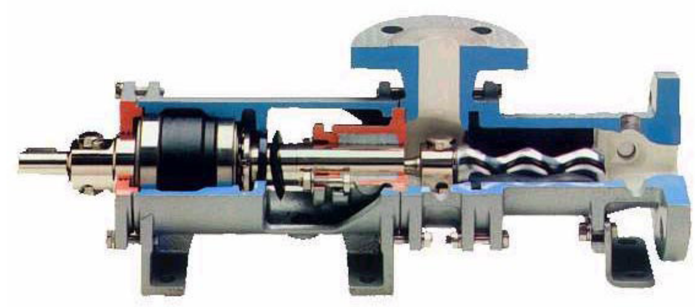
1. Overview of Pump Failure Modes.

When a helical rotor pump is bought it is usually meant to be in service for 10 to 40 years. During that time everyone wants it to run well with no stoppages or failures of any type.



To prevent any failure over all those years you have to:

1. Buy the right pump in the first place,
2. Install it for long-life service,
3. Keep it running in its design conditions envelope,
4. Monitor it so that you find and correct any possible problems before they cause the pump to fail.

If you want great service from a helical rotor pump you must get all four factors right for the pump's entire life.

They are also known as progressive cavity, 'wiggle' or 'Mono' pumps. The rotor is usually made of a hard alloy steel with a harder chrome plated outer surface. Ceramic rotors are available from some suppliers. The stator is made of molded elastomer bonded to an outer metal barrel. Various rubbers and urethanes are available for the pump depending on the service. The size of the cavity is the difference between the volume of the stator void minus the volume occupied by the rotor.

2. Understand The Pump Service Duty, Conditions And Environment.

A qualified engineer typically does the calculation of the duty point. Though an experienced technician trained in the necessary calculations can also do them. Below are the issues to be considered when determining the design duty point for the pump.

1. What is the chemical(s) name to be pumped? What is the viscosity (slipperiness) of the chemical(s)? What is the specific gravity (weight per unit volume) of the chemical(s)? What is the maximum operating temperature? These issues affect the friction losses which then affect how much power the pump needs to drive it.
2. If particulates are present then take samples for inspection. What are their shapes? Do they have sharp or rounded edges? What is the smallest particle size? What is the biggest size particle or solid? Is it true slurry with its own behaviour characteristics?

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3. The Floor Under The Pump.

One thing you need to appreciate if you want failure-free life from helical rotor pumps is they need to be firmly mounted. The pump manufacture has designed the pump assuming it will be on a rigid, unmoving base. A pump must not shake itself.

A firm pump mounting starts with the floor. The pump is supported off the floor and the floor needs to be sound.

1. Is the floor under the plinth strong enough to take the pump and piping weight? 150 mm of high strength, steel reinforced concrete is best.
2. Is the floor unmoving relative to the pump? It's okay for the pump to move with the floor as long as long as they move together, like on a ship rolling over waves. Minor temperature differential expansion of a 0.01 mm (0.004") is also acceptable between floor and pump plinth.
3. If the floor is structural steel is the steelwork under the pump well braced and made of strong members that won't deflect more than 0.1 mm (0.004")? If the floor bends the pump body buckles and all its internals go out of alignment!
4. You need to insure the pump is bolted to the floor through its plinth. This substantially reduces vibration problems.

4. The Pump Plinth On Which It Sits.

The pump ideally sits on a plinth to get it above the floor, clear of chemical spills and water, that from time to time may flood the area. Putting the pump on a plinth also raises it to a more comfortable height for operators and maintainers to work on it.

1. The pump set needs a substantial mass to mount to so that vibration is damped. The plinth should be at least five (5) times the mass of the whole pump set assembly.
2. The plinth should be bolted through the floor, or made as part of the floor, so the floor and plinth act as one big mass.
3. The plinth should be of steel reinforced high strength concrete. The concrete can be rafted over steel structures and used as a vibration dampener.

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6. The Pump Body From Which It Gets Rigidity.

The pump body is its skeleton and must support the bearings and shaft and keep them spinning perfectly straight. If the pump body is not stiff, robust and strong it will deflect and so cause the shaft and bearings to also deflect and run out of tolerance. The end result is a very shortened operating life with may failures along the way.

1. The materials used in the pump body must be corrosion resistant to the plant chemicals and local environment. Protective coatings provide a first layer of protection against corrosion and must be selected for the full operating life of the pump.
2. The wall cross-sections must be sufficiently thick to be structural rigid under the most severe of working loads and pipe stress. Don't buy cheap under-engineered pumps for heavy duties and expect them to provide long, failure-free, low maintenance service.
3. Pipe stresses will occur from temperature expansion of attached pipes, water hammer, poor alignment of flanges between pipe and pump on installation, unsupported pipe lengths hanging off a pump flange and vertical discharge pipes and in-line valves and instruments sitting on the discharge flange.
4. Pipe stress can be minimised by careful installation supervision of the installers and by placing pipe bracketing close to the pump flanges. This is in the ideal world and many times it still done wrongly. The only protection you have is to buy pumps of great structural strength and strong flange designs.
5. Cast steel is stronger than cast iron as a pump body material. Cast iron bodies crack from high pipe stress loads.

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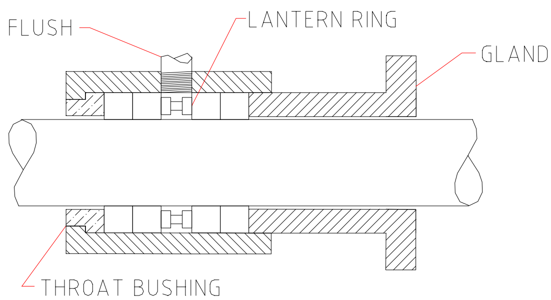
Requirements For Long Gland Packing Seal Life

Compressed, stacked packing is used to seal the hole created by a shaft passing through a piece of equipment. The sketch below shows a typical packed shaft configuration.



Because compressed, stacked packing requires leakage to cool and lubricate, one would normally use packing on benign products. If used on environmentally unfriendly products or dangerous goods, the leakage must be collected and suitably treated to protect people and environment. Graphite impregnated shaft packing is self-lubricating and reduces wear on the shaft.

How Compressed Packing Works

As packing is squeezed into place it fills the cavity in which it sits. The packing will seal against the side and bottom of the stuffing box and on the shaft surface. When the shaft turns, it rubs against the packing and is wiped clean. Except for slurries, 70% of wear normally takes place in the first two packing rings nearest the gland throat.

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Requirements For Long Mechanical Seal Life

To get a long life, mechanical seal faces must be kept clean, cool, lubricated, square to the shaft and flat together.

Achieve A Healthy Local Environment

Use a barrier fluid to clean, cool and lubricate. These three requirements are best achieved by pressurising the spring/bellows chamber with a suitable clean, cool barrier fluid at a pressure higher than on the process side (stuffing box) of the stationary seal. The barrier fluid can be a liquid or gas depending on the service required of the seal. Usually a pressure difference of 100 kPa is sufficient to guarantee slight weeping across the seal faces from the barrier fluid into the process.

An exception to use of a barrier fluid is when the fluid being pumped is itself clean and non-threatening to safety and the environment. Products such as clean water do not need a barrier fluid because the centrifugal action of the spinning seal will draw in minute amounts of water that will cool and lubricate the faces. This water escapes as vapor to atmosphere.

The inside of the stuffing box should taper from small diameter at the seal end to large diameter at the impeller so that it can be washed clean of debris and cooled by the process liquid. A 15^{o} taper is ideal, but even a 5^{o} taper helps.

Achieve Precision Assembly

Mechanical seal faces are manufactured to a flatness that is measured using wavelengths of light. Such fine tolerances imply high precision equipment. This is why seals reconstructed in maintenance workshop conditions never last. Precision manufacture requires a precision environment.

High precision is normally only possible at the time of manufacture. Mechanical seals installed by the pump manufacturer tend to last longer than seals installed in the same pump when on-site. The growth in cartridge seal use reflects a growing awareness of the importance of precision in the construction and installation of mechanical seals.

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The Pump Helical Rotor Shaft Cont.

Don't dry run the pump. The rubbing action of rotor over stator requires lubrication. If run dry chunks of rubber will be ripped out of the stator. To protect the pump, create a 'U' dead-leg using the inlet and outlet piping. Liquid sits in the dead leg and keeps the pump flooded. Another way is to run a recirculation pipeline from the discharge pipe back to the inlet pipe. The recirculation pipe is of small bore so the majority of the flow still discharges through the outlet pipe. A recirculation line or dead-leg will not work for thick slurries, or liquids that set when cold. In this case it may be necessary to purposely introduce a clean lubricating fluid.

A torn stator with chunks ripped out is an indication that the particulate in the product was jammed into the rubber and then torn out by the action of the passing rotor, or that the particulate shape is jagged and sharp edged. This seems to be worst for very fine particulate as it more easily imbeds into the rubber until another particle is forced up against it and rips it from the rubber. Slow the pump down.

There are temperature limits for the rubber in the stator. Depending on the rubber, its working temperature limit before becoming too soft is between 90^o C and 150^o C.

11. The Pump Electric Motor.

Usually an electric motor is used to drive and spin the impeller in the pump. The motor needs to be as robust as the pump for the environment in which it is located.

1. Insure the motor is protected from chemicals in the locality.
2. Select motors that are rated against hose down water ingress, as operators will often clean an area by hosing it down with water.
3. Insure the bearings used in the motor are robust in selection and design and are made by a high quality bearing manufacturer. Cheap motors are cheap for a reason.
4. Check the start and load characteristics of the motor suit the pump's duty.
5. Check the motor's temperature rating suites the hazardous area grading that applies to the locality.
6. Insure that three phase motors are wired correctly and the impeller turns the right way.
7. Insure the motor has overload protection on its power supply to stop it incase the pump cannot turn for some reason.

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20. Pump Corrosion Protection.

Corrosion in a pump is related to material and chemical compatibility. Select pump materials that are not affected by the chemical being pumped. The pump manufacturer can provide data on compatibility.

21. Pump Erosion Protection.

Pump erosion can be from wear or cavitation. In the case of wear from sediment or particulate select a material for the rotor and stator with good wear characteristics. This maybe a harder metal, or a non-metal such as rubber or urethane plastic. Both these non-metals have good wear properties as they absorb impact energy from the particles and return to their natural position.

The following issues affecting the mechanism of abrasion need to be understood.

* The shape of the surface being worn away.
* The shape of the surface or particles doing the abrading.
* The hardness of surfaces and particles.
* The velocity (speed) involved.
* The momentum (a mass moving at a speed) involved.
* The contact time and contact angles during abrasion.
* Contact pressures during abrasion.
* Deformation characteristics of surfaces and particles.
* Chemical and physical properties of surfaces and particles.
* Properties of the components of the surface and particles.
* Particle size range.
* Moisture content effects.
* If the product is in a slurry what is the effect on contact properties due to the presence of the liquid.

All and any of the factors listed play a part in the abrasion process. This provides many opportunities to alter the effect of abrasion by altering the influence of the factors.

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