life. Bearings are seldom a failure because of fatigue; far more commonly, they fail from contamination and water emulsions in a pump's bearing housing. Upgrade your lip seals **every time you change bearings** on your pumps and you will see the bearing life triple and quadruple. Upgrade from lip seals to whatever your engineering staff decides is best; labyrinth seals, full face seals, magnetic seals, etc. Which one of us would buy equipment designed in the Forties today for any application in our plants or homes?

Finally, TRAIN YOUR OPERATORS!! They deserve and need training, because they are the people causing the majority of your seal and bearing failures. I have yet to work with a maintenance man who didn't care about the quality of his work; maintenance people are not the ones wrecking the production equipment. Untrained operators regularly run pumps dry, start them with closed suction or discharge valves, and fail to report increased noise or vibrations from the equipment they run. They don't do this to sabotage the plant; they do it from ignorance. Production "owns" the equipment: maintenance just "borrows it" when it needs to be repaired. Stop cursing your maintenance budget and start training your operators: you'll see how quickly maintenance can become a profit center for your plant instead of "the ugly step-child" it too often is perceived as in the plant budget and planning sessions.

CONCLUSIONS

Seal failure analysis does not have to be complicated or time consuming. Most of it can be done by your in-house staff in less than ten minutes at the time of failure with reasonable accuracy. Don't lose the data; gather it on the simple form enclosed, and log it into a simple data retrieval system. Marshall the assets you already have in-house to get a better view of your problem pump applications**,** make a few simple upgrades on repeat offender pumps, and improve your bottom line today. Plants can readily improve their overall profitability with better training of operators and giving their maintenance people the freedom to make some simple upgrades at the time of seal/bearing failures.

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This article was published in "Pumps & Systems" magazine, May 1996

FAILED SEAL RETURN FORM

1. MECHANIC'S NAME_____

2. WORK ORDER #_____DATE_____

3. EQUIPMENT I.D.#_____

4. EQUIP. MODEL/SIZE/NAMEPLATE INFO_____

_____

5. PLACE AN "X" NEXT TO THE APPROPRIATE BOX FOR THE CAUSE OF SEAL FAILURE IF YOU HAVE EXAMINED THE FAILED SEAL:

I.D./O.D. RUB_____ O-RING FAILURE_____

BEARINGS/PUMP_____ POOR INSTALLATION_____

LOST ENVIRO. CONTROLS_____ CORROSION_____

FACES WORN/OPENED_____ PUMP RAN DRY_____

6. ANYTHING CHANGED ON PUMP? (IMPELLER ADJUSTED, SLEEVE/SHAFT CHANGED, BEARINGS CHANGED, STUFFING BOX BORED OUT, ETC.)

_____

_____

7. ENVIRONMENTAL CONTROLS INSTALLED/RE-INSTALLED? Y____ N_____

8. ADDITIONAL COMMENTS?_____

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