KelairPumps

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PumpAction

ISSUE 42 JULY 07

Welcome to the 42nd edition of Pump Action

This month we concentrate on Warren Rupp's Sandpiper Air-powered Double Diaphragm pumps. In the first article we look at some changes the company has recently made to its 11/2" and 2" Polypropylene pumps, the reasons, and the benefits to users.

Our feature article looks at the costs of running air-powered diaphragm pumps and shows how you can manage these when you know what they are, and save energy. Many will find this fairly detailed article very interesting.

Pump Clinic returns to mechanical seals this month with an overview of seal troubleshooting covering a lot of ground.

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NEW PRODUCTS

Quit stalling with new Sandpiper mining pumps

Sales Engineer Anthony Sidawi (NSW)

Warren Rupp has just released the ideal pump for underground mining, the Sandpiper 1½" and 2" pumps constructed from Polypropylene wetted parts and non-wetted parts. The pumps are light, with high flow rates, low air consumption and large solids capability.

The Aluminum centre section has been replaced with Polypropylene meaning the weight of the 2" pump has decreased from 53kg to 40kg and the weight of the 1½" pump, from 48kg to 29.5kg. And we all know that miners love light-weight but heavy duty pumps!

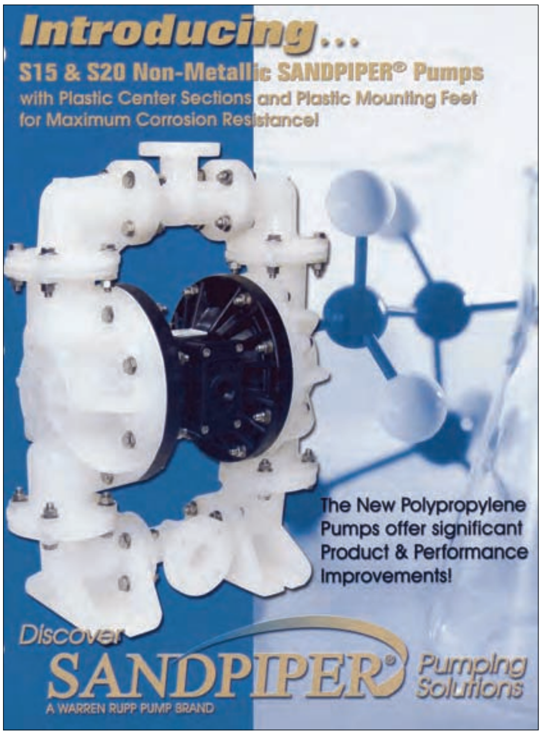
The thick moulded Polypropylene wetted parts offer substantial resistance to wear.

The pump's performance has also been improved by increasing the maximum flow rate of the 2" pump to 605 l/min and reducing the maximum air consumption to 80SCFM. Also for the 1 ½" pump, the maximum flow rate is 378 l/min and maximum air consumption is 50 SCFM. So the new Sandpiper pump has higher dewatering capability while consuming less air pressure. A quick calculation using a power cost of 10cents/kW/hr shows that a 20 SCFM reduction in air consumption running the pump continuously over a year will reduce the running cost by $2,400.00.

One of the important features of the new Sandpiper pumps is their ability to handle solids. The new S20 2" Sandpiper pump is able to handle 17mm solids and the S15 1½" Sandpiper pump will handle 12mm solids. With bigger solids' capability, these pumps are less likely to seize during operation. Another feature is the modular design of the ball cage and seat allowing for easy maintenance and parts replacement.

Both of these pumps have the largest solids-handling capability of any plastic ball check valve pumps available in the Australian market today.

Clever design of the new Sandpiper plastic pumps means that many components are shared between the two pump sizes, in particular the air and pilot valve. By sharing these vital parts, users can reduce spare parts inventories or simply share pump spare parts.



All Sandpiper pumps feature ESADS+Plus (*Externally Serviceable Air Distribution System*) that allows access to the complete air system, including the pilot valve, without the need to remove the pump from the pipe work or breaking the integrity of the wetted ends, thus reducing maintenance time and eliminating possible leaks on re-assembly, resulting in significant reductions in down-time costs.

Also the ESADS+Plus air valve is totally lube-free in design, eliminating the need for in-line lubricators and problems associated with over-and-under lubrication, therefore saving the user the initial cost of the lubricator and on-going costs of oil level monitoring and oil supply.

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FEATURE

Saving energy when using air-powered pumps

Sales Engineer Myro Bratkovic (QLD)

Compressed air-powered diaphragm pumps are relatively cheap to buy, intrinsically safe and easy to operate and if used efficiently, running costs can be reduced.

Savings in energy can be achieved when considering the application and duty cycle of the pump, meaning how often, or for how many hours a day, the pump operates. In almost all cases, the application will determine that the air-powered pump is the most suitable pump for the duty. Some of these determining factors may include the specific liquid characteristics such as viscosity, shear sensitivity and importantly, the type of liquid itself. Is it clean, dirty, aggressive, volatile, solids- laden, etc?

The application itself may require the pump to self-prime, run dry, empty a vessel or simply transfer a liquid from one place to another.

Armed with the details of the application - head, flow, liquid details etc, the selection of a suitable pump is made. What is generally overlooked is the efficiency of the pump that has been selected. Why? In many cases it is considered as just being a part of the cost of ownership of that pump.

In today's 'green-thinking' world this is not really an acceptable oversight. There are efficiencies to be sought by the user and these efficiencies will lead to energy cost-savings and payback on investment in a short space of time. If the customer's daily duty cycle calls for the pump to operate continuously for six or more hours a day, then there is a strong case of energy cost for consideration.

Users of air-powered diaphragm pumps should make themselves aware of the operational cost-savings that can be made by purchasing the most efficient pump they can for their application. This might not sit too well for some users that are brand-loyal because as we see following, some brands are not as efficient or cost-friendly as others.

Duty:
Acid, 340 LPM, 20m total head, operating 6-hours-day-5-days-week-42 weeks. For the sake of this example, the materials of construction for this pump could be Polypropylene body with Teflon elastomers.

Consulting two competitive manufacturer's performance charts and using a proprietary air usage calculation programme 'Air Savings' we arrive at the following results:

Pump Brand "SP", 50mm Polypropylene/Teflon Pump
At 340 LPM, brand 'SP' will consume 70 CFM of air at 80 psi pressure. Cost of power used is 0.10c/kW/hr. The cost to run this pump for one year will be approximately $1,154.00

By contrast:

Pump Brand "W", 50mm Polypropylene/Teflon Pump
At 340 LPM, brand "W" will consume 110 CFM of air at 95 psi pressure. Cost of power used is 0.10c / kW/hr. The cost to run this pump for one year will be approximately $2,011.00

Brand 'SP' will save the customer $857.00 per year in energy costs compared to brand 'W' for the same application. It is important to note that this not a once-off saving, but rather an ongoing saving for the life of the pump. Considering that the initial capital outlay for both pumps is approximately the same, there is certainly merit in looking at pump efficiencies for actual cost-savings.

There are other ways of achieving cost-savings, particularly in controlling air-powered pumps that are used for evacuating sump or pits. This can be achieved quite simply by using some form of level control device such as a level probe, electric float switch, or pneumatic float controller.

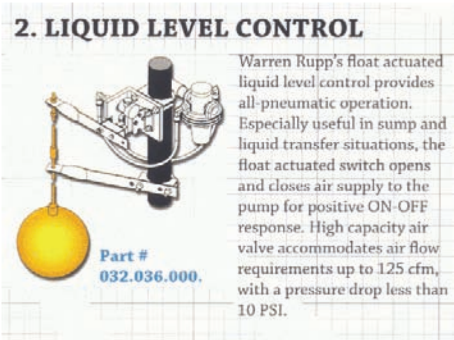
Level probes and electric float switches are simple to use and install but do need an electrical supply for operation. For this reason electrical level control devices might be impractical for some remote locations or for pits that are located in an environment that may contain explosive gasses or vapours.

For such environments the pneumatic-type controllers are best suited. The controller simply senses the rise

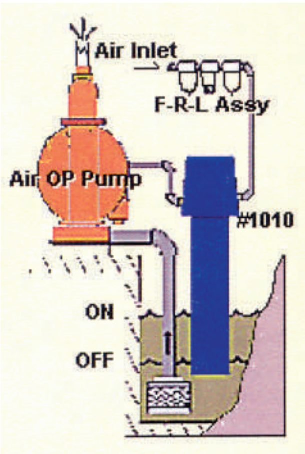
Feature (Cont.)

and fall of liquid in the pit or sump. When the level rises to a preset level, the controller will allow air to pass through a normally closed valve to the air diaphragm pump. The pump will then reduce the level in the pit until the controller senses the pre-determined low level or off position has been reached, closing the air supply valve to the pump.

For such applications, Kelair Pumps stocks pneumatic devices for large wide sumps as well as smaller sized opening pits.



For large pits, the Warren Rupp liquid level controller is commonly used. It uses a ball float and arm arrangement to open and close an air valve that will allow air to pass to the pump. This device is easily adjustable to give both a wide and narrow level band and suits all sizes of Sandpiper and other brand air-diaphragm pumps.



Controlling Pump
Shallow Sump Application

Another device is the Model 1010 and 3500 which are both 'floatless' level controllers. This clever design works on the principle pneumatic pressure of the rising liquid raising a diaphragm in the head section of the controller, which when differential pressure is reached, a pilot valve is tripped allowing air to pass to the pump. Once the differential pressure in the sensing tube is normalised, the pilot valve will return to closed position and stop the air supply to the pump. These devices are suited to all large and particularly small opening and shallow sumps.

How does this translate to cost savings? Consider an underground mine application as a prime example of how these devises can save energy and compressed air using specific application examples.

Underground coal mines use air-powered diaphragm pumps as primary means of lifting ground water off the mine floor and into the primary dewatering system. Mines need to control ground water as failing to do so would result in roadways being inundated with water and slurry that will impede the movement of heavy mining equipment and lead to costly equipment damage and loss.

The mines use diaphragm pumps due directly to their portability, ease of installation, ability to run dry, ability to handle solids in some cases and intrinsic safety.

One of the methods of dewatering in an underground mine is to auger a hole into the mine floor. A diaphragm pump is installed above the hole and suction hose is placed into the hole and the pump normally cycles away slurping up any water as it enters the hole.

The problem with this method of dewatering is that when there is a low water make up in the hole (commonly called a birdhole), the pump is left to run on 'snore'. That is the pump mostly is running dry, but will occasionally catch a gulp of liquid.

The biggest hurdle with running on 'snore' is to make sure the pump is kept cycling fast enough so as not to stall. Stalling is encountered specifically by pumps that don't have non-centering air valves designed to operate at low air pressures. Sandpiper pumps have non-stalling air-valves, so this is not a problem.

Also when running for prolonged periods on 'snore' pumps may tend to air-lock so that when water has accumulated in the 'birdhole' the pump is unable to release the air from within itself and the discharge hose without manual bleeding off. This can be a problem if the pump is only checked once a day, or in some cases only weekly.

Looking at the cost of one uncontrolled running 2" diaphragm pump in a birdhole - picking up less than 1 LPM, the uncontrolled pump may consume 60 CFM of air at 90 psi air pressure. The duty cycle is 24hrs-day-7-days-year. The estimated cost of power is 0.10c / kW/Hr.

Feature (Cont.)

This pump, running on snore, will consume $8,650.00 worth of energy per year and 60CFM of valuable compressed air. This cost does not include wear on the pump which would normally require 2-3 overhauls during this twelve-month period. When considered that coalmines would have dozens of pumps operating in this manner, the waste of energy and associated costs is staggering.

The perfect solution to this problem is to install a Model 1010 pneumatic level controller as it is of a compact design and can be installed in a birdhole. The optimum solution is to install the Model 1010 controller with a smaller, more efficient pump like the Sandpiper S05-Miner pump set that uses even less air, leaving the bigger pump free to be used in areas where the water make up is greater.

The benefits are:

- The pump automatically starts and stops when required.
- The pump does not waste energy running on snore.
- Reduced pump wear and tear.
- Improved dewatering - the pump starts and stops when it's full of liquid, thus eliminating possible air locks.

Consider this scenario as an example of the savings that can be achieved in a coal mine application.

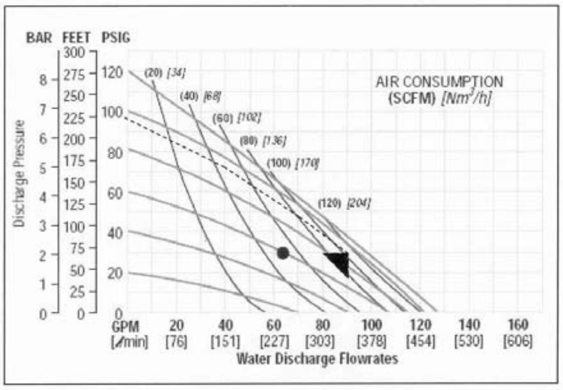
Duty:
Birdhole - 40 l/h, 40m total head, operating on demand 24-hours-day-7-days-week-year. The estimated cost of power is 0.10c / kW/hr.

Using a Sandpiper S05-Miner pump in conjunction with a Model 1010 level controller, the pump is preset to flow 40 LPM at 100 psi air pressure. The air consumption is 16 CFM. Based on this, the Sandpiper S05-Miner pump operating in conjunction with a Model 1010 pneumatic level controller will only cost around 10c per day to run, equating to $35.60 per year in energy.

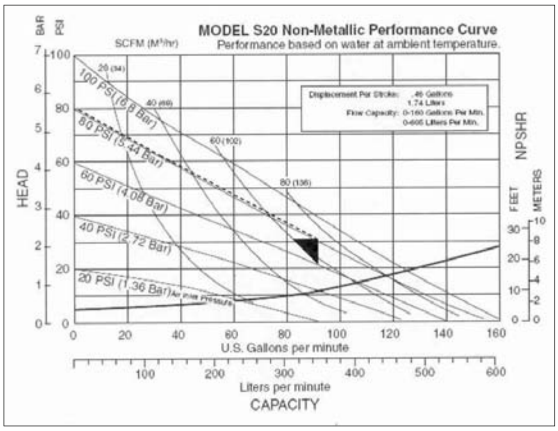
As a return on investment, the Sandpiper S05-Miner Pump / Model 1010 controller combination would cost approximately $2,850.00 and would pay for itself in terms of energy-savings in less than four months of operation. This is a remarkable example of how much energy can be saved by using clever technology.

Kelair Pumps will happily provide pneumatic controllers for those customers who do not wish to change their existing pumps or as a specially tailored low energy package like that pictured above.

Kelair is confident these customers will enjoy substantial operational and energy cost-savings when using these products.



Published performance curve for brand W - Teflon-fitted



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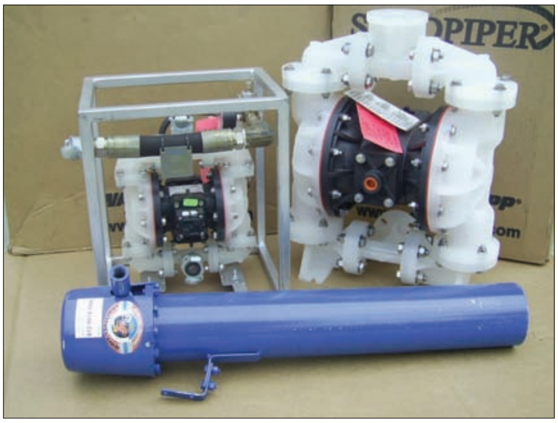

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PUMP CLINIC 16

AN OVERVIEW OF SEAL TROUBLESHOOTING

“Seal problems are almost always associated with face leakage, but as we will soon learn, there are other leak paths in addition to the obvious one between the lapped seal faces.

In the following paragraphs, we'll be looking at all these leak paths. Keep in mind that seals are classified into many categories: stationary, rotary, balanced, unbalanced, inside, outside, metallic, non-metallic, single, dual, elastomer, metal bellows, rubber bellows, cartridge, split, solid, etc. Try to keep these classifications in mind as we investigate the cause of seal failure.

I will be presenting the troubleshooting hints in an outline form. You should not find these terms confusing because I've assumed you have a pretty good knowledge of mechanical seals or otherwise you wouldn't be attempting to troubleshoot them.

LEAKAGE AT THE SEAL FACES

The seal face is not flat. (Flatness should be measured within three helium light bands, (0,000033" or 1 micron)

- The face was damaged by mishandling.
- Poor packaging. The seal should be able to survive a 39" (1 metre) drop. To ensure this, the seal must be shipped in a reusable box insulated with plenty of foam or any other adequate insulation.
- The face was distorted by high pressure or surges in pressure. "Water hammer" would be an example.
- The face was distorted when you tightened it against an uneven surface.
- The clamping is not "equal and opposite" across the stationary hard face. This is a common problem with "L" shaped and "T" shaped stationary faces.
- The "hard" seal face has been installed backwards. You're running on a non-lapped seal face. It is common practice to lap only one side of a hard face.
- The face is being distorted by a change in temperature. This happens when you forget to vent a vertical pump.
- The face never was flat. You have a bad part.
- The carbon metal composite was not stress-relieved after the carbon was "pressed in".

The face has been chemically attacked.

- Oxidizing agents attack all forms and grades of carbon graphite.
- Some de-ionized water will attack any form of carbon.
- Corrosion increases with a temperature increase. A 10°Centigrade (18°F) rise in temperature will double the corrosion rate of most corrosives.
- A cleaner or solvent is being flushed through the lines and is attacking the carbon.

- You are using a poor grade of Carbon. Go to an unfilled grade such as Pure Carbon Company grade 658 RC. This is a common occurrence if the seal is being repaired by someone other than the original manufacturer.

The plating or hard coating is coming off the hard face.

- All coatings are porous. The chemical is penetrating this porous coating and attacking the bond between the coating and the base material, or the base material itself.
- An inferior plating was originally put on the base material.
- Differential expansion of the dissimilar materials is causing them to separate.

The seal face is cracked, pitted or damaged.

- High temperature is heat checking (cracking) the plated face. This is a common problem with cobalt based tungsten carbide. The nickel base version is less likely to crack.
- The product is solidifying between the faces and they're breaking at start up. Most face materials have high compressive strength, but tend to be weak in tension.
- Excessive vibration is causing the drive pins to crack the face. Low cost seals experience this problem quite often.
- There is a high temperature differential across the ceramic, 7 to 10 cycles can break even good ceramics in hot water or hot petroleum products.
- Air is trapped in the carbon face. Heat is causing it to expand and blow out pieces of the carbon face. The carbon usually blisters prior to blowing out. The solution is to go to a more dense carbon.
- The product is vaporizing and allowing solid material to blow across the lapped face. This is a common occurrence in boiler feed water applications.
- The seal faces have opened, solids penetrated and imbedded into the soft carbon are causing rapid wear in the hard face. The same problem occurs if the carbon was re-lapped using lapping powder.
- Lubricant on the faces is freezing in cryogenic (cold) applications.
- The elastomer is being chemically attacked and swelling up. This can break the face in those seal applications where the elastomer is positioned in the seal inside diameter. In some instances the swelling elastomer will open up the two faces, allowing the solids to penetrate. This can be a problem with boot mounted faces
- The rotating shaft, or sleeve, is hitting the stationary face. This can happen if the pump is running off of its B.E.P. which almost always occurs at start up.
- The seal is being mishandled during installation. Good packaging and proper training can solve many of these problems.
- The crack may have occurred during disassembly. Check to see if there is discoloration deep in the crack. Discoloration means that it occurred during, or before, operation.
- Petroleum products can "coke" at the face causing pieces of carbon to be pulled out as the face rotates. You will have to select two hard faces for this application.
- The rotating face is not centered in the stationary face and is running off the edge of the stationary face. Look for rubbing marks around the O.D. of the rotary unit. A bent shaft or out of balance rotating assembly is the most common cause.
    - You will notice a much wider wear track if you are experiencing this problem.

  - The seal will appear to "spit" as lubricant is dragged across the face and off the seal outside diameter.
  - Dirt can be dragged across the faces as they separate.

The movable face is not free to follow whip, wobble or run out.

- The rotating face is hitting the I.D. of the stuffing box.
- The recirculation line from the pump discharge is aimed at the seal faces and interfering with their free movement.
- Dirt or solids are clogging the movable components. Magnetite is a very big problem in most hot water applications.
- The product is interfering with the free movement of the components. It is:
  - Crystallizing (like sugar)
  - Solidifying (like glue)
  - Viscous (molasses)
  - Building a film on the sliding components (hard water or paint)
  - Coking (oil or any other petroleum product)
- The elastomer has been chemically attacked causing it to swell up and interfere with free movement of the face.
- Temperature growth of the shaft is interfering with the free movement of the movable face.
- The shaft or sleeve is the problem.
  - It is over size - + 0.00" - 0.002" (0,00-0,05 mm.) is ideal.
  - It is too rough; it should be at least 32 R.M.S. (0,8 microns)
  - It is fretted, corroded or damaged in some way.
  - Solids have attached themselves to that portion of the shaft where the dynamic elastomer is located.
- A gasket or fitting is protruding into the stuffing box.
- Solids from outside the stuffing box are getting under the faces. This is a common problem with vertical pumps.
- The elastomer is spring loaded and the interference on the shaft is restricting the face movement.
- The elastomer has extruded because of high pressure or excessive clearance.
- A foreign object has passed into the seal chamber and is interfering with the free movement of the seal.

The product has plated, or formed on the face and a piece of it has broken off.

- This problem occurs with products that are sensitive to temperature and/ or pressure changes.

The set screws have come loose.

- The shaft has been hardened.
- They have worked loose in a sleeve that is too soft.
- The hardened set screws have corroded.
- They were not replaced when the seal was rebuilt and as a result are not "digging" into the shaft.

The face has lost its spring load.

- The initial setting was wrong.
- Temperature growth of the shaft has altered the original setting.
- The impeller has been adjusted towards the wet end of the pump.
- The sleeve moved when the impeller was tightened to the shaft.
- The cartridge seal was pushed on the shaft by pushing on the gland and the seal is now over compressed.
    - In a dual seal application this will over compress the inner seal and open up, or unload the outer seal.

The product is vaporizing and blowing the faces open. This happens in hot applications if there is water in the product.

- It can also occur if the pump/seal was hydrostatically tested with a water base fluid.

The inner seal, of a dual seal application was not balanced in both directions and is opening up with reversing pressure. This is a common problem in unbalanced seals that are subject to both vacuum and pressure or if the barrier fluid pressure varies.

The single spring, found in some seal designs, was wound in the wrong direction for the shaft rotation.

The Bellows seal has lost cooling and the anti vibration lugs are engaging the shaft. Shaft movement will cause the faces to open.

LEAKAGE AT THE ELASTOMER LOCATION

Compression set (the elastomer has changed shape).

- Either the product is too hot or there is too much heat being generated at the seal faces. You must vent vertical pumps to prevent this problem.

The elastomer is cracked.

- The shelf life has been exceeded. Buna N (Nitrile) has a shelf life of only twelve months because of its sensitivity to ozone attack.
- High heat is the main cause.
- Chemical attack. In most cases the elastomer swells, but cracking and shrinking does occur in isolated cases.
- Cryogenic (cold) temperatures freeze the elastomer and it will crack when hit.
- The rubber bellows did not stick to the shaft because the wrong lubricant was used. The shaft turned inside the bellows causing high heat.

- The seal faces stuck together. The shaft was turning inside the rubber bellows causing excessive heat.

The elastomer is cut or damaged.

- Mishandling.
- The elastomer was slid over a rough spot on the shaft or sleeve. Be careful of old set screw marks, splined shafts, key ways, etc.
- It was extruded by high pressure. You may need a backup ring.
- The product is penetrating into the elastomer and blowing out the other side. This problem is a common occurrence when you are trying to seal ethylene oxide.
- Teflon jacketed o-rings can split in the presence of halogenated fluids. The halogen will cause the elastomer to swell up, inside of the teflon jacket. Halogens can be recognized because most of them end in the letters "ine", such as bromine, astintine, chlorine, fluorine, iodine, etc..

The elastomer is not seated properly.

- It was twisted during installation. O-rings groove.
- Solids have "built up" or penetrated between the elastomer and the shaft.
- The shaft is corroded, damaged, or fretted.
- The shaft is oversized.
- Excessive travel can cause the elastomer to "snake". Most o-rings can roll up to one half of their diameter.
- The o-rings groove is damaged or coated with a solid material.

The elastomer has swollen or changed color.

- Product attack. This is the most common cause and usually occurs within five to ten days
- The wrong lubricant was used at installation. As an example, you should never put petroleum grease on EPR o-rings.
- Solvents or chemicals used to clean the lines are not compatible with the elastomer.
- Steam can harm many elastomers including most grades of Viton®.
- Oxidizers can attack the carbon black in o-rings and other elastomers.

The elastomer leaks when pressurized in the opposite direction.

- A common problem with unbalanced, dual seal applications. Two-way balanced seals are recommended for these applications.
- Remember that o-rings are the only elastomers that seal in both directions. Wedges, U cups, and chevrons do not have this ability.

OTHER LEAK PATHS TO CONSIDER

Between the carbon and its metal holder.

- Some seal companies, and most seal repair facilities, glue the carbon in place. The glue may not be compatible with the product you're sealing.
- "Pressed in" carbons can leak in a high temperature application because of the differential expansion between the carbon and its metal retainer. Low expansion metal is available for these applications

Between the shaft and the sleeve.

- Damaged gasket or gasket surface.
- Distorted sleeve or shaft. Many packed, double ended pumps have this problem because there's no gasket between the impeller and the sleeve that's holding it in place.

Stationary face gasket or elastomer leaking.

- This leak path isn't always visible. It often looks like face leakage.

Gland gasket or gasket surface leakage.

- This leak path should always be visible.

Pipe flange leaking above the seal and dripping into the seal area.

- I found this one after every other troubleshooting avenue was exhausted.

At the weld location if a seal face holder is welded to the cartridge sleeve.

At the pipe connections, ancillary hardware, A.P.I. Gland fittings, and recirculation lines.

A scratch or nick in the o-ring groove. Remember that up to 100 psi (6 bar) o-rings seal on the O.D. and the I.D. not the sides.

Seal faces will not leak visibly if they are lapped flat and we keep them in total contact. Shaft movement is the main contributor to the opening of the seal faces and allowing solids to penetrate. Shaft movement is caused by many factors. In the following paragraphs we'll be looking at most of them.

CAUSES OF EXCESSIVE SHAFT MOVEMENT, INCLUDING VIBRATION

Cavitation

- Vaporization caused by too high a product temperature, or too low a suction head.
- Air is entering the stuffing box. A common problem with pumps that run in a vacuum or taking a suction from an evaporator or condenser.
- Internal recirculation. Occurs when the Suction Specific Speed is too high, or when either the impeller or wear ring clearance becomes excessive.
- The vane passing syndrome form of cavitation occurs if the O.D. of the impeller is too close to the pump cutwater. This clearance should be at least 4% of the impeller diameter in the smaller size impellers and at least 6% in the larger diameter impellers (greater than 14 inch or 355 mm.)
- Turbulence. Occurs if there's not laminar flow in the lines.

The bearings are worn excessively.

- Contamination of the lubricant is the biggest cause. Grease or lip seals have a useful life of only 2000 hours (84 days).

- Poor fit or installation.
- Serious misalignment. The misalignment can be the result of pipe strain, or misalignment between the pump and its driver.

The shaft is bent.

- Usually occurs during sleeve removal, or if the bearing was installed with an arbor press.
- Improper storage with the long shaft supported only on the ends causing it to sag.
- Heating the shaft to remove the sleeve is another common cause

The impeller is out of balance.

- The impeller was damaged by either wear or corrosion or cavitation.
- Product has built up on the vanes or in the balance holes.
- The impeller diameter was reduced and the impeller was not re-balanced
- The impeller never was balanced.

An unbalanced rotating assembly.

Pressure surges or water hammer.

Worn coupling.

The pump is operating off its best efficiency point.

Rubbing of a rotating component.

- The shaft is hitting the wear ring, or a stationary wear ring is contacting a rotating wear ring.
- The shaft is hitting the seal gland or stationary face.
- A seal rotating component is hitting the stuffing box I.D..
- A gasket or fitting is protruding into the stuffing box.

The stationary seal face is not perpendicular to the rotating shaft. This causes the spring loaded, rotating face to move back and forth twice per revolution.

- The stuffing box face is not square to the shaft. The stuffing box face is often a rough casting.
- Tightening the gland bolts through a gasket is cocking the stationary face.
- Pipe strain.
- Temperature growth.
- A convection tank, or some other heavy device is hanging off the gland distorting it.
- Bearing fit or wear.
- Coupling alignment.
- Shaft deflection. The deflection can be caused by operating the pump off its best efficiency point, the rotating assembly is out of balance, or the shaft is bent.

- Poor installation technique.

VIBRATION AT THE SEAL FACES

Harmonic vibration.

- The seal is vibrating in harmony with some rotating component. The same thing that causes a rear view mirror to vibrate in an automobile. Most harmonic vibration can be stopped by changing the speed of the equipment or "damping" the vibrating component.

Slipstick (an alternating slipping and sticking of the seal faces,) caused by:

- Poor lubricating fluids.
- Hot water.
- Solvents.
- Some detergents.
- Gases
- Dry running applications.
- Too high a face load.
  - You are using unbalanced seals.
- Poor installation technique.
- Face load has changed because of temperature growth, or impeller adjustment.
- You are using a high friction face combination. Often occurs if you use two hard faces.

A discharge recirculation line aimed at the seal faces.

- Each time the impeller passes the recirculation connection it causes a pulse of fluid at the seal face.

Vaporization of the product at the seal face.

- Happens with products that contain water, and are operated at elevated temperature.
- Can occur at the seal face because of high face load caused by using unbalanced seals.

EXCESSIVE AXIAL MOVEMENT OF THE SEAL

- Temperature growth.
- The impeller was adjusted, after the seal was installed, to compensate for wear.
- The rotor motor, moved to its magnetic centre at start up.
- The equipment is equipped with sleeve or babbitted bearings and has excessive end play.
- Shaft thrust.

- There is a thrust towards the bearings caused by the combination of the fluid changing direction in the impeller and acting on the shaft and/or impeller surfaces. This thrust is offset by a thrust towards the wet end caused by the impeller shape.
- In centrifugal pumps the resulting force can be in either direction, depending upon how close the pump is operating to its best efficiency point. Above 65% of its best efficiency, the thrust is towards the wet end. Below 65% of the best efficiency the thrust is towards the power or bearing end. There is little to no movement at 65% of the pump's best efficiency. This means that at start up the shaft moves in both directions accounting for a higher percentage of seal failure at start up.

- Vertical mixer shafts often lift vertically when solids are mixed with liquid.

THE SHAFT IS NOT CONCENTRIC WITH THE STUFFING BOX, this will cause a wiping action in stationary seals.

- The shaft is bending as you move away from the pump B.E.P.
  - It bends at 240 degrees, from the cutwater, at low flow and high head.
  - It bends at 60 degrees, from the cutwater, at high flow and low head.
- Coupling misalignment.
- Poor bearing fit.
- Pipe strain.
- Temperature growth causes the stuffing box to move relative to the shaft.
- The sleeve is not concentric with the shaft.
- The seal is not concentric with the sleeve / shaft.
- A bolted on stuffing box has slipped.
- The back plate is not machined concentric to the stuffing box.

Heat is always an indication of wasted energy, but it can also have a disastrous affect on seal life and performance. Let's take a look at what's causing this heat.

CAUSES OF HIGH HEAT AT THE SEAL FACES.

Too much spring compression.

- Installation error.
- No print was used, or the mechanic cannot read the print he was given.
- The shaft installation reference was marked in the wrong location.
- The mechanic used the wrong marking tool. The mark is too wide.
- The sleeve moved when the impeller was tightened.
- The impeller was adjusted after the seal was installed.

- A cartridge seal was installed on the shaft, by pushing on the gland. Interference from the sleeve elastomer has caused an over compression of the seal. In some dual seal applications the outer seal will become under compressed.
- The shaft moved because of thrust.
- Thermal growth of the shaft.

Problems with some seal designs.

- Unbalanced seals are supplied by original equipment companies. They generate more heat than balanced seals.
- The elastomer is located too close to the seal faces. The heat generated at the faces is affecting both the elastomer and the seal face.
- The carbon face is insulated by an elastomer.
- The face is too wide causing the hydraulic force to generate excessive heat.
- The carbon seal face is too narrow causing excessive heat from the spring pressure.
- A vertical seal installation is not being vented. The faces are running dry in a bubble.
- Speeds above 5000 F.P.M. (25 m/sec) require a special hydraulic balance and less spring load. A 60/40 balance and a face load of 8 psi to 15 psi (0,07 to 0,2 n/mm2) would be normal.
- An outside metal or elastomer bellows seal is almost impossible to vent.
- Spring loaded elastomers cause varying seal face loads. The actual load depends upon shaft tolerance and installation dimension.
- Some seal faces are glued in. The glue acts as an insulator preventing the face heat from conducting to the metal holder.
- Many single spring designs are uni-directional requiring both right handed and left handed seals on a double ended pump.
- Many metal bellows designs lack effective vibration damping.
- Stationary seal designs require clean flushing if solids are present. Centrifugal force does not throw the solids away from the moveable (spring loaded) components.

Problems with face materials.

- Heat conductivity is low in some materials. (Ceramic, carbon, Teflon)
- The coefficient of friction varies with face combinations and various sealing products.
- Carbon / metal composite faces conduct heat better than plain carbon / graphite, as long as there is a true interference fit and they're not glued together to hold them in place.

Problems with the pump operation that causes high heat at the faces.

- Operating off the B.E.P
- The degree of the problem is determined by the L^3/D^4 ratio.
- Operating too close to the vapor point, causing cavitation.

- Running dry.
- Gases.
- Dry solids.
- Pumping a tank dry.
- Losing barrier fluid in a dual seal application.
- Shutting off the flushing water.
- Vacuum applications.
- Vertical pumps not vented in the stuffing box.
- The liquid is not a lubricant.
- Pump out rings on the back of the impeller, running too close to the pump back plate.

Other causes of high heat.

- The shaft, or sleeve is rubbing a stationary component.
  - The gland.
  - The bushing in the bottom of the stuffing box.
  - The bushing in the A.P.I. gland.
  - A pump wear ring.
  - A protruding gasket.
  - A fitting.
  - The stationary portion of a mechanical seal.
- The shaft, or sleeve, is not straight.
  - It is bending, because the pump is operating off its best efficiency point.
  - It is bent. This often happens when the sleeve is removed.
  - The rotating assembly is not balanced.
  - The shaft never was straight.
- There is not enough circulation around the seal.
  - Install a large diameter stuffing box. You should be able to get at least 1" (25 mm) all around the rotating unit.
  - Connect a recirculation line from the bottom of the stuffing box to the suction side of the pump. You can do this in almost every case except when you're pumping a product at its vapor point, or if the solids have a specific gravity lower than the fluid.
- The cooling jacket is clogged.
- There is no carbon restriction bushing in the bottom of the stuffing box and you are using the cooling jacket. The restriction bushing slows down the heat transfer.

- Loss of an environmental control.
  - The flush is not constant. The pressure is changing.
  - Quenching steam or water has been shut off during pump shut down.
  - The double seal barrier fluid is not circulating.
  - The cooling jacket has become clogged by the calcium in the hard water. Try condensate instead.
- The filter, or separator, is clogged.
- Either the suction or discharge recirculation line is clogged.
- If you are using double seals, remember that two seals generate twice as much heat and conventional cooling may not be sufficient. Contact the manufacturer for the rules when using convection tanks and dual seals. You may need a "built in" pumping ring.
- Solids in the stuffing box are interfering with a rotating component."