SMARTFLOW - AN APPROACH TO WATER SAVINGS

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ABSTRACT

Opportunities for water conservation abound in industry within areas that are traditionally overlooked. Centrifugal pumps, which represent a significant proportion of the variety of equipment found in most mineral processing and industrial manufacturing environments, can be a substantial user of water. With the right approach, significant water reductions can be realised offering savings, not only in water consumption, but improvements in reliability and the associated lowering of maintenance costs.

John Crane Australia has approached water conservation with the SmartFlow, a simple product that regulates water consumption to match the heat load placed on the system. It also has applications beyond pumps to include any system that utilises water to dissipate heat, including bearing coolers, cooling jackets and similar equipment.

1.0 INTRODUCTION

Packed glands have been traditionally used for many years to seal centrifugal pumps and, with proper care and attention, can lead to a low cost and reliable sealing solution. The packing is housed in a chamber (stuffing box) formed around the point where the rotating shaft passes through the stationary pump casing. With water pumps, the pumped fluid can be used to cool and lubricate the packing. Slurry pumps however, have abrasive particles that wear the sleeve and abrade the packing resulting in a very short life. It is normal practice to inject pressurised water (Gland Water) via the Lantern Ring into the stuffing box to flush solid particles away and to provide cooling and lubrication to the packing.

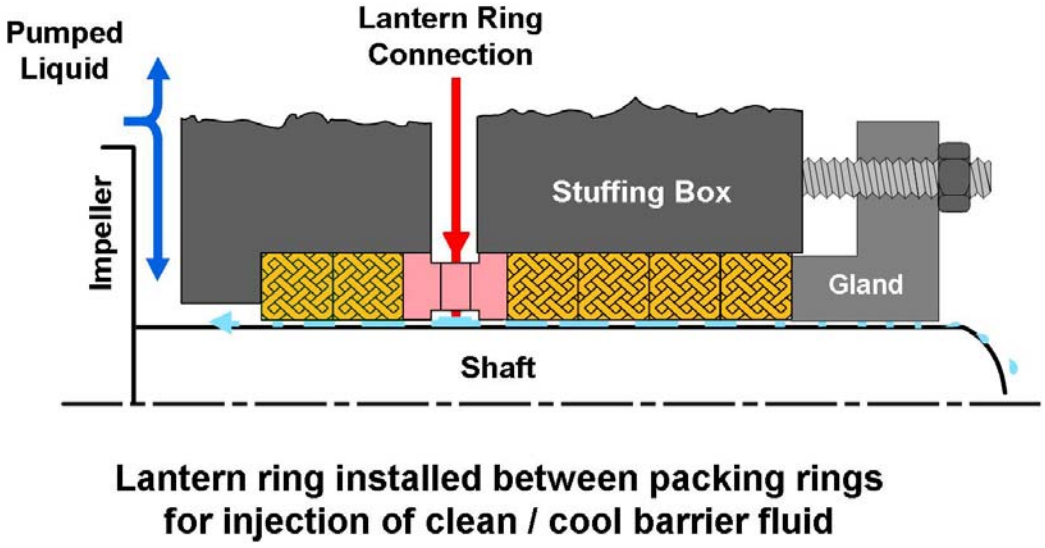


Figure 3: ***Typical stuffing box arrangement***

It is important for the Gland water to be supplied at the correct flow and pressure. The flow rate is governed to some extent by the stuffing box dimensions. It is adjustable by means of compression of the packing by the gland follower and the gland water supply pressure should be controlled within acceptable limits.

For normal operation, the gland water pressure should be set above the pump discharge pressure, ensuring that water will enter the gland with sufficient pressure to flush solids away. If the gland water pressure is too low, the pump pressure can force abrasives into the gland and even up into the gland water supply lines. Gland water pressure that is too high will cause extrusion of the packing into the pump resulting in premature failures.

It is essential for packing to leak in order to lubricate the packing. Incorrectly adjusted glands or excessive gland water pressure results in leakage inward (illegally diluting product), outward (atmospheric discharge and bearing contamination) or both.

Figure 2: ***Examples of excessive leakage to atmosphere***

An alternate to packing is the mechanical seal. Mechanical seals offer the benefit of almost no water leakage to atmosphere; protecting the bearings from gland water contamination, eliminating parasitic power losses whilst lowering the maintenance requirements associated with packing.

The most common form of a mechanical seal is a single seal. A single mechanical seal operate by two very flat seal faces that rub against each other. One seal face is stationary with the pump housing while the other is rotating with the shaft. Provisions are incorporated into the mechanical seal to permit some relative movement (such as thermal expansion, movement due to bearing clearances, deflection, etc.) between the shaft and the seal face that is rotating with the shaft while maintaining the seal between the two components. The heart of the seal is the rubbing of the two seal faces. These components are lubricated by the pumped media through a combination of hydrostatic and hydrodynamic forces acting on this lubricating film.

In the case of dirty or abrasive pump services, this lubricating film invariably contains abrasive particles that accelerate the wear of the seal faces. Additionally the abrasives particles can cause abrasive wear other components within the seal and can also interfere with the mechanism that allows the relative motion between the shaft and rotating seal face. Although seal designs exist that are more tolerant to the presence of abrasive particles, a common method of counteracting the affects of the abrasive particles is to inject clean water into the pump around the mechanical seal. This creates a cleaner environment in the seal chamber, however, like packing it requires a reliable gland water supply with a suitable control pressure and flow to ensure the reliability of the mechanical seal.

2.0 THE SMARTFLOW APPROACH

Mechanical seals have been used in Slurry Pumps with mixed results across the industry. Traditionally single seals are used with or without gland water injection into the mechanical seal and pump. In an effort to improve reliability and eliminate the need for gland water injection, SmartFlow is now being used in slurry pumps fitted with mechanical seals.

The SmartFlow Control System is a piece of equipment that automatically regulates seal water consumption. It is designed to be used in conjunction with John Crane dual seals – particularly when gland water injection leads to dilution or contamination of the product being pumped. A dual seal is a seal assembly that contains two single seals in series unitised into one assembly that is mounted onto the rotating pump shaft. The cavity that is formed between the inner and outer seal is filled with pressurised water that provides lubrication to the seal faces (and displaces any abrasive particles that may be present) whilst dissipating any frictional heat generated or heat soak from the pump.

This intelligent system uses seal water only when the mechanical seal requires cooling. Based on field tests and laboratory experiments the system saves over 95% (on average) of seal water compared to traditional flow meter regulated control systems. SmartFlow operation is based on a heat-activated, shape memory alloy spring that mechanically opens and closes a relief flow channel. The system automatically adjusts to new operating conditions by consuming only the required amount of water to meet the heat load demands. Water usage can be cut dramatically; potentially saving thousands of dollars per pump.

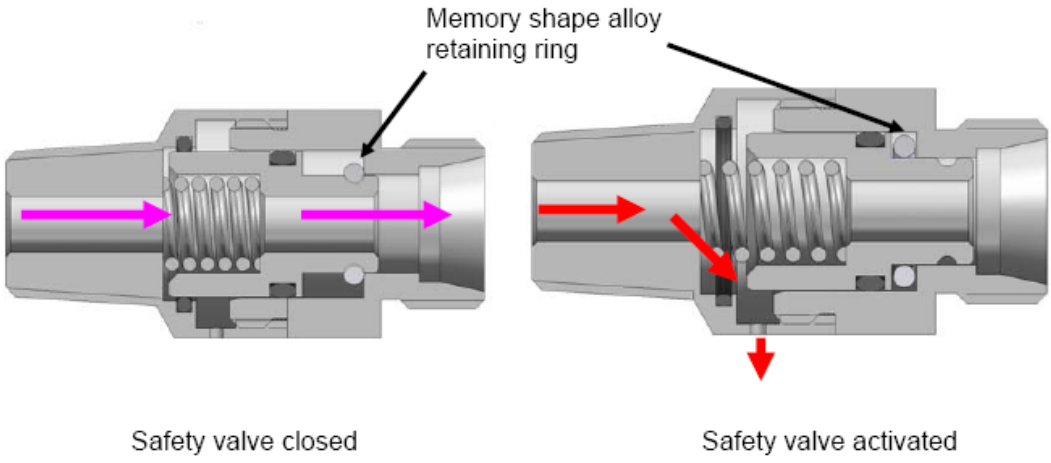


Figure 3: ***Memory Spring Function***

2.1 SmartFlow Function

SmartFlow is an Intelligent Seal Water Control System which considerably reduces water usage and hence operating costs. The two forms available are; a Universal design suitable for all pumps and an Integrated version designed for use with JC Safematic JCS2 seals. The principle operation is common for both variants, however the Universal SmartFlow requires water circulation to transfer heat to the operating valve while the

SmartFlow IG is integrated to (and operates inside) the seal so does not need an additional circulating device.

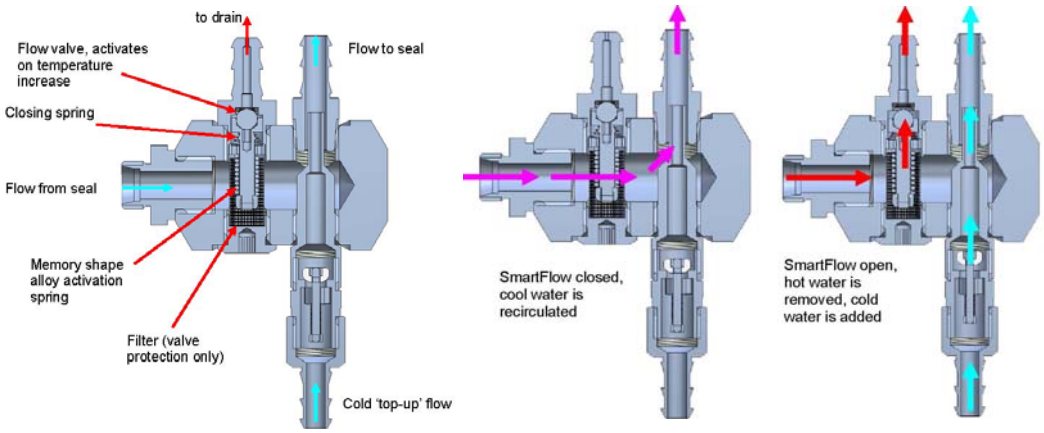
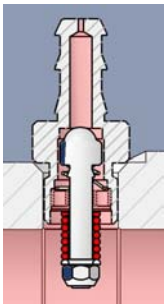


Figure 4: ***Key Features of Universal SmartFlow***

When the gland water or barrier fluid is cold the spring is in its pliable state and the flow valve in the SmartFlow remains closed. This causes the fluid to recirculate through the mechanical seal. When the temperature increases the alloy changes and transmits axial force like a normal spring. This force opens the flow valve allowing hot seal water to flow to drain (or a collection point) and the system is topped-up by cold water supplied to it. This cools the circulation flow and returns the spring to its pliable state, the flow valve then closes and the cycle repeats itself. A separate safety valve, based on seal water temperature, is normally located at the outlet from the mechanical seal gland plate.

The safety valve is normally held closed. Should an operational upset occur, causing seal water temperature to increase, the device will 'activate'. This allows the spring to open the valve and release hot water. Once the SmartFlow safety valve has operated it can be manually re-set and does not require replacement.

2.2 Three Outstanding Failsafe Features

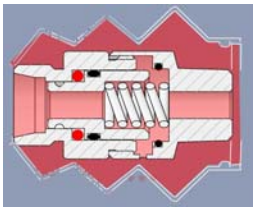


1. Memory shape spring

The spring is a temperature-activated material, when cool it is pliable and can be easily deformed to any shape. If the material is heated to its 'activation temperature' it "remembers" its original 'programmed' shape and returns to it - applying force against anything in its way. I.e. it changes from a pliable piece of material to a spring.

2. Filter

The Universal SmartFlow includes a filter to ensure reliability of equipment operation. This filter is for the valves protection only and is not suitable as an inline filtration device. The filter should be checked and cleaned on a regular basis in order to prevent clogging. Cleaning frequency is dependant on the quality of seal water used.



3. Safety valve

A safety valve based on seal water over temperature is incorporated in the equipment. This is not shown in the above diagram (Universal SmartFlow) but is normally located at the outlet from the seal plate. The safety valve will open should such operational failure occur on the equipment causing the seal water temperature to exceed 90 °C (195 °F). In the Integrated SmartFlow a safety valve is integral to the unit.

3.0 BENEFITS AND REALISABLE SAVINGS

SmartFlow has primarily been used in the pulp and paper, steel and fertiliser industries where seal water (barrier fluid for double seals) is extensively used. It can however be applied across any industry or application where water savings are demanded and water barrier fluids are used.

The primary use of SmartFlow is for controlling seal water flow in dual pressurized mechanical seals. Most sites are demanding reduced seal water consumption yielding substantial savings, significant improvements in reliability and compliance with environmental standards. SmartFlow delivers those savings with reduction in seal water usage of typically 95% compared to flow meter regulated flow-through systems. Seal water consumption is affected by product temperature, rotation speed, seal water temperature (from line), surrounding temperature and seal water pressure – therefore reductions in seal water usage can only be quoted as 'typical'.

4.0 CASE STUDIES

4.1 A major mineral extraction and ore processing site in Australia uses water to pressurise double seals fitted in their process pumps.

The seals in the SX (Solvent Extraction) plant use potable water;

a) as a quench medium to prevent crystallization in single seals,
b) as a barrier fluid to pressurize the double seals.

Both seal designs use approximately 6 litres per minute. Water usage is controlled via a flow meter and diverted to open drain.

It is estimated that 80 pumps in SX consume approximately 252 ML of water per year.

John Crane offered a SmartFlow on a trial basis in the existing John Crane Type 5620 dual pressurized seals. After 1 month in operation, the SmartFlow used only 1 litre of water. In this arrangement, it should be noted that standby pumps do not consume any water. As a result of this success, there is a program in place to install SmartFlow in all the pumps in SX and there are trials taking place to use SmartFlow in Slurry applications.

Larger Slurry pumps use up to 30 litres per minute of gland water to support and lubricate the gland packing – offering a potential saving of approximately 15.5 ML per pump per year.

SX Installation:

Fig 5a: ***SmartFlow*** **Fig 5b:** ***Pressure Switch & Flow Meter*** **Fig 5c:** ***SmartFlow***

4.2 A large municipal waste water treatment facility operating a Warman 4/4 TC series pump with 85mm shaft (converted from gland packing to dual mechanical seals) operating with a 1.5m discharge head on 4-6 % solids at a speed of 1450 rpm.

After 3 months, the SmartFlow installations have not used any water. Prior to SmartFlow, water consumption was 6 litres per minute per pump. The cycle run times of the pumps allows the water in the SmartFlow loop to remain cool and, as such, does not activate the safety valve, which means zero water consumption and reliable sealing. There are 36 pumps on this site - a saving of approximately 113 ML annually.

Figure 6: ***Site Installation***

The same end-user is currently examining the viability of utilising the SmartFlow to reduce the volumes of potable water required to provide 'once-through' bearing cooling on a large sludge pump. Thermodynamic calculations suggest this application will reduce water consumption by approximately 85% from the current rate of 0.5 litres per second – a saving of approximately 13.4 ML per pump per annum.

5.0 AWARDS

John Crane SmartFlow was recognized in June of this year as the Best Specific Environmental Initiative within the "Business Enterprise" Category of the United Nations Association of Australia 2007 World Environment Day Awards. Further information regarding the United Nations Association of Australia can be found on their web site: www.unaavictoria.org.au