PIPELINE POSSIBILITIES
Seals with laser machined wavy SiC faces support uninterrupted flow of crude oil and natural gas liquids
Natural gas liquids (NGLs) and crude oil are pumped in batch mode, so seal pressure varies over a wide range and the pumps are subjected to vigorous start/stop operation. The presence of abrasive pipe rouge (iron fines) is a further complication. Mechanical seals were developed to perform in such demanding pipeline applications.

Flowserve engineers used state-of-the-art technology to design seals for this difficult application, and verify seal performance in laboratory tests. Mechanical seals incorporating laser machined wavy silicon carbide (SiC) faces have been running in the field since September 2000, with great success.

Pipeline pump stations are spaced about 30 to 40 miles apart. Each station uses three or four pumps in series. One to four pumps are active at the same time. The third or fourth pump experiences a wide range in suction (seal) pressure. To determine seal operating conditions, the fourth pump at one station was monitored using instrumentation hard-wired to a computer in the station control room.

A modem was used to access performance in real time and download data. This information
A mechanical seal incorporating laser machined wavy silicon carbide faces can perform successfully in demanding NGL/crude oil pipeline applications.

Laser Machining Solves Pipeline Problems Fast

The Flowserv-designed laser micro-machining process has been used to solve other pipeline application problems.

Laser technology produces very uniform patterns, improves surface finish and allows more complex patterns to be made and tested more quickly. "The time needed to move from pattern concept to prototype is much shorter," says Lionel Young, specialized technology manager at Flowserv’s Temecula, Calif., facility. "Before, the process could take weeks. Now we can make new patterns within minutes.”

In a Canadian pipeline application that runs a crude oil/ethane batch, the seals endured abrasive conditions and pressures ranging from 400 to 1,000 psi. A special problem, however, was the specific gravity, which ranged widely from 0.85 to 0.44. "Ethane is hard to seal because it tends to go into a gaseous form between the faces," says Young. "When this happens, the pumped fluid no longer provided lubricity."

Laser machined waves on the stationary face of the Flowserv HDHW 5500 seal (which features silicon carbide against silicon carbide) coupled with a GSL 5250 backup provided the solution. "After pulling out one set of seals after 5,000 hours of operation, the faces [were] in excellent condition," says Young.

Multiphase pumping applications in Venezuela are a good example of where laser machined wavy faces have helped solve a tough sealing condition. These applications pump crude oil directly from the ground. The process temperature on the twin screw pump – 90 to 125 degrees F – wasn’t that bad, and the shaft speed was a low 900 rpm. But the problem was the pressure, particularly the 750 psi start up pressure, compared to the steady-state pressure of 90 psi. The crude oil also is extremely viscous, and it contains gas, water and sand, which makes it hard to pump and hard to seal. Laser machined wavy faces solved the problem.

revealed that seal chamber pressure varied from about 150 psi to more than 1,300 psi. In addition, the data showed seal pressure spikes of 350 psi (up or down) when a pump 1, 2 or 3 was turned on or off.

The dual mechanical seal arrangement consists of an HDHW primary seal that handles full system pressure drop and a dry running GSL containment seal (see Figure 1). The primary seal is designed to handle NGL and crude oil at pressures as high as 1,500 psig. The containment seal minimizes product release to the environment in the event of a primary seal failure; it features a bi-directional wavy lift-off face for long life and low wear. This tandem seal arrangement with a dry running secondary seal is easy to maintain, as it doesn’t require a liquid buffer fluid support system.

Special analysis software was used to design seal faces to handle the range of operating conditions. Seal faces distort (cone) as a result of pressure and thermal loading. To ensure long life and low leak rate, net face deflection coning must be less than about 1/400 the thickness of a sheet of paper. The final seal design was

Fig. 1 The dual mechanical seal arrangement consists of an HDHW primary seal that handles full system pressure drop and a dry running GSL containment seal.
The wavy SiC seals are achieving significantly longer life compared to conventional seals using non-featured faces of carbon against silicon carbide.
Like the “embedded journalists” interested in getting the best possible story from the warfront, embedded engineers from Flowserve Flow Solutions Division get up close and personal with customer pump systems in order to improve equipment reliability. These on-site Application Engineers (AEs) are Flowserve employees who work exclusively for a specific customer, such as Marathon Ashland Petroleum (MAP).

Flowserve did not have to look far to find an AE for the MAP refinery in Robinson, Ill. Ted Stone knows the Robinson plant better than just about anyone—because he was a MAP employee for 32 years. Stone had already been part of the MAP-Robinson Seal Improvement Team and, after he retired, he joined up with Flowserve.

MAP is a member of Flowserve’s Alliance Program, in which the two companies work toward a common goal of reducing pump failures and improving equipment reliability at MAP refineries. MAP-Robinson signed its first five-year agreement with Flowserve in September 1998, and another just last year.

“We’re like one of their employees,” explains Flowserve District Sales Manager Brian Bradley. “It’s a team. We’re all part of the same team.”

Although all seven MAP refineries participate in fixed-fee contracts, the arrangement works particularly well at the Robinson facility, which is far from any major highway or Flowserve QRC facility.

The centerpiece of the alliance is the embedded on-site AE. They are tasked with executing the Alliance and managing the overall program on a daily basis. This includes performing a review of all failed equipment and suggesting solutions that help improve overall reliability. Rather than MAP having to call for services every time something breaks down, the on-site application engineer can make equipment upgrades quickly. This helps keep the costs for such maintenance consistent – no budget surprises, and no delays for funding to be approved.

“You look at every aspect of the pump and try to make it work better.” – Ted Stone

With the agreement, the MAP-Robinson Seal Improvement Team consists of the plant’s craft supervisor, reliability supervisor, machine shop foreman, a rotating equipment engineer and someone from the purchasing side of the business. The group meets monthly to discuss the concerns of each department and share advice on improving plant operations.

Flowserve’s equipment database, Flowstar.net, is also used by MAP-Robinson. Flowstar.net keeps an inventory of all pumps in the program and a record of past equipment failures so engineers can avoid the same problems in the future.

Stone raves about the operator training course developed by the Seal Improvement Team — including an online version created by Paschen. The course shows MAP technicians the proper ways to operate and maintain equipment.

At MAP-Robinson, the teamwork that arises from the Alliance program has led to an improvement in MTBF from 24 to 70 months in five years. This results in an annual savings of over $1.4 million dollars to MAP-Robinson. While all customers may not achieve such tremendous results so quickly or enjoy such extensive, site-specific experience from a Flowserve on-site engineer like Stone, they can expect the same level of attention, cost-savings and continuous improvement from every Flowserve AE as part of Flowserve’s Alliance program.
Every two years in Dortmund, Germany, Flowserve’s Flow Solutions Division customers attend a Technical Forum to learn about the latest technical advances. In Spring 2004, the Technical Forum coincided with the re-opening of the FSD test lab, which added additional compressor seal test capability.

Key European customers toured the facility in which offices were moved to create a customer monitoring area. Test data streamed live onto LCD monitors in a quiet room away from the testers that kept customers safe from test pressures up to 450 bar (6,500 psi).

Flowserve FSD President Andy Beall, who was in Dortmund for the grand re-opening, said, "This state-of-the-art test facility in Dortmund is yet another example of our commitment to providing our customers with excellent capability and service."

During the forum presentations, the Circpac LO was introduced. As the newest solution for reducing nitrogen consumption as a separation seal in compressors, this carbon ring seal is in contact with the shaft during static conditions, but lifts once the shaft starts to rotate. This allows for low leakage rates both statically and dynamically, and eliminates carbon wear and contamination from the rings.

A correctly specified seal support system contributes significantly to the durability and correct function of pumping systems. Seal support systems provide fluid at the right temperature and pressure to keep the mechanical seal properly lubricated. This helps achieve maximum safety and maximum useful life with minimum leakage.

Flowserve Flow Solutions has standard API plan 52 or plan 53A reservoirs in stock and ready for fast delivery. These reservoirs satisfy the API 682 guidelines and are designed to ASME VIII div 1 standards, in accordance with the Pressure Equipment Directive (P.E.D.).
Both the first and second edition of API 682 contain clear design guidelines for reservoirs that are to be used for API plan 52 or 53A configurations. API plan 52 calls for the use of buffer fluids for “dual unpressurized seals.” In this design, an unpressurized buffer fluid in the reservoir acts as a receptacle for primary seal leakage. For volatile liquids, any leakage evaporates and is vented through an orifice in a controlled fashion. For non-volatile liquids, the primary seal leakage is dissolved into the buffer fluid, which needs to be replaced periodically.

API plan 53A calls for “dual pressurized seals,” in which a pressurized barrier fluid fills the cavity between the two seals. Because the pressure in the barrier system is higher than the seal chamber pressure, pump product is prevented from leaking to the atmosphere.

Connections are present on the Flowserve Flow Solutions reservoirs for the most commonly used components, such as level switches, pressure switches and pressure gauges. Both Flowserve standard components and customer-specific components can be supplied. The standard specification includes a cooling water element, so an extra cooler is not normally required.

The AR material is a composite specially developed for bushings, bearings and wear rings in pumps moving abrasive and erosive substances. The material is also highly resistant to thermal shock and very impact-resistant. This makes it a good alternative to traditional rubber and bronze material.

Ben van Eyndhoven, director of EMA sales for Flowserve Flow Solutions, says, “We have extensively tested the WR and AR materials from Greene Tweed and these tests confirmed what we believed. Pumps run more efficiently when these high-quality composite pump elements are used. This is good news for our clients in the chemical and petrochemical industries.”

Says Robert van de Velde, general manager of Greene, Tweed & Co. Holdings International BV, “We are very pleased with the deal with Flowserve. Worldwide, the company has a great reputation in the field of producing and maintaining mechanical seals for pumps in the process industry. Our WR and AR materials fit well with the high quality products and service offered by Flowserve.”

The best little reference guide in the business

The Flowserve Piping Plan Flip Book

a durable, compact reference book provides concise summaries of the essential piping plans used successfully in today’s process plants

For each piping plan identified in API Standard 682 2nd edition and recommended by Flowserve, each page set of this book shows:

For each piping plan identified in API Standard 682 2nd edition and recommended by Flowserve, each page set of this book shows:

Seal End View
- Suggested view and shows preferred setup configuration

Piping Plan Layout
- Illustrated schematic of auxiliary components

What, Why, and Where
- Diagram piping plans, their purpose, and typical applications

Preventative Maintenance
- Provides general tips to improve reliability and to troubleshoot

• Simplified centrifugal pump shown for all plans
• Shows typical seal arrangements
• Provides general tips to improve reliability and for troubleshooting

Flowserve Flow Solutions Primary Contacts

Argentina, Buenos Aires
Phone 54-11-4709-6800

Australia, Marayong, NSW
Phone 61-2-8822-7100

Austria, Sieghartskirchen
Phone (43) 2274-6991

Belgium, Antwerpen
Phone (32) 3-5460450

Brazil, Sao Paulo
Phone 55-11-4231-6300

Canada, Edmonton, AL
Phone 780-464-1188

Denmark, Allerød
Phone (45) 48 176500

France, Courtaboeuf
Phone (33) 1-69592400

Germany, Dortmund
Phone (49) 231-6964-0

Italy, Cormanio (Milano)
Phone (39) 02-61558.1

Japan, Osaka
Phone 81-72-885-5571

The Netherlands, Roosendaal
Phone (31) 165-581400

Mexico, Tlaxcalca
Phone 52-2-461-6791

Poland, Warszawa
Phone (48) 22-844-7108

Russia, Moscow
Phone (7) 095-777 717

Saudi Arabia, Al Khobar
Phone (966) 3-857-3150

Singapore
Phone 65-6-8465100

Spain, Tarragona
Phone (34) 977-544400

Switzerland, Oensingen
Phone (41) 62-3883088

United Arab Emirates, Abu Dhabi
Phone (971) 2-317141

United Kingdom, Manchester
Phone (44) 161-8691200

United States, Kalamazoo, MI
Phone 269-226-3927

Argentina, Buenos Aires
Phone 54-11-4709-6800

Australia, Marayong, NSW
Phone 61-2-8822-7100

Austria, Sieghartskirchen
Phone (43) 2274-6991

Belgium, Antwerpen
Phone (32) 3-5460450

Brazil, Sao Paulo
Phone 55-11-4231-6300

Canada, Edmonton, AL
Phone 780-464-1188

Denmark, Allerød
Phone (45) 48 176500

France, Courtaboeuf
Phone (33) 1-69592400

Germany, Dortmund
Phone (49) 231-6964-0

Italy, Cormanio (Milano)
Phone (39) 02-61558.1

Japan, Osaka
Phone 81-72-885-5571

The Netherlands, Roosendaal
Phone (31) 165-581400

Mexico, Tlaxcalca
Phone 52-2-461-6791

Poland, Warszawa
Phone (48) 22-844-7108

Russia, Moscow
Phone (7) 095-777 717

Saudi Arabia, Al Khobar
Phone (966) 3-857-3150

Singapore
Phone 65-6-8465100

Spain, Tarragona
Phone (34) 977-544400

Switzerland, Oensingen
Phone (41) 62-3883088

United Arab Emirates, Abu Dhabi
Phone (971) 2-317141

United Kingdom, Manchester
Phone (44) 161-8691200

United States, Kalamazoo, MI
Phone 269-226-3927

© 2004 Flowserve Corporation