



Ebullating PR Pump Reactor Recycle and Recirculation System



Experience In Motion

Type PR Reactor Recycle (Ebullating) and Recirculation Systems

Flowserve's Type PR ebullating pump system is engineered for the severe operating conditions of ebullated bed hydrocracking and reactor recycle service. It helps refiners improve conversion of heavy oils, residues, and coal slurries while supporting reliable, efficient unit operation.

A typical ebullating pump system includes the ebullating pump, variable frequency drive, and oil injection and oil conditioning skids working together to ebullate the catalyst bed. The Type PR pump is also used in distillate hydrocracking applications where pressure boost is required between reactor vessels.

Designed for demanding refinery service, the unspared Type PR pump operates at pressures up to 220 bar (3200 psi) and temperatures up to 480°C (900°F), with run times of four years or more between turnarounds.

Flowserve developed the first PR ebullating pump in 1965, and more than 70 units are in service worldwide. The Type PR pump design has also been applied in coal liquefaction and hydrogenation processes.

A Heritage of Innovation and Leadership

Advancing ebullating system performance

Flowserve has worked closely with major process licensors from the beginning, helping ensure that ebullating pump systems meet the industry's most demanding process requirements.

Today, Flowserve continues to advance ebullating system technology through new equipment, system upgrades, and engineered reliability improvements. With oil-filled motors, polymer pad bearings, oil injection and oil conditioning systems, and remote monitoring through the Online Assurance platform, Flowserve delivers a comprehensive solution designed to enhance reliability, availability, and performance.

Key System Elements

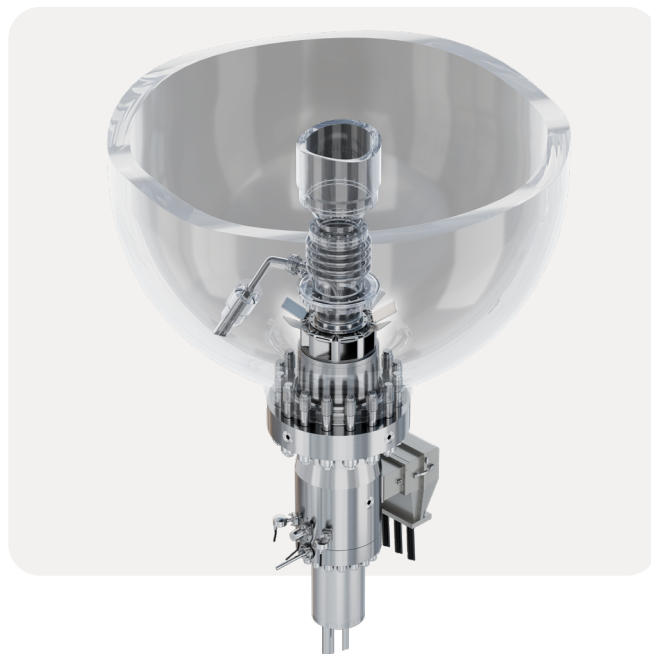
Over time, Flowserve's scope of supply has expanded beyond the pump itself to include the supporting equipment and auxiliary systems required for dependable operation in critical service.

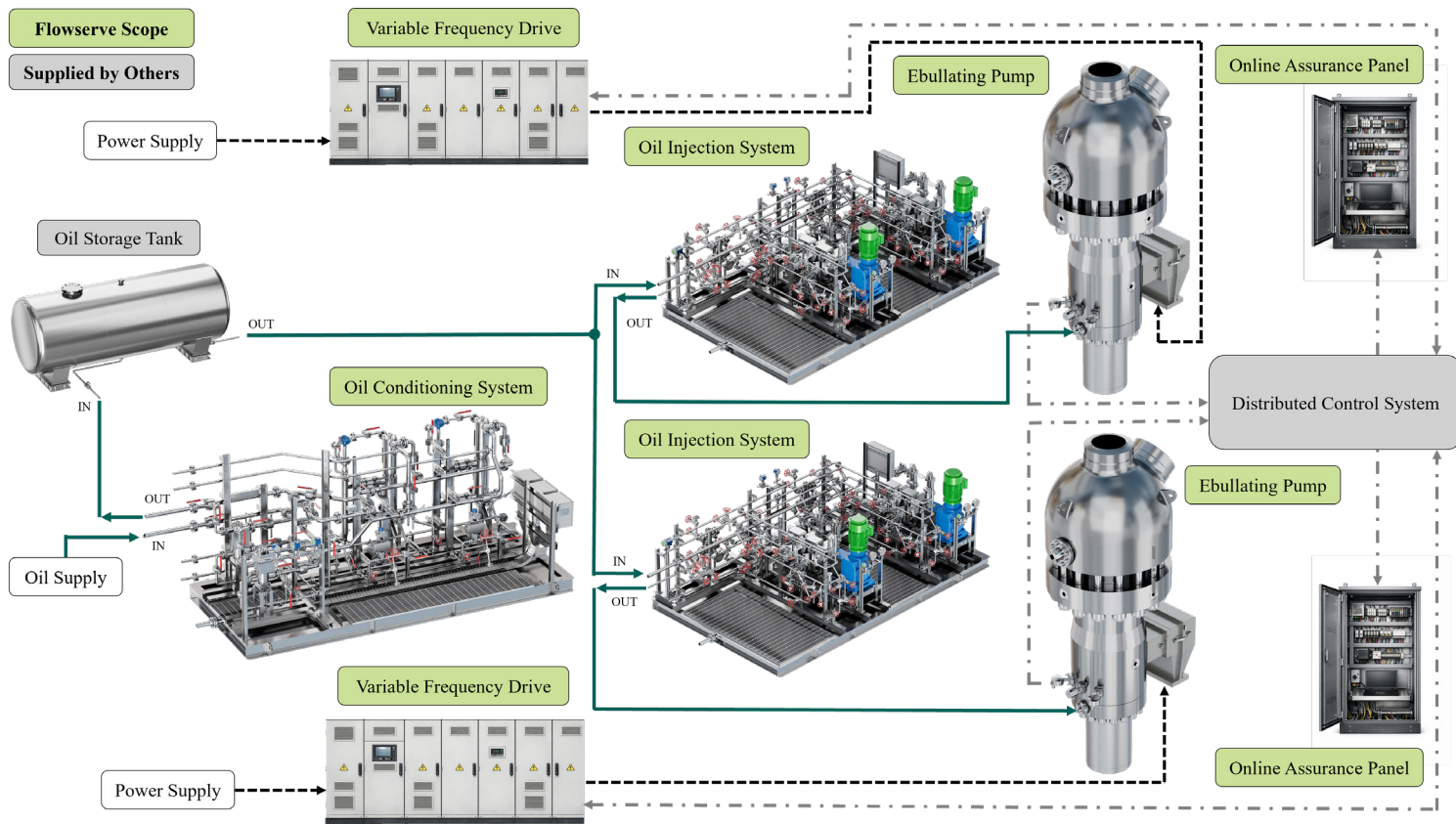
Core system elements include:

- Type PR ebullating pumps for bed expansion and effective mixing of resid oil, catalyst, and hydrogen gas
- Redundant variable frequency drives for pump speed control and process optimization
- Redundant oil conditioning skids to help remove impurities from injection oil
- Redundant oil injection skids to provide a continuous supply of clean oil for cooling and lubrication
- Online Assurance condition monitoring systems that provide operating parameters, trend data, and equipment remaining-life estimates based on Flowserve algorithms

Additional design enhancements may include:

- Thermal Class C motors
- Polymer pad thrust bearings
- HVOF-coated hydraulic components
- Labyrinth seals
- Improved heat exchanger design
- Improved process instrumentation
- Explosion-proof motor terminal boxes
- Vigorous factory pressure and performance testing





Digital Monitoring and Lifecycle Management

Turning operating data into action

Flowserve combines pumping technology with lifecycle management tools that help refiners reduce total cost of ownership. In many flow management systems, most lifecycle cost is incurred after equipment is purchased and installed. That makes operational visibility, predictive maintenance, and service planning essential.

Flowserve's asset management program for reactor ebullating pump systems provides 24/7/365 remote monitoring and lifecycle support. Using advanced algorithms and operating data from the pump and surrounding system, the program helps monitor:

- Thrust bearing safety factor and bearing pads temperature
- Motor winding temperature
- Motor slip
- Catalyst, gas, and liquid fractions at various reactor levels
- Catalyst, gas, and liquid fractions at the pump suction

The system also helps users assess the remaining life of critical components such as electric motor windings, thrust bearings, heat exchanger condition, and pump impellers following upset conditions. This insight supports better maintenance planning and can help reduce unnecessary shutdowns.

Using the platform's historian and trend analysis tools, operators and reliability teams can investigate alarms, analyze event history, and compare time-based operating parameters to support root cause analysis and better decision-making.

Advanced diagnostics can also help identify process disturbances such as:

- Carryover events
- Catalyst bed compression
- Impeller jam
- Gas holdup conditions
- Heat exchanger fouling

Because ebullated bed hydroprocessing units depend on unsparred pumps, early detection and condition visibility are especially important. Better insight into pump health can help operators avoid unplanned outages, protect production, and schedule shutdowns more effectively.

Bottom-Line Results

Highly efficient oil conversion technologies such as the ebullated bed process help refiners increase production of saleable products. To maximize the value of these systems, refiners need a comprehensive asset management strategy that goes beyond the initial equipment purchase.

By combining advanced monitoring, diagnostic capabilities, inventory management, and expert support, Flowserve helps customers move from reactive maintenance to a more predictive and strategic operating model. The result is improved equipment availability, reduced emergency shutdown risk, more efficient use of maintenance resources, and stronger lifecycle cost performance.

Ebullating Pump System Upgrades and Services

Complete upgrade solutions for the future

Whether the goal is improving heavy resid conversion, increasing refinery yields, or addressing safety, environmental, and maintenance requirements, Flowserve ebullating specialists work closely with refinery teams to identify practical upgrade opportunities.

Flowserve offers a broad range of safety, performance, and reliability upgrades for existing installations, including new and significantly redesigned equipment for legacy systems.

Field Service and Technical Support

Flowserve customer service technicians are available 24/7 to support scheduled and unscheduled outages, construction activities, installation, start-up, and commissioning requirements. These specialists are trained to evaluate and troubleshoot ebullating systems and equipment, and they are backed by Flowserve engineering and design teams to help develop practical, reliable field solutions.

Comprehensive Product and System Support

Flowserve supports customers with a broad range of services, including:

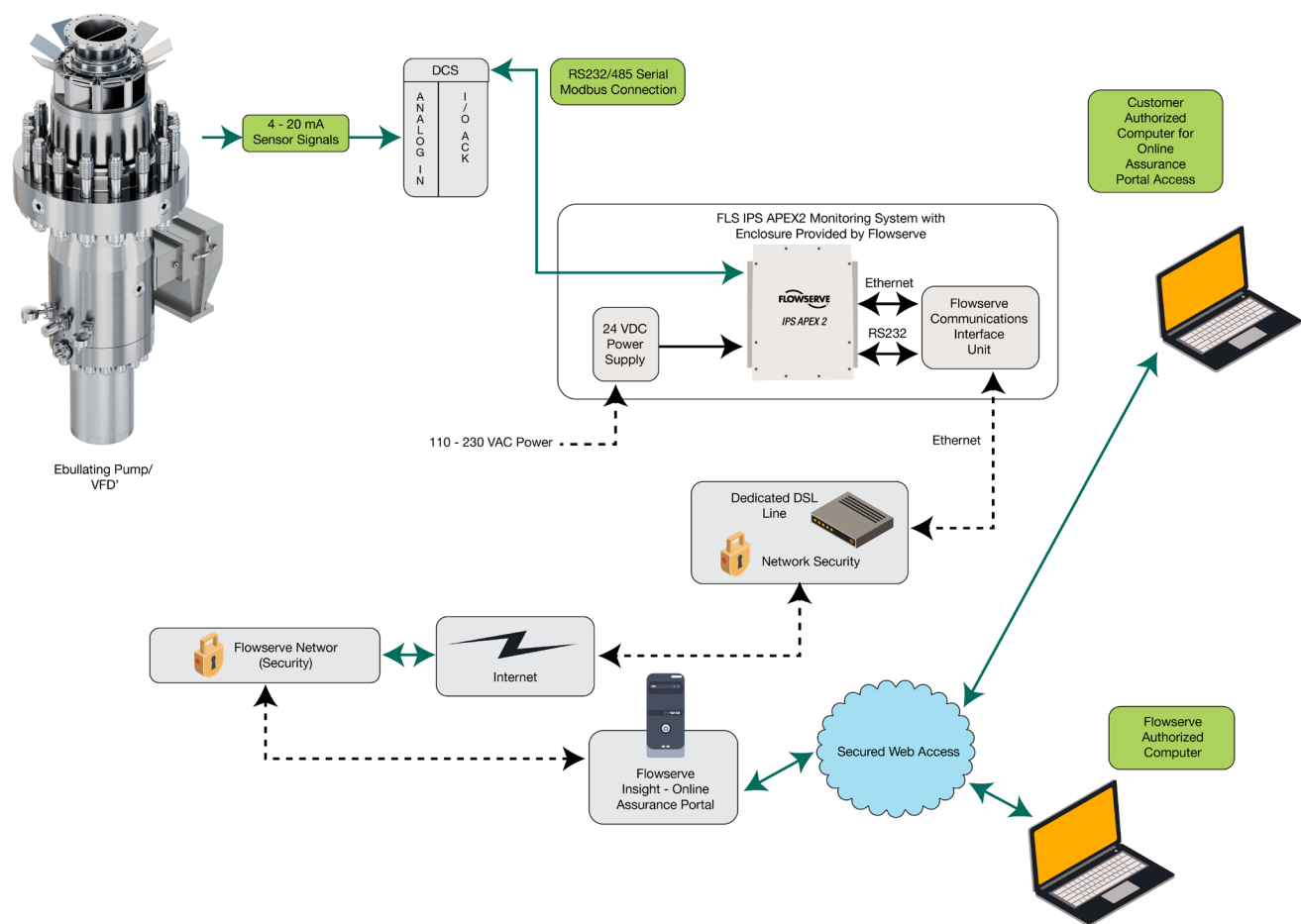
- Turnaround planning
- Spare parts support
- Auxiliary equipment support
- Training
- Alliance agreements
- Local or on-site repair
- Plant evaluations and walk-throughs
- Site-specific training
- Inventory optimization

Proven Experience

Flowserve's ebullating pump heritage traces back to the original Byron Jackson Pump Company, which developed these pumps to meet the need for reliable circulation equipment capable of operating at extreme pressures and temperatures.

The first ebullated bed hydroprocessing unit in the world was commissioned in Kuwait in 1967. Since then, Flowserve Type PR recycle pumps have been used in subsequent ebullated bed hydroprocessing applications, with ongoing design evolution informed by operating experience and customer feedback. Today's design reflects multiple generations of continuous improvement focused on increasing reliability and performance.

Flowserve Ebullator / Type PR Online Assurance: Serial Modbus Communication Connection Option





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