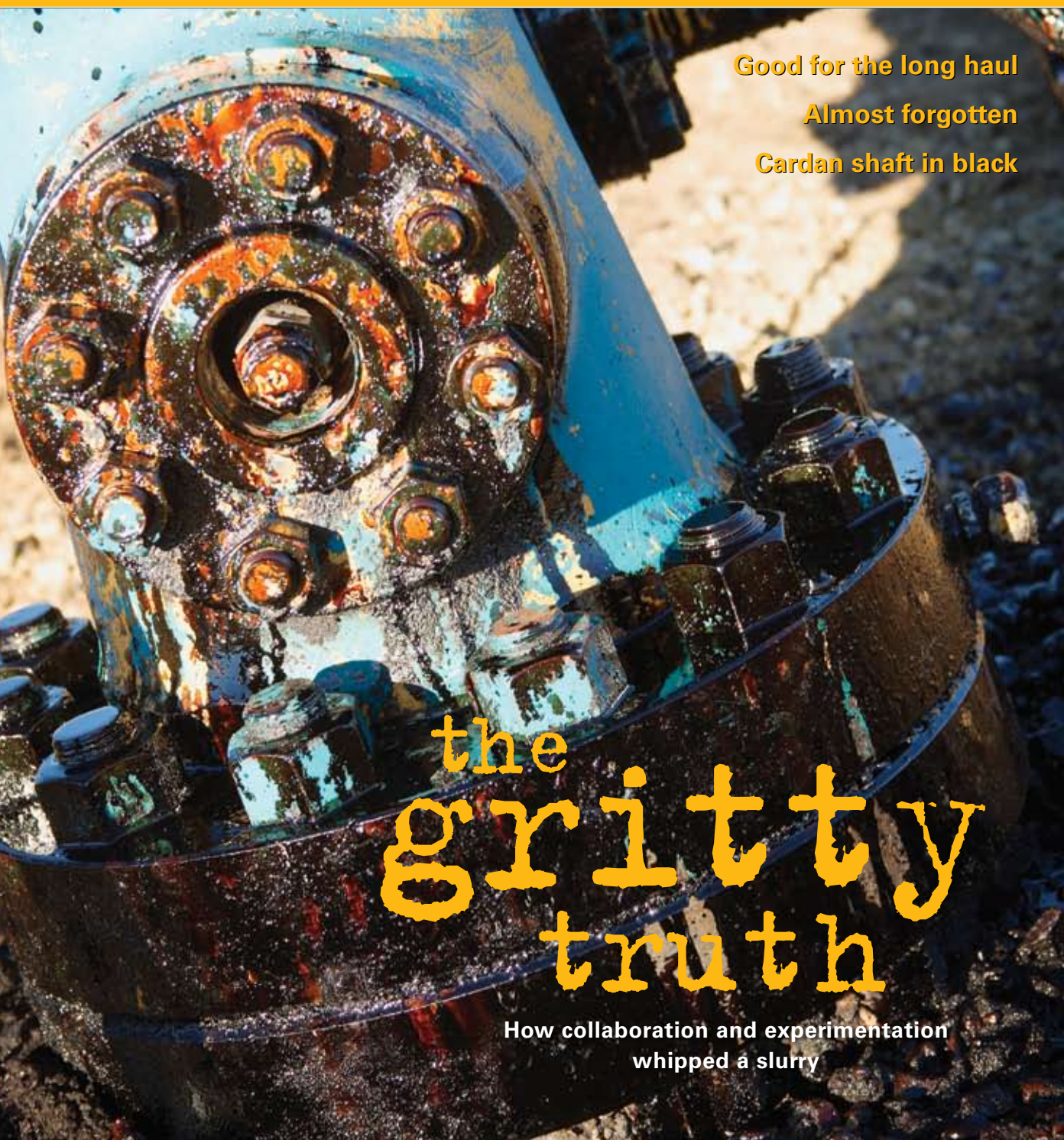
FLOWSERVE

Vol. 18 No. 2

Face to Face

THE SEALING TECHNOLOGY MAGAZINE



Good for the long haul

Almost forgotten

Cardan shaft in black

the gritty truth

How collaboration and experimentation whipped a slurry

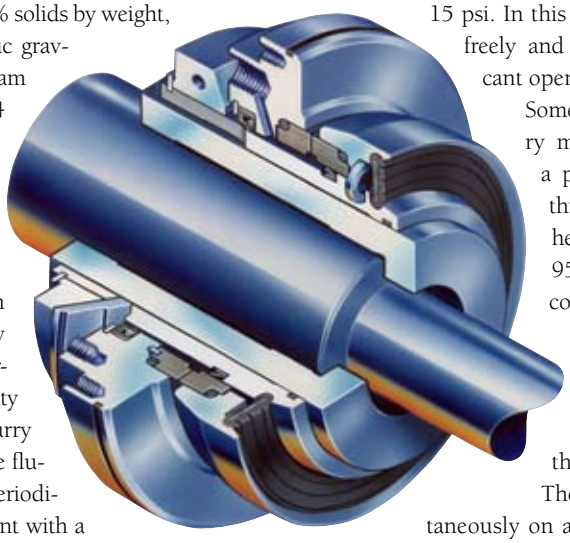
The gritty **truth**

How collaboration and experimentation whipped a slurry

Thermphos UK Ltd. is a producer of phosphorus, phosphoric acid, phosphates and phosphorus derivatives for a variety of applications. It operates on a 60-acre site in Oldbury, near Birmingham in England's West Midlands. The 77 employees, 20 of whom are in maintenance, annually produce 30,000 tons of phosphate materials.

During 1994, the facility upgraded its tricalcium phosphate plant. Part of the project involved replacing a rotary vacuum filter with a Svedala tube press system to improve productivity in handling calcium phosphate slurry.

The slurry has 20% solids by weight, giving it a 1.2 specific gravity. The process stream has a pH between 4 and 5 and flows at a temperature of 80°C. Because of variations in raw material, the slurry texture can range from a prototypical grainy slurry-like appearance to a creamy/fatty texture. Also, the slurry causes scaling and the fluid handling system periodically requires treatment with a boiling phosphoric acid solution.



The slurry feed pump in the tube press must move 25 m^3/hr. (92 gpm) at 60 m (197 ft.) discharge head. From the moment the new processing system was commissioned, the manufacturer's original feed pump proved to be troublesome. "The slurry is very abrasive," said 35-year professional Alan Ostojitsch, the Thermphos plant engineer. "It attacks stainless steel. The packing erodes and it leaks."

This required almost constant attention. "When the seals leaked, we dismantled the pump and replaced it," added Ostojitsch. Aside from frequent replacements, the pumps were noisy. Slurry-induced abrasion very quickly wore through the internal parts. The gland area constantly leaked, maintenance was difficult, spare parts were expensive, and the supply chain for obtaining them was unreliable.

Process

The slurry pump runs fully flooded, fed from a holding tank. It has three operating modes. When the system is idling, the slurry recirculates through a header located 15 m (49 ft.) above the pump. The discharge head in this mode is about 14-15 psi. In this mode, the slurry moves freely and doesn't present significant operational problems.

Sometimes, however, the slurry must recirculate through a plate heat exchanger. In this mode, the discharge head ranges from 15 psi to 95 psi, depending on the condition of the heat exchanger internals.

It is in the third mode, feeding the tube presses, where the action takes place. The presses operate simultaneously on a five-minute cycle. The pumps require anywhere from 25 sec. to 100 sec. to load the presses, depending on the age of the filter cloth, the number of filter tubes in operation and the physical properties of the slurry.

It is illustrative to examine the extreme conditions. The filter can be charged in 25 sec, if the slurry is thicker, the filter is using only one filter tube and the cloth in that filter is partially blinded. This situation requires minimal flow, and the discharge pressure rises within eight seconds to a maximum of 105 psi, where it stays for the remaining 17 seconds.

Ancillary benefits

- Reduced the cost of spare pumps from £4,000 (approximately $8,000) in 2005 to zero in 2007
- Significant maintenance labor freed up to be used elsewhere
- Less plant downtime and greater operator productivity
- Stopping the seal leakage reduced effluent and product loss costs
- Environmental improvements from improved visual appearance and noise reduction
- Safety benefits achieved through reduced maintenance, consequential isolations and permit-to-work issues as, statistically speaking, more accidents occur during plant maintenance

The charging cycle extends to 100 seconds when the slurry is thinner or the filter is operating with three tubes, each of which is new or recently cleaned. In this case, the discharge pressure rises to 70 psi within 15 seconds, builds to 85 psi during the next 40 seconds, and slowly increases to 95 psi during the remaining 40 seconds.

Brief history

When the filter system was purchased in 1994, the manufacturer's original slurry pump used a packed gland. This design was noisy, required daily maintenance and had to be replaced monthly. In a 1999 attempt to improve overall reliability, the plant replaced the problematic OEM pump with a 1-1/2 x 1 BAH Warman slurry pump with an expeller, a device that flings slurry away from the bearings. Unfortunately, that unit suffered from similar problems. The only upside to the pump change was that the Warman unit operated for two to three weeks before it exhibited excessive wear, leaks at the gland/expeller and noise. Thermphos generally tolerated the leakage for an additional two weeks before replacing the pump, unless slurry destroyed the bearings sooner.

Tricalcium phosphate crystallizing the seal faces could mimic a dry running condition.

In 2001, the company retrofitted the Warman pump with a double mechanical seal and thermosyphone seal pot. What was supposed to be a spectacular improvement turned into a spectacular failure. The company then experimented with a variety of mechanical seals, most of which apparently failed because of dry running. In 2002, the plant tried a single mechanical seal, which provided no advantage. In 2003, Thermphos reverted to the packing/expeller design.

In 2005, the plant experimented with a Flowserve double mechanical seal, only to see the same dry running failure mode. In 2006, the experiment used a Flowserve single mechanical seal specifically designed for slurry applications. Again, dry running was identified as the failure mode. At this point, Thermphos and Flowserve conferred about the problem pump and hypothesized that tricalcium phosphate crystallizing on the outside of the seal faces could prevent flow across the seal faces and mimic a dry running condition.

Flowserve suggested using a SLC Group 1 single balanced cartridge seal designed for tough slurries. It features a non-clogging cone spring design that increases seal reliability. The addition of a lip seal permitted Thermphos to install a Plan 32 water quench system to flush the seal's external surface and prevent crystallization. The scheme was facilitated by the drain from the water-cooled bearings on an adjacent mill, which could be rerouted to provide the recommended water flow of 2 lpm at 0.2 bar to the proposed seal arrangement.

The idea worked and the pump and seal are still running trouble-free after a year. The only leak now is clean water coming past the lip seal. "I want to see the interior of the pump when we finally take it out of service," said Ostojitsch. "I think there will be nothing left of the insides. The seal will probably be the only thing left. We're more than pleased with the outcome."

It shouldn't be surprising that Thermphos has already ordered a duplicate arrangement for the standby pump.

Cardan shaft in black

Chemical plant quenches vibrations in its cooling tower

A plant in South Wales is the world's largest manufacturer of a class of chemical intermediates that finds its way into many common household products used everyday. The 600 employees produce nearly 9,000 formulations for highly diverse uses in the marketplace.

Situated on the 100-acre (40-hectare) site is a two-cell cooling tower that had been a trouble spot for years. Constructed of timber, the 40-ft.-high tower features a pair of 20-ft.-diameter fans mounted on right-angle gearboxes that have a reduction ratio between 5:1 and 6:1. Each fan is powered by a 22 kW (30 hp) variable-speed motor mounted outside the periphery of the fan tips. The motor speed ranges from about 700 rpm to about 1,450 rpm. Each motor is connected to its respective gearbox shaft by a 4.5 m-long (15 ft.), stainless steel coupling. Only 75 mm (3 in.) in diameter, these couplings exhibit a rather large length-to-width ratio, which, combined with the flexibility of the metal, proved to be the source of a worrisome vibration problem.

At both the low- and high-ends of the motor's speed range, coupling vibration was minimal. But as the motors sped up to about 1,200 rpm, the couplings passed through a region of resonance. The coupling began to vibrate severely and, because of the flexibility of the timber structure, the whole cooling tower began to shake.

This situation was a concern, but it never resulted in any significant downtime. It never demanded intense maintenance efforts or led to repetitive mechanical failures. This was fortunate, because the plant couldn't afford to have the cooling tower offline for very long. Besides, the maintenance department didn't have the time to perform a detailed root cause analysis to determine how to eliminate the vibration. There was, however, the persistent threat of a catastrophic failure should some structural component fail while the coupling was badly vibrating.

Failed fix

When conditions were right, the plant had the opportunity to remove the couplings to allow a machine shop to give them a precision balancing and eliminate any run-out and straightness problems they might exhibit. With the newly refurbished couplings installed, the maintenance staff was sure the resonance and vibration problem was consigned to history. But as soon as the cooling towers were put back into service, the vibration problem reappeared.

In 1999, the plant upgraded its maintenance capabilities to include vibration monitoring. This provided the opportunity to quantify and characterize the cooling tower vibrations. The instrumentation revealed that the maximum vibration veloc-

ity ranged from 16 mm/sec. to 20 mm/sec. (0.63 in./sec. to 0.79 in./sec.). When operating outside the critical middle speeds, the vibration velocity ranged between 3 mm/sec. and 4 mm/sec. (0.12 in./sec. to 0.16 in./sec.).

In late 2005, a confluence of factors solved the vibration problem. That was when the area engineer who was responsible for the cooling tower decided that eliminating the vibration was now a priority. He became convinced that he needed couplings with a different material of construction.

That was also when Wayne Pedlar, Flowserve senior sales engineer, who had a relationship with the plant, was seeking applications for a new line of mechanical couplings. Flowserve at the time was introducing the benefits of its global agreement with coupling manufacturer Autogard.

"Pedlar is a rare breed who knows both seals and couplings," says the plant's rotating equipment engineer. Pedlar offered the plant his expertise and asked if there were any applications for carbon fiber couplings. The cooling towers immediately came to mind.

The time was right

Early in 2006, Wayne talked to the area engineer and they agreed that the time was right. Through the Flowserve connection, the area engineer was able to deal directly with a known vendor instead of going through middlemen to get the new coupling.

The Autoflex High Speed series CT coupling was selected as the replacement. The unit is a 2,750 mm-long (9 ft.) hollow carbon-fiber composite shaft with stainless steel fittings bonded to the ends. With an outside diameter of only 83 mm (3.25 in.), it weighs less than 12 Kg (26 lbs.). These couplings require no lubrication, which minimizes maintenance. They are direct replacements for existing couplings. This minimizes installation problems and operational risk.

After aligning the motor shaft and gearbox shaft with a laser unit, the coupling ends were fitted with flexible elements that can accommodate as much as 0.25 angular degree of residual misalignment. But

it's the rigidity of the carbon fiber coupling shaft that makes a difference in the vibration readings. The carbon fiber composite simply doesn't flex as much as the stainless steel unit flexed.

During the past year, the plant has been monitoring cooling tower drive system vibration, mainly to protect the bearings in the motor and gearbox. "Now, we're getting a vibration of 2.5 mm/sec., worst case," says the plant's rotating equipment engineer. "That is consistent across the motor speed range."

The carbon fiber couplings are no longer a maintenance issue. The plant performs visual inspections on the fans and condition monitoring on the drive system every fortnight. The regimen includes oil analysis to monitor the condition of the gearbox. Every three years, the plant performs a more intense inspection of the entire cooling tower structure to check for corrosion and structural damage and degradation of the resin in the carbon composite by solar ultraviolet or chemical attack. The plant anticipates the couplings will have a service life of at least 10 years of trouble-free operation.

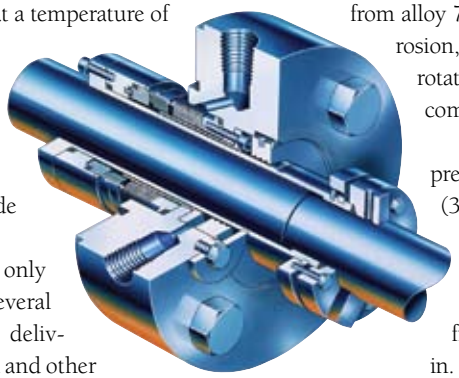
Based on the success of this project, the plant has made carbon fiber couplings an integral part of the engineering specifications for new cooling towers and any renovations to existing units.

Almost forgotten

The true story of a bellows seal that beat the heat for more than a decade

Petroplus operates a bitumen plant in Llandarcy, Glamorgan, South Wales, a town east of Swansea. The facility is on what had been a large petroleum refinery that closed in 1999. Today, the 70-acre (28 hectare) bitumen plant is the only part still operating. Its 65 employees process and ship 25 rail cars of product on a normal day.

Bitumen, a mixture of organic materials, is a viscous, black, sticky material similar in appearance to asphalt used for paving roadways. It is a by-product of the fractional distillation of crude oil. Of the products that come out of the refining process, bitumen is the heaviest and has a high boiling point. Consequently, any pumps, seals, valves and process piping that come in contact with it must be steam-traced and insulated to keep the product freely flowing. Bitumen pumps operate at a temperature of 175°C (340°F) and pressures of about 6 bar (90 psi). A failure of the supplemental heating system would allow the hot, fluid bitumen to thicken to a solid mass inside the pipelines and pumps.



Bitumen is the plant's only product, but it's made in several grades. The raw bitumen is delivered via rail cars from Corinth and other locations. The plant oxidizes some of it with compressed air to make it harder, some is polymerized. The plant then blends various grades to maintain consistency in its customized final products.

Service counts

Petroplus has used Flowserve mechanical seals exclusively for many years. Productivity is one reason why. "The plant rarely suffers significant downtime attributable to mechanical seal failure," says Alun Richards, the Petroplus plant engineer. Flowserve makes this possible by keeping stocks of the required seals at its own warehouse. "I need only to call Flowserve to secure replacement seals," adds Richards. In response to the call, Wayne Pedlar, Flowserve senior sales engineer, arranges to have new seals and any needed repair parts on-site at Petroplus within 24 hours.

In 1992, the plant established a policy of using only pusher seals on the bitumen pumps. This decision resulted in field trials with a series of Flowserve pusher seals. But none lasted for more than a few weeks at the high-temperature service conditions.

After considering the available options, Petroplus agreed to deviate from policy and try a Flowserve BXRH high-temperature stationary bellows seal. This particular unit features a semi-cartridge design that simplifies installation, graphite gasketing that handles the temperature, a bellows fabricated from alloy 718 to prevent potential corrosion, and Type 316 stainless steel rotating parts. The BXRH seal complies with API 682.

The BXRH seals handle pressures as high as 20 bar (300 psi), temperatures to 427°C (800°F) and surface speeds to 46 m/sec (150 ft/sec). They fit shaft sizes from 25 mm to 101 mm (1 in. to 4 in.). Because the bellows is stationary, the BXRH seal can tolerate higher speeds and some misalignment.

Petroplus installed its first BXRH seal on a bitumen pump in December of 1992. Initially, the seal was the subject of close monitoring, but it exhibited no obvious symptoms of failure. As it continued to operate without incident, its priority ebbed and it was soon off the radar screen. Such was the situation until April, 2007, when the seal flange drain port became blocked. That's when Richards realized that the BXRH seal served more than 15 years without a problem. And, that problem was only a minor one, easily resolved with a simple cleaning.

The **long haul**

A chemical plant profits greatly by using the Life Cycle Advantage program

A major chemical plant on Spain's north Mediterranean coast manufactures polymers in several of the plants on its campus. In response to increased demand for its chemicals during the past three years, the plant was forced to increase staffing by more than 30% to about 600 people.

The gas and steam turbines, centrifugal and reciprocating compressors, mixers and pumps operate at widely varied temperatures, pressures and flow rates. Because much of this equipment relies on mechanical seals, the plant protects the seals on 10 blowers, 48 mixers and more than 600 pumps with the Flowserve LifeCycle Advantage™ program.

The start

As recently as 1998, 95% of the mechanical seals were competitor's units. But the plant was unhappy with the prices, delivery and quality. That same year, the plant agreed to a Flowserve fixed-fee LifeCycle Advantage program as a reasonable alternative.

Nobody realized the program would turn into a long-term relationship operating under a global umbrella agreement. The key to success has been the culture of teamwork that developed between the plant staff and the Flowserve representatives. Membership in the long-term initiative changed over time, and each new person involved with the program embraced the culture established earlier.

The KPIs

Another reason the LifeCycle Advantage program has endured is its practical operational results. For example, the mean-time-between-repairs for seals has increased from 26 months to 42 months.

Production is paramount. When equipment needs new seals, they're needed immediately. The LifeCycle Advantage program has reduced its standard delivery time to 24 hours. If critical equipment needs seals, the program shifts to a four-hour delivery schedule. But getting seals quickly still isn't sufficient. The seals must be functional right out of the box. The Flowserve LifeCycle Advantage program drove seal quality issues to zero, according to the program records.

Strategy and tactics

A strategic advantage of the program is the institutionalized learning gained over time. Having an evolving set of tools to control program performance gives ability to manage in an increasingly professional manner. Team-building is enhanced by regular meetings to share information, procedures and expectations; to define and review goals; and to provide feedback.

Effective troubleshooting reduced the number of bad-actor seals and allowed the team to tighten the criteria that defines a bad actor. This has had a positive effect on uptime, profitability, material cost, inventory and fixed costs.

The Flowserve commitment to a four-hour emergency response hasn't been breached even once. Standardization and inventory optimization achieved this goal, and the Flowserve Quick Response Center has played a critical role when hardware needed to be manufactured."

The plant can link the LifeCycle Advantage program to a quarterly savings of as much as €50,000, better mean-time-between-repairs and reduced leak rates, cost and lead time. "The plant is very happy," says Ricardo Comenge, Flowserve area sales manager. "To them, we are their seal solution provider. They have subcontracted everything related to seals - service, know-how, training. Our team leads in these aspects."

A testament to program effectiveness, the plant uses Flowserve to support equipment that's outside the original scope of work. The performance of the LifeCycle Advantage program was so valuable that the plant now uses only Flowserve seals on the 250 pumps and mixers at its two newest plants.

FLOWSERVE

A global leader in fluid motion and control

Flowserve products and solutions are well recognized and play key roles in the oil, gas, chemical and power markets.

A wealth of products, systems, solutions and services

The Flowserve reputation is based on experience to deliver industrial and highly engineered pumps, precision mechanical seals, and various control valves and valve actuators.

That reputation is by delivering life cycle management services and a full range of training and engineering solutions.

Unmatched global reach with a truly local presence

Flowserve people, processes and experience help leading companies in more than 70 countries worldwide.

To learn more, visit www.flowserve.com