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VOL. 13, NO. 3

FLOWSERVE

Face to Face

THE SEALING TECHNOLOGY MAGAZINE

The cutting edge

Laser machining technology improves the micromachining of mechanical seals

Breakthrough in sealing technology laser machining

Flowserve leads the way

The Dallas, Texas-headquartered Flowserve Corp. is pioneering new dimensions of micromachining for mechanical seal faces through the use of laser machining technology.

"Although we manufacture several different types of microfeatures for mechanical seal faces, there were limitations on what we could produce. So, about three years ago, we set out to explore the use of laser technology," explains Lionel Young, specialized technology manager at Flowserve's Temecula, Calif. facility.

The company did considerable research on the many types of laser technology available, then chose one closest to its needs. It then designed and built, in-house, a complete manufacturing system around the laser at 1/10th the cost of an outside vendor to do the work.

"The laser technology allows us to do a number of things we could not do before," says Young. "For instance, we can now produce very uniform patterns. A laser pattern is repeatable, so any number of repetitions is exactly the same." The laser significantly improves surface finish, is capable of making novel patterns, and is not limited to the kinds of microfeatures that could be made before. "Finally, the time needed to move from pattern concept to prototype is much shorter," Young says. "Before, this process could take weeks. But now with in-house developed computer code, we can make new patterns within minutes." The variety of laser-machined faces includes T-Groove, APGS, GSL /GTS/GSS with OD waves, SLM 6200 with ID waves,and GSG with HST features.

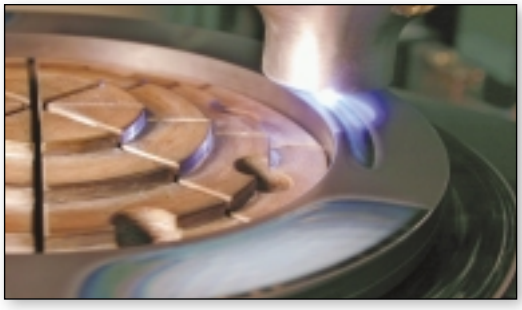
The real world

To turn to some case histories, consider first a Canadian Pipeline application in which both crude oil and NGL run in batch mode. "Normally you design a seal for one service or the other," says Young. "It's very difficult to have the same seal work for crude and a light hydrocarbon, such as NGL."

"This is a particularly harsh environment for a mechanical seal, explains Young. "The crude oil has abrasive properties; there are frequent starts and stops (well over 200 to date); and there is wide pressure variation, from 100 to 1,400 psi."

This application depends on the Flowserve HDHW 4500 seal, with a GSL 4437 backup, and uses silicon carbide against silicon carbide with waves on the primary face. Young says that conventional seals performed poorly. But this laser variation, when last checked in August, had lasted two years without a problem. At year end, 12 seals were in operation in Canada, and 18 in the U.S.

In another Canadian Pipeline application, which runs a crude oil/ethane batch, the seals endure abrasive conditions and pressures ranging from 400 to 1,000 psi. A special problem is the specific gravity, which has a wide range from 0.85 to 0.44. "Ethane is hard to seal because it tends to go into a gaseous form between the faces," says



Flowserve Corp. is pioneering new dimensions of micromachining for mechanical seal faces.

Young. When that happens, the pumped fluid no longer provides lubricity. The Flowserve HDHW 5500, with a GSL 5250 backup, also features silicon carbide against silicon carbide, with laser machined waves on the stationary face. Four such seals are in operation at four stations. "They've just pulled one set of seals out after more than 5,000 hours of operation, and the faces are in

excellent condition," Young reports.

Multiphase seals

Young describes a multiphase application in Venezuela, which pumps crude oil directly from the ground, as an extremely tough operation. The crude oil contains gas, water and sand, which makes it hard to pump and hard to seal. "Previously we had not been able to build seals for this application," says Young.

The process temperature on this twin screw pump, 90 to 125˚ F (32 to 52˚ C) is not that bad, and uses a low shaft speed of 900 rpm. The problem is the pressure; not so much the 90 psi steady-state pressure, but rather the 750 psi at start-up. "This is a big problem because the crude is so viscous," says Young. Again, the wavy seal faces from the laser machining operation solved the problem. The first seals were installed in December, 2001, and are still operating. "Our competitors are still having difficulty putting seals on similar work," says Young.

Boilers

Flowserve also has designed and tested seals for boiler circulation and boiler feed applications in power plants. "In boiler circulation application, the difficulty is the high pressure, 2,800 psi, and because the fluid is water, it's a tough service," says Young. "What most vendors try to do is put carbon against silicon carbide. What we've done is run silicon carbide against silicon carbide, with the addition of wavy face technology. This seal is a Tandem DHTW 4250. Ordinarily, running silicon carbide against silicon carbide tears up faces rather quickly under these conditions. With wavy hydrodynamic features, ours run so the faces don't touch—which means they can run for a very long time."

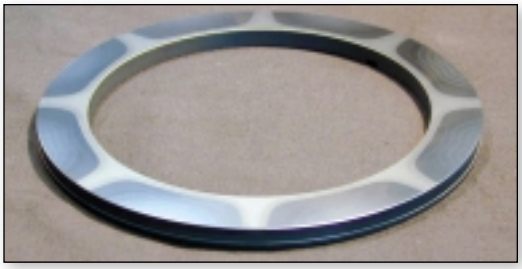
The boiler feed application is difficult because it requires good performance at moderately high pressures (600 psi) but high speeds (5,000 to 6,000 rpm) and temperatures potentially greater than 400˚ F. The proposed seal was a DHTW 6750, (again with wavy SiC against SiC). Test results showed successful operation at pressures to 585 psi, water temperature to 400˚ F and speeds to 5,555 rpm.

Gearboxes

New at Flowserve is its GSG seal

a non-contacting zero-leakage gearbox seal for integrally geared API pumps and compressors. "API pumps and compressors equipped with integral gearboxes, have had various degrees of success when it came to performance of gearbox seals," says Young. "One problem is that the carbon face can develop blisters resulting in oil leakage."

Studies done in the Temecula test facility and verified through research at University of Western Michigan have shown that blistering is the result of sudden starts in an oil environment. Under usual conditions, when a carbon face runs against a tungsten carbide face, oil impregnates itself into the carbon. As the faces rotate says Young, "the shear of the oil develops enormous forces that cause carbon blistering.The more viscous the oil, the more severe the blistering. The GSG gearbox seal features a silicon carbide stationary face that incorporates laser machined HST features (Hydrodynamic Surface Tension) and a tungsten carbide rotating face.



Laser technology has helped Flowserve develop a number of new seals.

Another Flowserve innovation is Hydrodynamic Surface Tension Technology. "It's the combination of two principles," Young says. "One involves the use of wave technology to create non-contacting face operation, and the other is a series of concentric face grooves that take advantage of surface tension principles to eliminate leakage. The grooves cause gas to separate from the oil and form liquid bands at the land regions between grooves. Surface tension allows each band of liquid to support a pressure drop. The amount of pressure drop is a function of the fluid type and film thickness. For oil in this application, a proprietary computer code has calculated the pressure drop capability to be approximately three psi per liquid band. When the seal is in static mode, leakage is eliminated because of intimate contact of the faces."

"When we run the laser machined HST face against the tungsten carbide, the faces don't touch," says Young. "In conventional terms, having seal faces not touch with zero leakage is an oxymoron. If they don't touch, there is no sealing and you have leakage. What we have now is a non-contacting seal with zero leakage and it would not have been possible without the advent of laser micromachining." The GSG was tested at speeds ranging from 8,000 to 40,000 rpm for as long as 1,700 hours with no measurable wear and no measurable oil leakage. Almost 200 GSG seals have been installed since its introduction.

"Laser machining is a growing part of our business and we are exploring the use of HST technology as well as other unique face microfeatures in various applications," says Young.

From extreme job security to extreme reliability

You see, seals are the key to moving crude oil

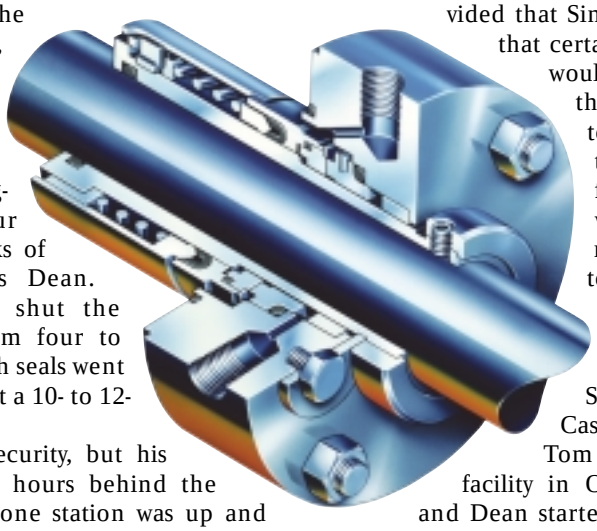
Sinclair Pipeline is the business unit that transports crude oil its parent company purchases. The flow suffers frictional losses during every inch of its travel through the long pipelines moving it to the company's refineries. Spaced every 80 to 100 miles, pumping stations boost pressure to keep the black gold flowing.

In each station, multi-stage, high-pressure pumps boost pressure as high as 2,000 psi before returning it to the eight- or ten-inch pipelines. Pressure in the pump's two seal chambers regularly runs 500 to 1,000 psi.

The person behind the pumps

Alan Dean, Sinclair's master mechanic, keeps the oil moving. In 1990, he was in charge of maintenance for five pumping stations in Wyoming.

"We were averaging between four days and two weeks of seal life," reports Dean. Each seal failure shut the pipeline down from four to eight hours. "If both seals went out, I was looking at a 10- to 12-hour day," he adds.



Dean had job security, but his was a life of long hours behind the wheel. As soon as one station was up and running, a seal three hours away would fail. Off he would go. Drive and repair, drive and repair. For years, his was a never-ending, full-time job that kept him away from home too many weekends.

The cause

Dean realized the root cause was grit. Several pumps originally had been used for diesel fuel and gasoline, both very clean liquids. Now, the reliability was not stellar. The OEM seals for light hydrocarbons can't handle the harsher crude.

At each station, Dean kept component parts for rebuilding seal cartridges. After a repair, he sent the failed components to be refaced. Dean also experimented with combinations of face materials, ever searching for the Holy Grail.

Then Dean met Howard McDonald, Flowserve's representative covering the territory in which Sinclair operated. McDonald suggested using a Flowserve UC seal, a canned seal featuring an encapsulated graphite gasketed silicon carbide rotating face against a tungsten carbide stationary face. It's designed, McDonald explained, to minimize the probability of hang-up from packed solids. It's rated at 1,000 psi and can be modified to handle 1,500 psi.

Field testing

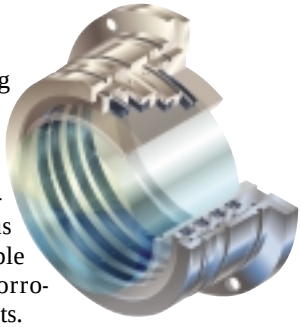
McDonald offered Dean a pair of seals to test. He also offered a six-month warrantee, provided that Sinclair could guarantee that certain process conditions would always be met and that Dean used only factory-assembled seal cartridges. "That's better for me," says Dean, who arranged for management approval to test the seals on that lone pump.

The seals shipped in mid-winter to Sinclair's Station I in Casper, Wyo. Assisted by Tom Rice from Flowserve's facility in Oklahoma, McDonald and Dean started installing the seals. In mid-process, an adjacent pump started leaking. With the performance test not even begun, Dean asked McDonald to provide a seal set for his newest leaker. Four days later, the second set was delivered and installed.

Within six months, another pump in Casper suffered four seal failures. That's when Sinclair management said "Go" and started using Flowserve UC seals. "We're getting one and one half to two years life from the new high-pressure seals," says Dean. "As of now, every crude unit we have has Flowserve seals on it." Incidentally, the original set of UC seals Sinclair installed to verify the performance are still in operation, five years later.

Presenting...

Flowserve's Circpac MD and Circpac HP seals



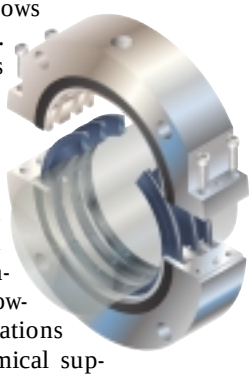
The Circpac family of dry running seals are segmented circumferential seals designed for low gas consumption using pressure balanced rings and hydrodynamic surface features. Standard designs consistently outperform packing, bushings, labyrinths, and similar seals over a range of operating conditions. Although they share the same basic seal technology, Circpac MD and Circpac HP seals compliment each other to satisfy a diverse range of equipment types and application conditions. The Circpac MD—Multiple Duty—runs in many types of services and combinations of conditions. The Circpac HP—High Performance—runs at the highest pressure and speed limits.

Features/benefits...

Floating circumferential rings are engineered for long-term, reliable performance. Their? hydraulically balanced rings with hydrodynamic surface features extend the maximum pressure, temperature and speed limits beyond conventional circumferential seal designs.

Robust carbon rings are designed with foul-resistant joints and large bearing pads to maintain integrity during off-design operation including oil-flooded conditions.

Materials of construction are selected for application compatibility. Various material grades are available to meet temperature and corrosion resistance requirements.



Lower gas consumption allows simplified gas control system. Circpac operating cost is less than typical circumferential or labyrinth seals.

Control panel...

An engineered control panel distributes filtered buffer and barrier gas with pressure control and flow monitoring. Flowserve offers standard configurations that provide reliable, economical support for seals and will custom engineer panels to meet customer specifications.

Contact Flowserve for extended conditions, alternate materials or custom configurations.

Seal	Circpac MD	Circpac HP
Equipment	Fans, blowers, dryers, turbines, centrifuges, refiners, augers	Screw and centrifugal compressors
Industries	Petrochemical, waste water, power, pharmaceutical, refining	Petrochemical, refining, pipeline
Standard operating parameters...		
Pressure	Vacuum to 100 psi	Vacuum to 150 psi
Temperature	to 1,100˚ F	to 350˚ F
Speed	to 150 fps	to 300 fps
Sizes	1.375 to 18.000 in.	1.000 to 11.000 in.
Materials of construction...		
Ring	Carbon graphite	Carbon graphite
Housing	Stainless steel or Ni Cr alloy	Stainless steel, Ni Cr alloy, or NACE-compliant
Garter spring	Ni Cr alloy	Ni Cr alloy or NACE-compliant
Axial springs	None	Ni Cr alloy or NACE-compliant
Sleeve	None	Hard coated stainless steel, Ni Cr alloy or NACE-compliant
Gaskets	Elastomer, fiber, graphite	Elastomer, fiber, graphite
Configurations	Single, double, triple	Multiple custom variations with modular ring units
Split housing	Standard	Optional
Leakage rates	Estimated	Guaranteed
Radial clearance	As much as 0.25 in.	0.032 in.
Upgrade to...	Circpac HP	Gaspac (face seal)

Confused by the names?

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