Pipeline Transportation Pumps
Crude Oil, Refined Products and NGL • Water • Slurry

Experience In Motion
Flowserve offers innovative pumping solutions for every conceivable pipeline application, including oil, refined products, natural gas liquids (NGLs), carbon dioxide (CO₂) liquid gases, water and slurry services. With more than 200 years of industrial pump experience and 100 years of pipeline pumping experience, Flowserve has earned a preeminent position in the industry through advanced design, engineered solutions, equipment re-rates and customer service excellence.

Customers all over the world turn to Flowserve for creative solutions that improve pipeline:

• Safety
• Lifecycle cost
• Profitability
• Reliability

Case study: Hydraulic re-rate

Installation: DVS single-stage, double-suction horizontal split case pumps on a 645 km (400 mi) pipeline in northwest United States to transport gasoline, diesel and jet fuel. Pipeline diameters: 300 mm (12 in) through 500 mm (20 in).

Problem: Over the years, pump flow rate had been significantly reduced, running at 46% BEP. In addition to lower efficiency, high vibration levels increased maintenance and operating costs.

Solution: Hydraulic re-rate to match lower current rated duty
• Replace impeller with lower flow design
• Reduce volute area to pull back BEP
• Increase volute cutwater diameter (“B” gap)

Benefits:
• Normal flow rate at 96% BEP
• Energy savings >135 kW (180 hp)
• Increased MTBR, resulting in maintenance savings
A complete range of pipeline pumps

Crude oil, refined products and NGL pipeline pumps

Mainline/booster pumps
- Single- and two-stage between bearings
- Multistage, horizontal split case
- Multistage, radially split double case
- Multistage vertical canned
- Twin screw multiphase

Auxiliary pumps
- Single-stage overhung
- Vertical in-line
- Submersible motor
- Single-stage and multistage vertical wet-pit
- Single-stage and multistage vertical canned
- Service-specific specialty designs

CO₂ pipeline pumps
- Single-stage, between bearings, radially split
- Multistage, horizontal split case
- Multistage, radially split double-case

Water pipeline pumps
- Single- and multistage overhung
- Axially split, single-stage between bearings
- Vertical turbine
- Submersible motor
- Horizontal, multistage ring section

Slurry pipeline pumps
- Single-stage overhung
  - Hard metal
  - Metallic and non-metallic lined

All the expertise you need

Flowserve has the expertise to serve as the overall systems manager for pipeline operations. Working with architect and construction firms or in-house design teams, Flowserve provides turnkey services, pump-specific diagnostics, maintenance and repair, and a full spectrum of technical services — including full-system analysis using dedicated pipeline design software — to optimize the return on pipeline investment.

Whether new equipment or system upgrades, Flowserve aggressively advances pipeline pump technology. Further information about system and equipment upgrades may be found beginning on page 14.

Market-focused customer support

Flowserve pipeline specialists provide customers the technical support necessary to develop effective solutions for tough pipeline challenges. These solutions can incorporate all manner of specific market and customer preferences. They offer technical advice and assistance throughout each stage of the product lifecycle. From feasibility through pipeline design, inquiry through order fulfillment, installation through startup and pipeline re-rates, Flowserve specialists work with customers to successfully achieve their operational goals.
Crude oil, refined products and NGL pipeline systems

Flowserve is the industry’s preferred supplier of petroleum product pipeline pumps. Reliability makes Flowserve pumps the products of choice for unattended mainline operation in some of the world’s most inhospitable environments. No other manufacturer offers a comparable breadth of products and services for transportation, transfer, storage and cargo stripping. Flowserve has reliable and cost-effective solutions for the most demanding upstream and downstream pipeline applications.

Offshore pipelines

Flowserve offers a complete line of single- and multistage pumps in either axial or radially split configurations. These pumps are perfectly suited for main oil line, transfer and tanker loading on offshore platforms. With a history of operating pumps at capacities up to 9500 m³/h (41,825 gpm) and differential heads to 6000 m (19,685 ft), Flowserve has the proven products capable of moving crude oil directly from the platform to marine terminals or waiting tankers. And Flowserve is the only manufacturer offering the safety and reliability of shaft seals to ISO 21049/API 682.

NGL pipelines

Because of their volatility and flammability, natural gas liquids can be more challenging to move than refined petroleum products. Flowserve offers numerous safe and cost-effective pumping systems that are well-suited to the demands of transporting NGLs from remote processing plants to end markets. Pump types include axially or radially split units in single and multistage configurations.

CO₂ pipelines

Flowserve has a significant amount of pioneering experience in the design and supply of pumping equipment for the transportation, injection and re-injection of CO₂. This capability is the result of: prior work on other near and supercritical fluids; and the development, design and supply of the pumping equipment for several CO₂ enhanced oil recovery projects. Pumps typically used in this application include horizontal axially split and radially split multistage pumps as well as specially designed high-pressure, single-stage pumps. (See bulletin FPD-17 for more information.)

Experience: Refined products pipeline

Installation: More than 300 DVS single-stage, double-suction horizontally split case pumps (sizes 24 x 27, 24 x 29, 30 x 27 and 30 x 29) with driver sizes up to 3730 kW (5000 hp).

Application: One of the world’s largest products pipelines, 4665 km (2900 mi) from the Gulf Coast to mid-/northeastern United States. Pipeline diameters: 900 mm (36 in) through 1050 mm (42 in).
**Diluent/bitumen, froth transfer and synthetic crude pipelines**

Flowserve pumps are especially suited to the unique requirements of diluent/bitumen service for steam-assisted gravity drainage (SAGD). Through extensive knowledge of heat tracing and variable-speed operation along with close working relationships with Flowserve seal experts and other mechanical seal suppliers, Flowserve pumps are custom-designed to suit each application. Typical models for this service include vertical canned and horizontal single- and multistage split case pumps.

In tar sands mining, Flowserve high-pressure, hard metal slurry pumps feed a mixture of air, water and bitumen down a pipeline from the sand extraction plant at the mine to the base plant for further extraction and refining. From there, axially split single- and multistage pumps transport the synthetic crude to the refinery.

**Products cavern and well storage transfer terminals**

Flowserve leads the way in providing vertical wet-pit and submersible motor pump solutions for direct storage transfer pumping applications in salt dome and cavern services. Additionally, horizontal single- and multistage pumps offer excellent injection solutions for indirect storage transfer applications.

**Crude oil and products supply pipeline and terminals**

Flowserve takes pride in its breadth of products designed for the transportation, transfer, storage and cargo stripping of crude oil and finished products for the pipeline market. With models ranging from pipeline sampling pumps to large radially split barrel mainline pumps, Flowserve can provide a cost-effective solution for all terminal and pipeline applications.

**Ship, tank car and truck loading terminals**

With a full line of ISO 2858/5199, ANSI B73.1, ISO 13709/ API 610, DIN and JIS compliant designs, Flowserve maintains the largest family of pumps to address any terminal application.

Low-NPSH pumps in both horizontal and vertical configurations are also available for booster-station service.
From the producing fields to the market, Flowserve has the pipeline pump solution

1. DVSH, LPN or LPLD (BB1)
   Axially split, single-stage

2. UZDL (BB1)
   Axially split, two-stage
   BFD (BB1)
   Double-suction

3. DVS R (BB2)
   Radially split, double-suction, single-stage

4. DMX (BB3)
   Axially split, multistage

5. WCC or WIK (BB5)
   Multistage, diffuser collector, barrel casing, volute collector

6. HDO or HSO (BB5)
   Multistage, volute casing, process barrel

7. WUJ or VTP (VS1)
   Wet-pit

8. VPC or WUC (VS6)
   Vertical, double-case diffuser
   QL (VS7)
   Vertical, double-case volute
SUBM – deep-well submersible
Byron Jackson® oil-filled

ESP3 or CPXV (VS4)
Vertical immersion sump

MP1
Multiphase

HPX (OH2)
Centerline mounted

HPX-V (OH3)
Vertical in-line

DSVP (OH4)
Double-suction vertical in-line

Mark 3™
ASME B73.1 and ISO 2858 standards

Type M
Hard metal slurry
**Mainline pumps**

**DVSH, LPN and LPLD (BB1) axially split, single-stage**
- Flows to 15,000 m³/h (65,000 gpm)
- Heads to 565 m (1854 ft)
- Pressures to 150 bar (2175 psi)
- Speeds to 6000 rpm

**UZDL (BB1) axially split, two-stage**
- Flows to 2950 m³/h (13,000 gpm)
- Heads to 685 m (2250 ft)
- Pressures to 64 bar (910 psi)

**DVSR (BB2) radially split, double-suction, single-stage**
- Flows to 6585 m³/h (29,000 gpm)
- Heads to 330 m (1080 ft)
- Pressures to 260 bar (3750 psi)

**DMX (BB3) axially split, multistage**
- Flows to 5621 m³/h (24,750 gpm)
- Heads to 2620 m (8600 ft)
- Pressures to 275 bar (4000 psi)
- Speeds to 6000 rpm

**WCC and WIK (BB5) multistage, diffuser collector, barrel casing**
- Flows to 4000 m³/h (17,610 gpm)
- Heads to 3050 m (10,000 ft)
- Discharge pressures to 650 bar (9425 psi)
- Speeds to 8600 rpm

**HDO and HSO (BB5) multistage, volute collector, barrel casing**
- Flows to 4000 m³/h (17,610 gpm)
- Heads to 5365 m (16,000 ft)
- Discharge pressures to 450 bar (6525 psi)
- Speeds to 9000 rpm

Note: The above values indicate the typical performance envelope for the models listed. Flowserve has significant experience beyond these limits. Consult your Flowserve representative with your specific performance requirements.
Auxiliary services pumps

**HPX (OH2)**
Centerline mounted
- Flows to 2000 m³/h (8800 gpm)
- Heads to 350 m (1100 ft)
- Pressures to 80 bar (1160 psi)

**HPX-V (OH3)**
Vertical in-line
- Flows to 1200 m³/h (5200 gpm)
- Heads to 325 m (1070 ft)
- Pressures to 42 bar (600 psi)

**Mark 3 ANSI and ISO**
- Flows to 4540 m³/h (20,000 gpm)
- Heads to 220 m (720 ft)
- Pressures to 27 bar (400 psi)

**ESP3 and CPXV vertical immersion sump**
- Flows to 1400 m³/h (6160 gpm)
- Heads to 250 m (820 ft)
- Pressures to 25 bar (365 psi)

**WUJ and VTP (VS1) wet-pit**
**WUC and VPC (VS6) vertical turbine, double casing**
- Flows to 13,600 m³/h (60,000 gpm)
- Heats to 2000 m (6560 ft)
- Pressures to 200 bar (2900 psi)

**Byron Jackson SUBM deep-well submersible (oil-filled design)**
- Flows to 6000 m³/h (26,415 gpm)
- Heads to 800 m (2625 ft)
- Motor sizes to 1650 kW (2200 hp)
- Speeds from 1000 to 3600 rpm

**Specialty designs**
- In-line, double-suction
- Multistage, axially split, double-suction
- Abrasive slurry pump
- Positive displacement two-screw
Flowserve traces its history to the late 1790s when its Simpson heritage brand began applying steam pumping engines to municipal waterworks in the United Kingdom. Today, Flowserve pumps are used extensively in:

- Source water and transmission
- Treated water distribution
- Irrigation

Where surface water or groundwater is not readily available, pipelines are required to transport water from alternate sources to its destination.

Flowserve offers the industry’s most complete and diverse line of water transmission and distribution pumps, including:

- Horizontal, axially split, single-stage
- Horizontal, radially split, end suction single-stage
- Horizontal, axially split multistage
- Between bearings, ring section multistage
- Overhung product-lubricated, ring section multistage
- Submersible motor
- Short-coupled, vertical turbine

**Case study: Middle East pipeline**

**Installation:** 22 DMX axially split, two-stage pumps (24 x 28) with driver sizes to 16,780 kW (22,500 hp) delivering 1.6 million bbl/d at heads to 625 m (2050 ft). Casing weights total equal 13,610 kg (30,000 lb).

**Application:** 1200 km (750 mi) pipeline across rugged terrain in the Middle East. Pipeline diameter of 1400 mm (56 in).

**Challenge:** Maintain problem-free operation across all flow range requirements.

**Solution:** Employ computational fluid dynamics to analyze and optimize impeller blade geometry.

**Result:** New impeller design demonstrated no cavitation, far exceeding previous industry acceptance criteria for high-energy impellers.
Water pipeline pumps

**LNN axially split, single-stage**
- Flows to 30,000 m³/h (132,000 gpm)
- Heads to 300 m (985 ft)
- Pressures to 40 bar (580 psi)

**MEN end suction**
- Flows to 800 m³/h (3520 gpm)
- Heads to 140 m (450 ft)
- Pressures to 16 bar (230 psi)

**F-Line end suction, multistage**
- Flows to 500 m³/h (2200 gpm)
- Heads to 250 m (820 ft)
- Discharge pressures to 25 bar (365 psi)

**VTP vertical turbine**
- Flows to 13,600 m³/h (60,000 gpm)
- Heads to 700 m (2300 ft)
- Sizes from 150 to 1375 mm (6 to 54 in)

**Byron Jackson SUBM deep-well submersible motors (oil-filled)**
- Flows to 6000 m³/h (26,415 gpm)
- Heads to 800 m (2625 ft)
- Motor sizes to 1650 kW (2200 hp)
- Speeds from 1000 to 3600 rpm

**WDX and NM radially split, multistage ring section**
- Flows to 3000 m³/h (13,210 gpm)
- Heads to 700 m (2300 ft)
- Pressures to 75 bar (1090 psi)

Note: The above values indicate the typical performance envelope for the models listed. Flowserve has significant experience beyond these limits. Consult your Flowserve representative with your specific performance requirements.
Slurry pipeline

Highly abrasive and often corrosive slurry creates an extraordinarily difficult pumping environment. Typical slurry pipeline applications include tailings (waste rock) disposal, extraction plant to concentrator, and concentrator or washery to loading terminal. Coal slurry, metal ore slurry and diluent/bitumen froth all present severe corrosive and erosive challenges to high-pressure pumping.

Flowserve is unequaled in its materials expertise, offering an extensive selection of metallic and non-metallic solutions. These include hard metal and specialized hardening techniques, rubber and elastomeric linings, and even ceramic linings for the most demanding services.

Slurry pipelines commonly employ multiple single-stage pumps in series to develop the pressure required to overcome pipe friction resistance. Series pumps require high-pressure casings (i.e., higher tensile strength material, more robust casing bolting, etc.) to cope with the high internal pressures. Flowserve has the necessary experience and engineering expertise to meet these challenges.

Flowserve offers a proven, application-tested line of slurry pipeline pumps, including:

• Titan™ slurry pumps with a choice of hard metal, rubber, elastomeric or ceramic liners within metal armor
• Type M hard metal abrasive slurry pumps
• Type R rubber-lined abrasive slurry pumps
• HPX6000 fully lined API slurry pump

Experience: Slurry pipeline

Installation: 10 horizontal triplex (three-cylinder) plunger pumps with stainless steel fluid ends. Rated for 220 m³/h (970 gpm) at 84 bar (1220 psi) discharge pressure.

Application: Fly ash removal from the scrubbers of a coal-fired power plant in China. Slurry of 35% fly ash by weight in seawater transported in a 22 km (13.7 mi) disposal pipeline.
**Slurry pipeline pumps**

**Titan-Slurry heavy-duty, rubber lined or metal lined**
- Flows to 3600 m³/h (16,000 gpm)
- Heads to 90 m (300 ft)
- Pressures to 40 bar (580 psi)
- Packed gland, expeller or mechanical shaft seal
- Multiple liner materials available
  - Natural rubber and polyurethane for fine solids and mildly corrosive slurries
  - High chrome iron for applications containing coarse solids, as well as those at higher pressures or high temperatures
  - Ceramic materials (exhibiting outstanding abrasion and corrosion resistance) for hot, corrosive slurries

**Type R rubber lined**
- Flows to 10,000 m³/h (44,000 gpm)
- Heads to 50 m (160 ft)
- Pressures to 10 bar (150 psi)
- Choice of materials

**HPX6000 fully lined**
- Flows to 3409 m³/h (15,000 gpm)
- Heads to 244 m (800 ft)
- Pressures to 83 bar (1200 psi)

**Type M hard metal**
- Flows to 10,000 m³/h (44,000 gpm)
- Heads to 90 m (300 ft)
- Pressures to 50 bar (725 psi)
- Packed gland, expeller or mechanical shaft seal

Note: The above values indicate the typical performance envelope for the models listed. Flowserve has significant experience beyond these limits. Consult your Flowserve representative with your specific performance requirements.
Engineering services for pipelines

Flowserve has extensive experience improving the performance of pipeline pumping assets. Our engineering capabilities cover a wide range of design and optimization expertise and include:

• Energy optimization of the entire pipeline using special pipeline design tools and hydraulic gradients to conduct a complete system energy review
• Re-rating pipeline pumps to meet new duty conditions, preventing the expensive implementation of completely new pipeline pumps
• Upgrading pipeline pumps for improved MTBR (mechanical upgrade)
• Noise identification and reduction of pipeline pumps and pump stations
• Improving the mechanical seal performance in pipeline pumps
• Root-cause analysis of vibration in pipeline pumps using state-of-the-art, vibro-elastic data acquisition tools and analysis methods
• Analyzing water hammer and pressure pulsations in pipelines using specialized engineering analysis tools
• Design of damping devices to reduce the effects of high-pressure pulsations
• Implementing the monitoring of pipeline pumps, up to advanced diagnostics and IoT
• Modernization of pipeline pump stations, including remote control
• Lifetime extension of pump assets, including extra qualifications such as ATEX, CE, etc.

Asset and system support

Flowserve offers a comprehensive suite of services designed to provide unprecedented value and cost savings. Our worldwide network of manufacturing facilities, design centers of excellence, and strategically located Quick Response Centers means you never have to look far for help with:

• Repairs and upgrades
• Spare part inventory and management programs
• Field services
• Technical assessments, reliability services and engineering support
• LifeCycle Advantage (LCA) agreements
• Education and training, including on-site
• Asset health monitoring

Sample project list

The following projects showcase the scope and capabilities of Flowserve aftermarket services:

• Adria-Wien (from Italy over the Alps to Austria): re-rated all pumps for duty and higher efficiency, including a lifetime extension
• NATO (Europe): executed multiple projects in France, Belgium, The Netherlands and Denmark for greater reliability and changing duties
• Buckey (U.S.): re-rated several pumps
• Sonatrach (Algeria): turnkey, remote control and pump monitoring
• Oldelval (Argentina): complete system design review, resulting in 15% energy savings and increased reliability
• CPC (Russia): full-maintenance contract and bad-actor upgrading
• Rotterdam (The Netherlands): noise reduction in Venlo pump station (part of RRP), to meet noise requirements in urban area
Asset health monitoring solutions

The Flowserve suite of IIoT products, software and services helps reliability engineers, operators and maintenance personnel monitor and predict equipment performance, so they can take prompt actions and reduce unplanned downtime.

**Predictive analytics**

Full-spectrum monitoring solution
- **Asset types:** Between bearings, overhung, vertical pumps
- **Criticality:** Critical and key processes
- **Scope:**
  - Wired sensors
  - Installation and commissioning
  - Portal setup and training
  - License to algorithms
  - Infrastructure and IT system support (remote)
  - Annual complete system health check (on-site)
  - Remote monitoring
- **Benefits:**
  - 24/7 real-time monitoring, analytics and diagnostics
  - Diagnose problems in early stages
  - Estimate remaining life
  - OEM recommendations
  - Monitoring center support

**Enhanced Condition Data Point Monitoring (eCDPM)**

Most efficient CDPM solution
- **Asset types:** Most rotating equipment
- **Criticality:** Key processes and balance of plant
- **Scope:**
  - Wireless sensors
  - Installation and commissioning
  - Portal setup and training
  - Infrastructure and IT system support (remote)
  - Annual complete system health check (on-site)
  - Remote monitoring
  - Route-based CDPM only on alerting assets
- **Benefits:**
  - 24/7 near real-time monitoring, alerts and trending reports
  - On-site visits by Flowserve specialists
  - OEM recommendations
  - Monitoring center support

**Condition monitoring**

Cost-effective, long-range solution
- **Asset types:** Most rotating equipment
- **Criticality:** Balance of plant
- **Scope:**
  - Wireless sensors
  - Installation and commissioning
  - Portal setup and training
  - Infrastructure and IT system support (remote)
  - Annual complete system health check (on-site)
  - Remote monitoring
- **Benefits:**
  - 24/7 near real-time monitoring, alerts and trending reports
  - OEM recommendations
  - Monitoring center support
Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve products might be used in numerous applications under a wide variety of industrial service conditions. Although Flowserve can provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user must therefore assume the ultimate responsibility for the proper sizing and selection, installation, operation, and maintenance of Flowserve products. The purchaser/user should read and understand the Installation Instructions included with the product, and train its employees and contractors in the safe use of Flowserve products in connection with the specific application.

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