AESSEAL® ENVIRONMENTAL TECHNOLOGY

WASTE WATER REDUCTION AT A SODIUM SILICATE PLANT

- SEAL WATER RECOVERY
- SUMMARY AND RECOMMENDATIONS
- SYSTEM DESIGN AND INSTALLATION
- MECHANICAL SEAL INSPECTION
- CASE HISTORIES

SODIUM SILICATE

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ACKNOWLEDGMENT

AESSEAL® wishes to acknowledge the following sources of information and data used in compiling this publication:

Austin, G. T. 1984. Shreve's Chemical Process Industries. 5th ed., McGraw-Hill Book Company, New York.

Bertrand, M. 1997. The PQ Corporation. Private Communication

Cheremisinoff, N. P. and P. N. 1992. Pumps and Pumping Operations Prentice-Hall, Englewood Cliffs, New Jersey.

Ebright, T. 1996. Enpro Incorporated. Private communication.

Elliot, T. 1997. Erdmann Corporation. Private communication.

Pittman, P. 1997. Private communication, use of drawing.

Pritchard, T. 1996. The PQ Corporation. Private communication.

Spraying Systems Co. 1996. Industrial Spray Products., catalogue.

The PQ Corporation. 1997. Use of drawing.

Vail, J. G. 1952. Soluble Silicates Their Properties and Uses Volume 1: Chemistry. Reinhold Publishing Corporation, 330 West Forty-second St., New York 36, NY.

Webber, J. 1996. AESSEAL® Private communication.

Silmaco - Cover Photos of a Sodium Silicate Plant. http://www.silmaco.com

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Introduction

The purpose of this research is to examine water usage and possible ways to reduce waste water generation at a Sodium Silicate plant. The focus is on three specific areas: the seal flushing system, product bucket conveyor and furnace air reversal valve.

For the first two areas, projects were partially completed at a plant in Jeffersonville, Indiana, USA and actual water savings were determined. For the furnace air reversal valve, various process improvements have been recommended to eliminate waste water.

Implementation of process improvements in the product conveyor and seal flushing system in the Jeffersonville have brought annual reductions of 19.3 million US gallons (73.05 million litres), thus saving $45,000 (£26,470) per year. Upon completion of all facets of this project, there is a potential saving of an additional 5.5 million US gallons (20.82 million litres) annually. Therefore, the total savings for the plant could be as high as $61,000 (£35,882) per year.

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Seal Water Recovery

The object of this exercise is to recover all water possible without reducing seal performance, by installing a seal water recovery system in the Silicate plant.

(a) Seal Water Use in the Silicate Plant

In the Silicate plant, seal flushing water is critical to maintaining pump life. Water has two functions in this system: removing heat from the seal and as a barrier fluid to keep abrasive product away from seal faces. Silicate sent through pumps is abrasive and hot, making pumps hard to seal. Water is used to flush seals in shipping pit pumps. (Where product is pumped throughout the plant, or to customer trucks). After passing through the seals once, flushing water is discharged directly to the sewer. Historically single seals were used, but were in constant need of repair. Instead of flushing the surface of the seal faces with water, as in a double seal, a single seal is designed to apply pressure against the seal face, driving a small amount of water into the product[6]. The single seal design could not remove enough heat from the seal face, and premature seal failure would inevitably occur.

In order to increase seal life, double seals with a water flush were installed. Newly installed double seals last longer (years as opposed to months) and although initially the cost may be higher, long term savings on maintenance and parts justify this investment[7].

Both the Silicate and Zeolite plants use softened water to flush pump seals. The Zeolite plant uses a water recovery system that re-circulates seal water throughout the plant, thus reducing water lost in process and to waste. Unlike the Zeolite plant, seal water used in sealing Silicate is not recovered, but is passed straight through seals to the on-site water treatment facility. At the treatment facility, waste water is adjusted for pH then sent directly to the sewer.

[6] Cheremisinoff, N. P. and P. N. 1992 Pumps and Pumping Operations. Prentice-Hall, Englewood Cliffs, New Jersey, p.284.
[7] Pritchard, T. 1996. Private communication.

(b) System Design and Installation

Examining the Zeolite seal water recovery system was the first step towards choosing a configuration for the Silicate plant. The Zeolite system consists of a large holding tank (650 US gallons) (2460 litres) and a large pump (including spare) distributing softened water to all seals. After passing through a seal, spent water is returned to the top of the holding tank. The holding tank dissipates heat generated by seals from friction and provides a means to visually inspect seals for possible leaks. Since the tube inlet to the tank is exposed and all seal water return tubes are next to one another, if one flow is noticeably lower than another, this may indicate a leaking seal.

There are several reasons why the Zeolite plant incorporates a seal water recovery system while the Silicate plant does not. The Zeolite plant was constructed in 1991; the Silicate plant in 1938. Since pump sealing technology was more advanced in 1991, a seal water recovery system was included in the initial design of the Zeolite plant. Also, a much larger water recovery system is needed in the Zeolite plant because there are 29 pumps operating with seal water as opposed to 11 in the Silicate plant. Many Silicate pumps have recently been converted from packing to mechanical seals, so there was no prior need for a water recovery system. Also, not all Silicate pumps were installed at the same time, but as needed over many years. Before selecting a system to recover seal flushing water, the amount of water used on a daily basis for Silicate seal flushing should be reviewed. Of 11 pumps used in Silicate, two have single seals. The other nine pumps all have double seals, which require flushing fluid. Four of the nine are spares, so they only operate when the main pump goes down. Of the nine pumps, there are a maximum of five running at any given time. Two pumps run almost continuously (for the neutralization and pre-neutralization system), and the other three have a combined daily operating time of about three to six hours. The seal water flow rate on each of the pumps is about 1-3 US GPM (3.78-11.36 litres/min); or, to be more exact, a value of 1.8 US GPM (6.8 litres/min). On average then, let's assume there are essentially three and a half pumps operating 24 hours a day, using seal water at a rate of 9100 US GPD (34447 litres/day). Using this estimate, and costs to purchase, dispose of, and soften water, there is the potential to save about $13,000 (£7,650) per year by recovering the wasted seal water (See Table 1). The type of system installed will be dictated by the cost of installation.

An initial idea was to consolidate Silicate pumps in the Zeolite system. This would provide an easy, economical option for reusing wasted seal water. Unfortunately, because of possible cross contamination between plants (through seals leaking back into the system) this option was rejected.

Since sharing the Zeolite system was rejected, installing a similar system in the Silicate plant was considered. There are several benefits to this option, including interchangeable parts, familiarity and using proven technology. Also, new pumps requiring seal flushing water could easily be added to the system without having to make many changes; simply install the necessary piping. If the Silicate system involved a high number of pumps (as in the Zeolite system), a centralized, distribution type system would be easier to maintain and service.

The main option available, other than a system similar to the Zeolite design, is one offered by the seal supplier, AESSEAL®. This system comprises a local (for use with one pump at a time) seal water collection system. The two systems were compared based on the estimated cost of installation. A centralized distribution system (like Zeolite's) has an initial estimated installation cost of $30,000 (£17,650). This cost includes the manufacture and installation of the water holding tank, two centrifugal pumps (for distributing the water), and all necessary piping, including the soft water feed line. Each pump added to the system costs an additional $500 (£300), for the installation of tubing to and from the seal. The cost to install a local tank is about $1700 (£1000) per pump.

Up to the incorporation of twenty five pumps, installing a local system is recommended (Figure 1) once more than twenty five pumps are involved, it becomes increasingly cheaper to install the central distribution system. The local system was chosen for use in the Silicate plant for the following reasons.

- Only nine pumps are involved.
- Savings of $19,000 (£11,200) in the price of installation when compared to the centralized system.
- There is little likelihood of expansion.

The system consists of a Stainless Steel tank (2.5 US gal/10 litres capacity), located next to a pump, which feeds water to the seal and collects returning water.

Water pressurizes the tank (from line pressure), and air vents out of the top through a pressure relief valve. The system is closed and the tank is placed so that natural convection by frictional heating creates the required flow through a seal. Water is completely contained inside the tank and wastage is eliminated. Each tank has a pressure gauge and temperature gauge for visual monitoring of the system to make sure the apparatus is operating under proper process conditions (Figure 2)[8] on page 10.

Possible problems are that, either the product leaks through the seal back into the tank, or the water leaks through the seal into the product. In order to visually monitor whether water is leaking into the product, rotameters are installed on the water inlet of the tank. Any indication of flow through the rotameter (once steady state is achieved) is evidence of a seal leak. Solenoid valves that open and close based on operation of the pump are installed before the tank in the soft water supply line. The valves supply water to a tank only when a corresponding pump is operating. Therefore, if a seal is leaking, water will not be continually fed into the product. An optimum pressure of 50 psi (3.5 bar) is recommended by the manufacturer[9] and is maintained by a regulator in the soft water supply line. Since pumps were already utilizing the flushing fluid system, most equipment needed for installation of the seal water recovery system (tubing, valves, check valves, solenoid valves, rotameters, water supply lines, etc.) were already located next to each pump.

Since four of the tanks were located outdoors, special precautions were taken to prevent water in the tanks freezing. Electrical heat tape was wrapped around the tanks, and the tanks were located inside an insulated box. All water lines were also heat traced and insulated. During the process of installing collection tanks, a pump was converted from a single seal to a double seal. The pump is a spare, and has seen relatively little (if any) service since this conversion. The conversion costs are not included in any cost estimations in this project because the conversion was to be made regardless of any water collection changes.

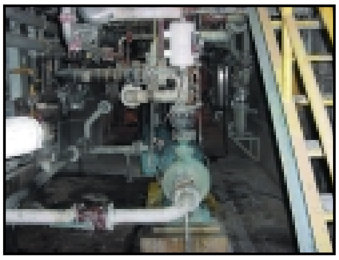
[8] AESSEAL®. 1996. Use of drawing.
[9] Webber, J. 1996. AESSEAL®. Private communication.

(c) Performance and Savings

To date five tanks have been installed, and there has already been an average drop of 3600 US gallons (13,627 litres) per day in seal water use (Figure 3). These five tanks only account for 40% of the Silicate pumps' total estimated waste water generation. The remaining 60% will be accounted for by four tanks not yet installed, two of which are in use with pumps operating on a continual basis. Predicted water savings for the remaining four tanks is 4,800 US GPD (18,170 litres/day). Based on current water reductions, money saved from purchasing, softening, and disposal is $5,000 (£2,900) per year. Once the project is complete, the plant should experience a total water saving of 8,400 US GPD (31,800 litres/day), or 3.1 million US GPY (11.73 million litres/year). Reducing water usage by such a level will save the plant $33.00 (£19.00) per day, or $12,000 (£7,000) per year (Table 1). This saving is based on changes in soft water supplied to the Zeolite seal water system, which supplies the Silicate plant. Although the Zeolite plant uses seal water from the same system, no reductions in water usage were made in the Zeolite plant, any water savings will be based solely on changes made to Silicate seal water collection methods. Based on the combined actual and projected savings from this project, we can determine the financial stability and profitability of the project. The total money spent on installation of the seal water recovery system in the Silicate plant is $15,300 (£9,000) (for a detailed break down of project costs see Table 2 in appendix). Based on the total money saved per year indicated in Table 1, ($12,000/£7,000), a pay back time of 1.3 years is estimated.

(d) Preventive Maintenance

The project also included training operators on system procedures and setting up a preventive maintenance schedule. For preventive maintenance, pumps are checked for leaks twice a month, according to the inspection procedure list included in the appendices (Figure 4). The preventive maintenance schedule increases the chance of catching a failed seal and so reduces the possibility of water leaking into product. Training the operators on seal leak detection prompts them to be constantly aware of the situation and to watch out for leaks during normal operations.



Sodium Silicate Load Out Pump. Goulds 3196MT Pump with AESSEAL® CDSA™ Double Mechanical Cartridge Seal and SSE10™ Barrier Fluid Tank System.

AESSEAL® SSE10™ Barrier Fluid Systems for AESSEAL® CDSA™ Double Mechanical Cartridge Seals in Sodium Silicate Service.

Sodium Silicate Transfer Pump with AESSEAL® CDSA™ in a Viking Pump.

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Summary and Recommendations

In the Sodium Silicate plant studied in this paper, the following areas were targeted for waste water reduction: seal water use, molten glass bucket conveyor cooling water and the forter valve. In seal water use and the molten glass bucket conveyor, actual changes were made to the process operation. Neither project was complete at the time of writing this paper, so we should also consider projected savings upon completion. This also includes the highest recommended change for the forter valve.

Total spending is $17,700 (£10,400) (including projected costs). Total savings per year associated with water purchasing and disposal are $61,000 (£35,900).

Table 1: Savings Associated with Seal Water Recovery

INITIAL ESTIMATES	DAILY	YEARLY
WATER USED	9100 US Gallons (34,450 litres)	3.3 million US Gallons (12.5 million litres)
WATER COSTS	$36.00 (£21.00)	$13,000.00 (£7,650.00)
ACTUAL WATER SAVED	**DAILY**	**YEARLY**
CURRENT	3,600 US Gallons (13,627 litres)	1.3 million US Gallons (5 million litres)
PROJECTED	4,800 US Gallons (18,170 litres)	1.75 million US Gallons (6.6 million litres)
TOTAL	**8,400 US Gallons (31,800 litres)**	**3.1 million US Gallons (11.7 million litres)**
ACTUAL MONEY SAVED	**DAILY**	**YEARLY**
CURRENT	$14.00 (£8.00)	$5,000.00 (£2,900.00)
PROJECTED	$19.00 (£11.00)	$7,000.00 (£4,100.00)
TOTAL	**$33.00 (£19.00)**	**$12,000.00 (£7,000.00)**

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Figure 1: Financial Comparison of a Local and Central Seal Water Distribution System

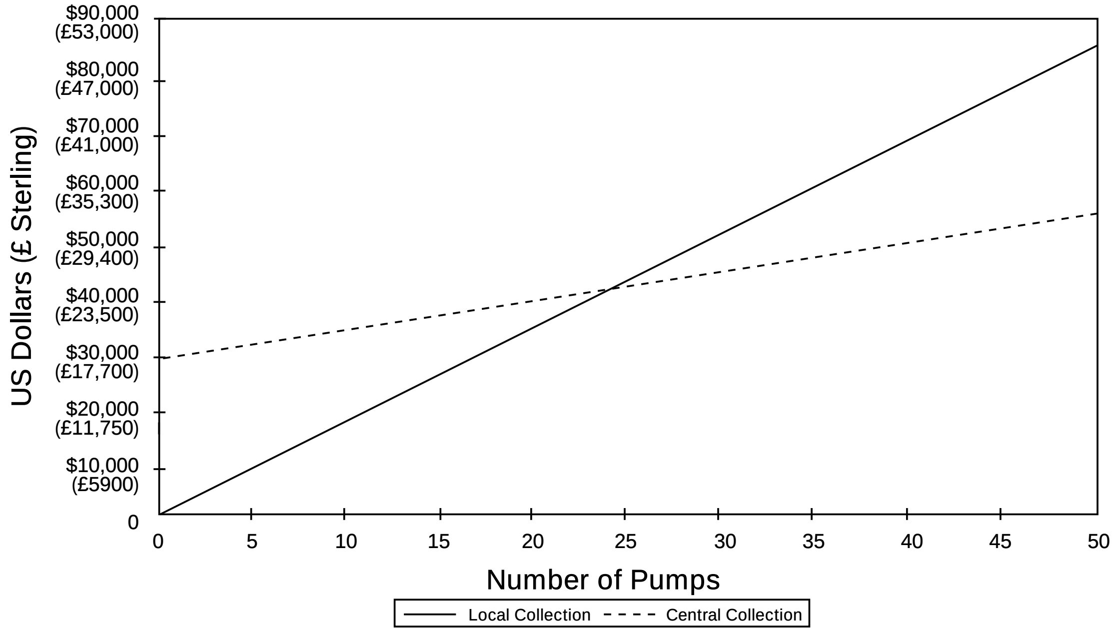

Figure 2: Silicate Seal Water Collection System

SSE10™ System W1

Basic Water Retention
Vessel Code Use / SW01

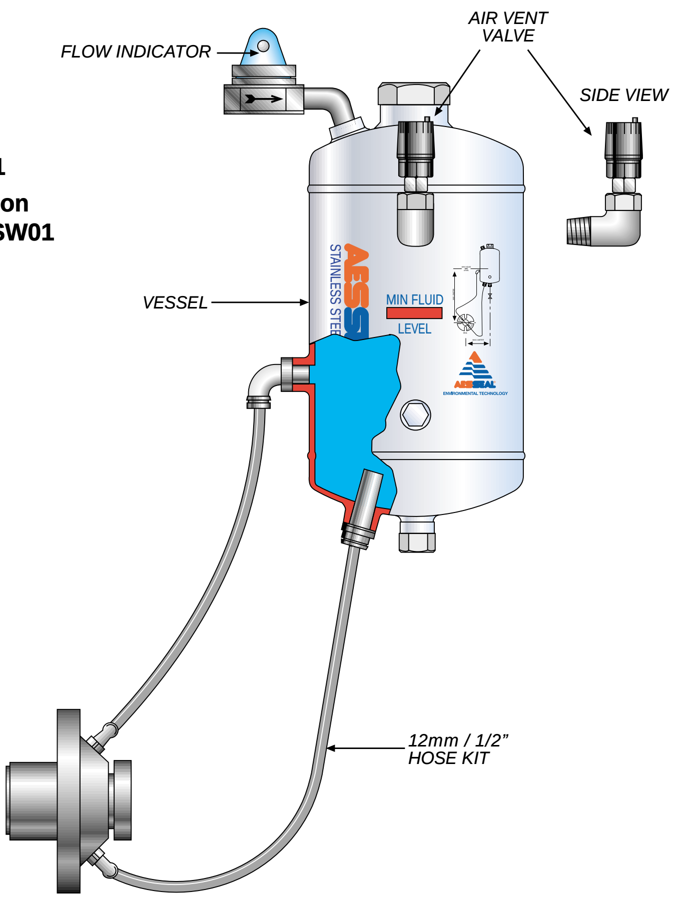

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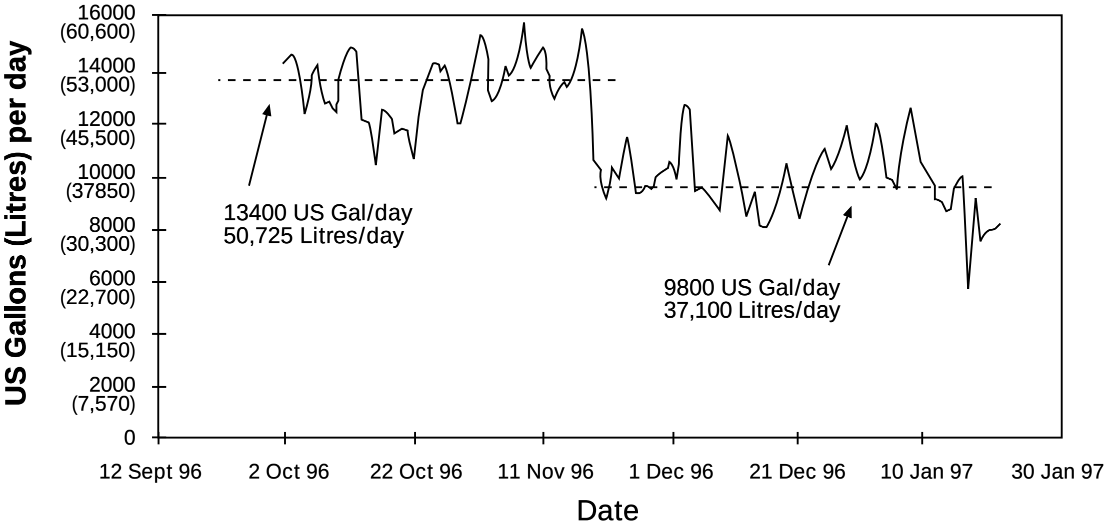
Table 2: Detailed Costs of Silicate Seal Water Collection System

ITEM	QUANTITY	AMOUNT	TOTAL
Insulation Box	4	$360.00 (£212.00)	$1,440.00 (£848.00)
AESSEAL® Tank	6	$575.00 (£340.00)	$3,450.00 (£2040.00)
	3	$355.00 (£210.00)	$1,065.00 (£630.00)
Vent Valve	6	$70.00 (£40.00)	$420.00 (£240.00)
	3	$46.67 (£27.50)	$140.00 (£82.50)
Temperature Gauge	9	$58.33 (£34.00)	$525.00 (£306.00)
Pressure Gauge	9	$37.78 (£22.00)	$340.00 (£198.00)
SS Check Valves	9	$70.00 (£40.00)	$630.00 (£360.00)
Heat Tracing Tape		$2,890.50 (£1700.00)	$2,890.50 (£1700.00)
Water Pressure Regulator	1	$79.50 (£47.00)	$79.50 (£47.00)
Labor Costs	144 hours	$30.00/hour (£18.00/hour)	$4,320.00 (£2592)
TOTAL			**$15,300 (£9043.50)**

Note: All costs are typical and are correct at time of original report publication.

Figure 3: Seal Water Use



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WASTE WATER REDUCTION

AT A SODIUM SILICATE PLANT

L-UK/US-SODSIL-03

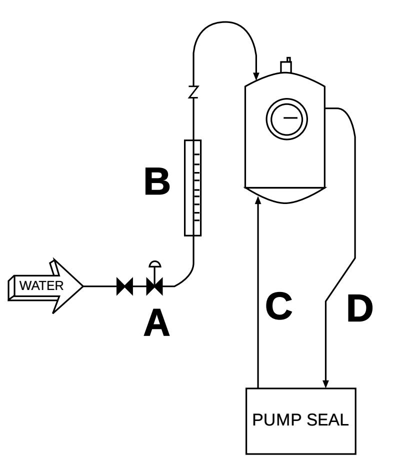
IN 4337 - 01/2002

Mechanical Seal Inspection

How to check a double seal:

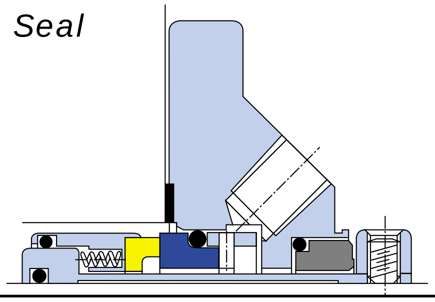
1. Check for visible signs of external fluid leakage on or around the mechanical seal itself.
2. Check for internal leak.
   - i. Make sure the pump is running.
   - ii. Inspect ball valve A and make sure it is open.
   - iii. Inspect fluid flow meter B. If there is any indication of flow, the seal is leaking.
   - iv. Inspect tubes C and D connecting the tank with the seal. Under normal operating conditions, one tube should be cold and one should be warm.
     If both tubes are cold, the seal may be leaking.z

Figure 4: Preventive Maintenance Schedule

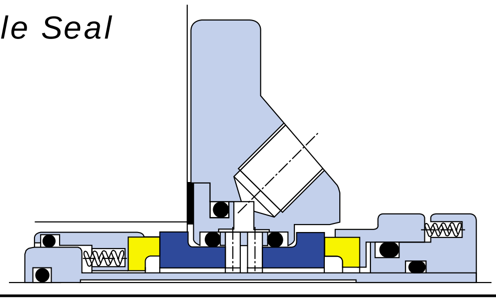


Main AESSEAL® seals used

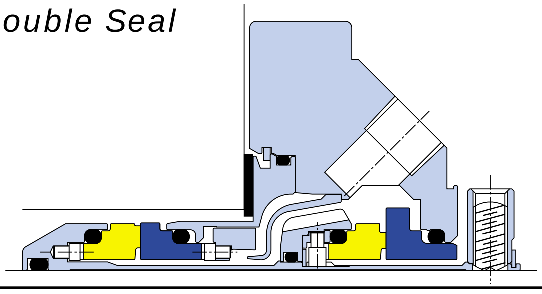
CURC™ - Single Seal



CDSA™ - Double Seal



DMSF™ - Double Seal



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CASE HISTORIES

CASE No. 362E

In a Chemical Company, a 43mm AESSEAL® CDSA™ seal with Carbon/Solid Tungsten Carbide faces and EPR 'O' rings was installed into Scan NB 100/65/20 pumps.
The pumps rotate at 2,900 rpm and circulate Sodium to maintain its best fluid characteristics prior to the next stage of production. The product is at 60ºC (140ºF) and 35 psi (2.5 bar) pressure. The pumps were previously sealed using rubber bellows type seals which were being ripped apart by the solidification of the product. The previous seals were lasting from a few days to three weeks maximum.

The AESSEAL® CDSA™ seals were installed in July 1992 and are operating leak-free with a water barrier fluid at 80 psig. (5.5 bar) via a SSE10™ pressure pot.
The seal outside diameter was reduced to 138mm (5.43"), the stuffing box insert removed and an adaptor plate fitted.

CASE No. 1009H

In a Sodium Silicate Production plant in the UK a 48mm CDSA™ C/TC//CROX/C with Aflas®/EPR elastomers was fitted to an ABS Centrifugal pump, model 100/65-26. Before installing the seal, the seal chamber was removed and the back plate was drilled and tapped. The seal was installed with a W2 seal support system.

The product being pumped was Sodium Silicate at a temperature of 60°C (140°F) with a shaft speed of 1450 rpm and a pressure of 29 psi (2 bar). The product had abrasive sand particles and could dry run.

The customer was previously using a single S02 GJ151/PP seal. The main problem with this seal was the seal faces stuck together and frequently broke on start up. The previous seal lasted 6 days.

CASE No. 1010H

In a Sodium Silicate Production plant in the UK a 7.250" CDSA™ TC/TC//CROX/C with Aflas®/EPR elastomers was fitted to a Warman Slurry pump, model 3/2 AH. Before installing the seal, the back plate and sleeve was modified. The seal was installed with a W2 seal support system with cooling coil.

The product being pumped was Sodium Silicate/Caustic/Sand at a temperature of 120°C (248°F) with a shaft speed of 3170 rpm and a pressure of 72 psi (5 bar). The product had abrasive silica sand particles.

The customer was previously using a Warman expellor seal and packed gland. The main problem with this seal was that the Silicate solidifies on shutdown and rips up the packing.

CASE No. 1011H

In a Sodium Silicate Production plant in the UK a 43mm DMSF™ TC/TC//TC/TC with Aflas®/EPR elastomers was fitted to a Labour Centrifugal pump, model EP. Before installing the seal, the adaptor plate required modifications. The seal was installed with a W2 seal support system.

The product being pumped was Sodium Silicate at a temperature of 60°C (140°F) with a shaft speed of 3000.

The customer was previously using a back to back double seal with SIC/SIC//CER/C elastomers. The main problem with this seal was when the seal water pressure dropped the inboard seal popped open. The previous seal lasted 2 weeks.

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CASE No. 1012H

In a Sodium Silicate Production plant in the UK a 50mm CDSA™ C/TC//CROX/C with Aflas®/EPR elastomers was fitted to an Stork Gear pump, model SRT. The seal was installed with a W2 seal support system.

The product being pumped was Sodium Silicate at a temperature of 60°C (140°F) with a shaft speed of 740 rpm.

The seal lasted 18 months. Normally changed due to idler gear wear.

CASE No. 1013H

In a Sodium Silicate Production plant in the UK a 48mm DMSF™ TC/TC//TC/C was fitted to an ABS Centrifugal pump, model 100/65-2O. The seal was installed with a W2 seal support system.
The product being pumped was Sodium Silicate at a temperature of 70°C (158°F) with a shaft speed of 2900 rpm.

CASE No. 1014H

In a Sodium Silicate Production plant in the UK a 48mm CDSA™ C/TC//CRO/C with Aflas® elastomers was fitted to an ABS Centrifugal pump, model 100/65-20. The seal was installed with a W2 seal support system.

The product being pumped was Sodium Silicate at a temperature of 70°C (158°F) with a shaft speed of 2900 rpm and a pressure of 43 psi (3 bar).
The customer was previously using a Single Spring seal. The main problem with this seal was that the seal faces broke on start-up due to silicate solidifying during shutdown. The previous seal lasted only 2 days.

CASE No. 1015H

In a Sodium Silicate Production plant in the UK a 25mm CDSA™ C/SIC//SIC/C with Aflas® elastomers was fitted to a Robins & Myers PCP pump, model AZA CDQDAA. The seal was installed with a W2 seal support system, which has now been in service 3 years.
The product being pumped was Sodium Silicate at a temperature of 30°C (86°F) with a shaft speed of 476 rpm and a pressure of 10 psi.

Case No. 1016H

In 1997, AESSEAL® supplied and installed a 1.750" CDSA™ double seal with TC/TC//TC/CAR faces and Aflas®/EPR ‘O’ rings for a Goulds 3196 MTX pump in a Sodium Silicate Plant in Indiana, USA.
The seal replaced a single cartridge seal, with TC faces and Aflas® elastomers, which ran for only 2 days leak free. The competitor seals were on a monthly repair schedule for economic (product loss), safety and housekeeping reasons.
The pump operates at 1,750 rpm, with a process temperature of 180°F (82°C), a stuffing box pressure of 25 psig (1.7 barg) and a barrier fluid pressure of 40 psig (2.7 barg). The barrier fluid is water.
The CDSA™ seals were supplied with fluid retention vessels to reduce effluent water and are still in service.

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Note:

Due to AESSEAL® policy of continuous improvement the following seal types have been upgraded:

SCI	*upgraded to*	*SCUSI*
CSAI	*upgraded to*	*CURC*
CAPI	*upgraded to*	*CURC*
CAPO	*upgraded to*	*CRCO*
CMDS	*upgraded to*	*CDSA & DMSF*

The original products evolved into more modern seals which were designed to enhance application performance. The product model reference in the case study is for the most modern design, even though at the time of installation the actual installation was the predecessor model.

All information featured in these case histories has been obtained directly from Plant Engineers.

Although we have confidence in the accuracy of this information, it is not offered as a guarantee for seals manufactured by AESSEAL®.

Any prospective user of our product should verify the information stated to their own satisfaction.

Further information is available on all the case histories contained in this booklet upon request.

Issue 'A' on a case history refers to information which was current on the 31st. January, 1989.

Issue 'B' refers to information which was current on 31st. January, 1990.

Issue 'C' refers to information which was current on 31st. January, 1991.

Issue 'D' refers to information which was current on 31st. January, 1992.

Issue 'E' refers to information which was current on 31st. January, 1993.

Issue 'F' refers to information which was current on 31st. January, 1995.

Issue 'G' refers to information which was current on 31st. January, 1998.

Issue 'H' refers to information which was current on 31st. October, 1999.

Issue 'I' refers to information which was current on 31st. March, 2000.

Issue 'J' refers to information which was current on 31st. November, 2000.

Where the statement 'The seals are still working' is made, this means that the customer is or was still using AESSEAL® mechanical seals at the time the case history was updated; as denoted by either:

Issue 'A', Issue 'B', Issue 'C', Issue 'D', Issue 'E', Issue 'F', Issue 'G', Issue 'H', Issue 'I' or Issue 'J'.

For more detailed information, please contact our Applications Department.

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THE QUEEN'S AWARDS FOR ENTERPRISE 2000

INVESTOR IN PEOPLE

USE DOUBLE MECHANICAL SEALS WITH HAZARDOUS PRODUCTS. ALWAYS TAKE SAFETY PRECAUTIONS:

- **GUARD YOUR EQUIPMENT**
- **WEAR PROTECTIVE CLOTHING**

WARNING

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