Increase Equipment Reliability & Reduce Costs with AESSEAL® Mechanical Seal Water Management Systems

Rising cost and shrinking availability of clean water for industrial equipment is a concern to many plant managers, as is as the high cost of treating this water for disposal.

The traditional method of providing cooling and flush water for shaft packing has been to pipe plant water through the gland packing and into the process stream (Plan 32).

The traditional method of providing cooling and flush water for mechanical seals has been to pipe plant water through the seal gland and either into the process stream (Plan 32) or to drain (Plan 62).

The normal consumption of water of these plans is 1.7 million gallons of water per pump each year. A plant running just 125 pumps in this manner is probably using over 200 million gallons of water each year.

The AESSEAL® water management system operates in a closed loop circuit, re-circulates the water and therefore reducing water consumption to around 113 litres (30 US gallons) per year per pump.

This water management system also increases the pump reliability and mean time between failures (MTBF) significantly, with a return on investment (ROI) that is usually around 6-12 months.

Furthermore, significant energy savings are documented through the use of this system, by greatly reducing or eliminating the amount of energy needed to heat the flush water up to process temperatures only to then to boil/evaporate this water from the process media.

The Impact of Industry

The 2nd most common machine in industry (after the electric motor) is the pump. It is estimated that there are about 600 million industrial pumps in the world (not counting about one billion pumps in domestic use, such as dishwashers, clothes washers, automobile water pumps, etc). These industrial pumps rely on a mechanical seal or shaft packing to seal the rotating shaft and contain the pressurized liquid within.

Mechanical seals and shaft packing require clean fluid, usually water and lots of it, for cooling and lubrication. As our world has become more industrialized, the population of pumps has grown accordingly, and so has our demand for clean water to service these pumps.

However, the rising cost of water, along with increasing awareness of the long-term consequences of unrestricted water use, has caused many forward-thinking companies to reconsider their traditional, wasteful water use practices. Moderate investments in proven new water-conserving technology can achieve financial payback within the first year, while having beneficial effects on our global water supply that last for decades.

The Importance of a Fluid Film

Process pumps usually use a mechanical seal to contain the pressurized fluid by creating a sliding seal between the rotating shaft and the pump housing. This mechanical seal is engineered to operate with a thin fluid film separating the highly-polished rotating and stationary seal faces (see Figure 1), with the face materials and seal design selected specifically for the particular pump application parameters and fluid properties (pressure, temperature, viscosity, etc.). The fluid film may consist of either the pumped process fluid, or a special fluid such as clean water may be introduced under pressure if the process fluid is not suitable (e.g., if it is too hot, too high solids content, tends to crystallize, etc.)

If this fluid film is not stable or not present, the two faces will contact, overheat, and damage each other and the mechanical seal will fail, causing the pump to fail (see Figure 2).

Figure 1 – Mechanical Seal "Good" Fluid Film

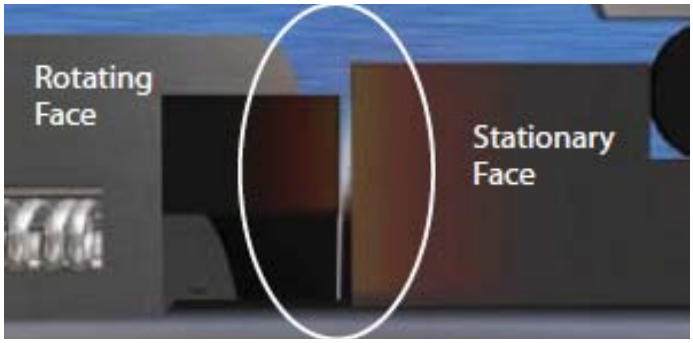
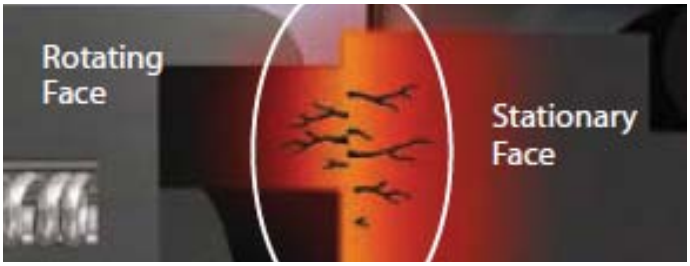


Figure 2 – Mechanical Seal "Poor" Fluid Film



When the seal fails, the entire pump unit is removed and repaired, at an average cost of £1,600 ($2,500) per repair. This is the maintenance cost (parts and labor) only and does not include the value of lost production, which can be thousands of $'s, £'s or □'s per hour.

The fluid film can be adversely affected by process upsets that lead to dry-running of the seal, which can include:

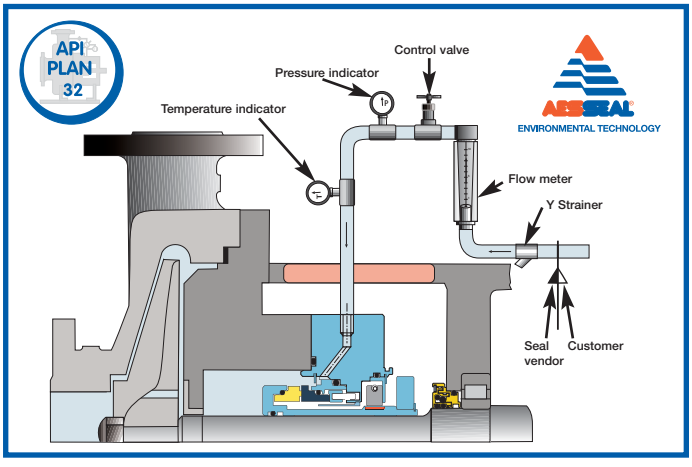
- Process changes upstream that lead to no liquid product at the pump.
- Operator error (opening or closing a valve which stops product flow to the pump, etc.)
- Cavitation, where there is inadequate net positive suction head to the pump and the liquid product changes into a vapor state at the impeller.

Mechanical seal faces can also be damaged by product crystallization due to temperature and pressure changes across the face. Suspended solids in the pumped liquid are another major cause of seal damage and these solids must be kept away from the faces with a supply of clean water to form the fluid film or the seal will fail prematurely.

Old "Water-to-Drain" Plan

Many industrial plants supply their double mechanical seals with a fresh supply of barrier water using the "water-to-drain" method, or API Plan 32, shown in Figure 3.

Figure 3 – API Plan 32 Water to Drain



In the water-to-drain plan, plant water is supplied to all of the single or double mechanical seals in parallel from a water header main. This plan can work satisfactorily if all conditions start out perfectly and stay perfect, but as we know, this level of perfection is rarely found or maintained in a real, operating, industrial plant. The water-to-drain plan is prone to process upsets that cause seals and pumps to fail, for example:

1. **Water will take the path of least resistance. If the pressure and flow rates of each branch of the piping are not set exactly right at startup, most of the water will selectively flow through the pipe with the least resistance, leaving the other seals to starve for water and seal failures can result.**

2. **If one mechanical seal fails and allows process fluid to enter the water supply line, ALL the seals can be cross-contaminated and thus lead to multiple seal failures.**

3. **If an alternative flow path is created, for example by an operator turning on a large water line for wash-down, the pressure and flow of water to the seals will drop and this could lead to seal failures.**

4. **If the quality of the water being supplied by this system is poor, it will lead to solids being delivered to, and collecting on, the seal faces; this will lead to premature seal failure. In addition to these failure modes, water-to drain has the following cost considerations:**

- If the supply water is being purchased from a municipal supply, the cost of the water can be very high, as can be the cost of treatment and disposal of the waste water.
- The typical water flow rate on a water-to-drain plan runs an average of 12 litres/minute (3.2 US gallons/minute) to drain. Running this 24 hours per day, 7 days/week amounts to a staggering 6.43 MILLION Litres (1.7 MILLION US Gallons) of water per year, per pump running to the drain!

The Water Saving Solution

The solution to ALL of the shortcomings of the water-to-drain plan is to install an AESSEAL® water management system as shown in Figure 4 for each pump. Recall that the sliding faces of the mechanical seal create frictional heat in the seal. Heat is also added to the seal by the hot process media.

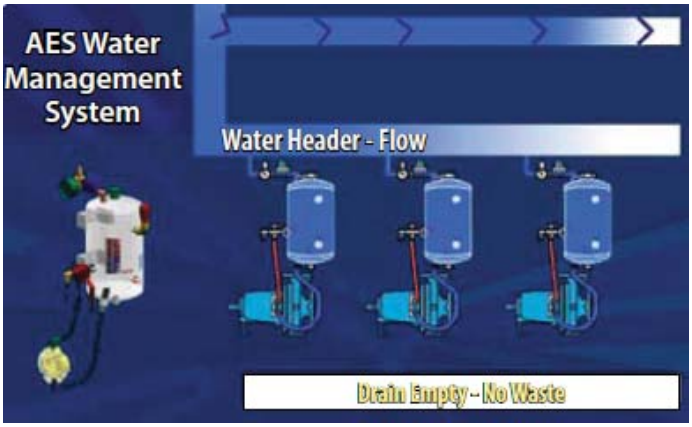
Figure 4 – AESSEAL® Water Management System

From Figure 4, hot barrier water from the double seal rises up to the tank via the upper tube, where the heat is radiated to the atmosphere; the cooled barrier water is then returned to the seal through the lower tube. Circulation of the barrier water from the seal to the tank, and back to the seal, is maintained by the thermosyphon effect (basically, hot water rises and cool water falls), with no moving parts. In cases where more flow of the barrier fluid is required, pumping assistance can be obtained from an optional bi-directional pumping ring (Plan 52/53) in the seal itself.

The tank is connected to the plant water main and automatically tops up with water to replace the very small amount (about 113 Litres or 30 gallons per year) of barrier water that is lost at the seal faces during normal operation. The tank is maintained at a pre-set pressure that is one bar (15 psi) above the pump's stuffing box pressure to maintain a positive pressure differential across the seal faces that ensures CLEAN barrier water is forming the fluid film (as opposed to process liquid). Additional cooling can be accomplished, where necessary, by adding fins to the tubing, adding a cooling coil to the tank and/or using a larger tank.

A diagram of a typical multi-pump layout is shown in Figure 5. Each tank system serves just one seal/pump set and is isolated from all other tanks.

Figure 5 – Multiple AESSEAL® Water Management Systems



Note that only 3 tanks/pumps are shown in the figure, but many hundreds of tanks/pumps are often connected in practice.) The advantages of this system include:

- The waste water-to-drain is completely eliminated, with huge savings in water resources, the cost of water, and the cost of treating waste water.
- Water from the plant main line passes through a check valve which prevents contamination caused by a seal failure from passing back into the main, so each pump and seal is isolated; one seal failure does not adversely affect other pumps.
- A pressure regulator on the water feed line into each tank sets the tank pressure at the correct pressure for that pump, so each pump can operate at a different pressure and have a fluid film that is maintained at 1 bar (15 psi) over its stuffing box pressure. Note that the maximum pressure possible in each tank is equal to the plant's main water line pressure.
- Each tank/seal/pump is a stand-alone system; changes in the operating conditions of one pump or the water flow to one seal do not affect the water flow to the seals of any other pump.
- Changes in the main line pressure, such as turning on a wash-down hose, do not affect the operation or the pressure in the tank systems, as each tank is isolated by its own check valve.
- The water quality is greatly improved by installing a filter on the incoming line to each tank. Since only about 30 gallons of water are used per tank per year, the filter will last a long time before plugging. Cleaner water leads to longer seal life.