Screw pumps

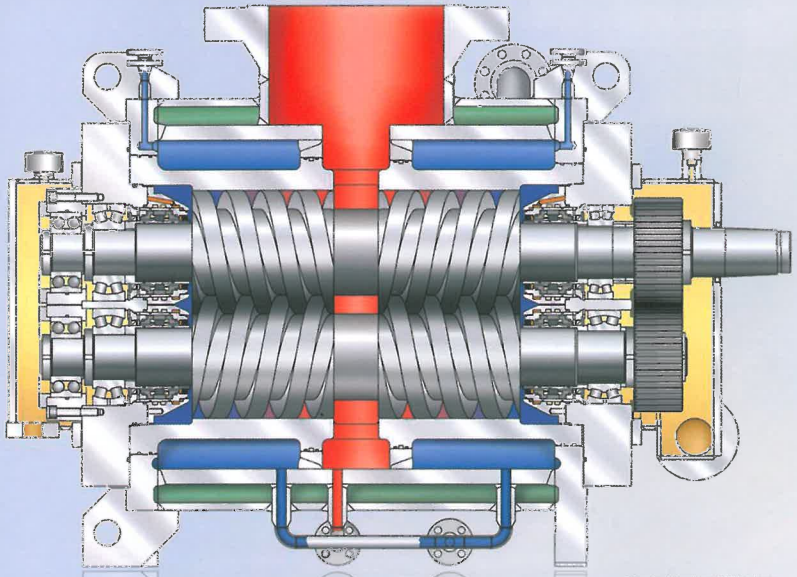


Figure 1. Leistritz high pressure twin screw pump.

Jeffery F. De Vaul, Leistritz Corporation, USA, talks about the different types of screw pumps used to transport heavy crude oil.

In the not too distant past, heavy crude oil was recognised as uneconomical to produce and transport. These heavy crudes required unique production, transportation and processing technologies that were at the time considered pioneering. Today, that is not the case. Heavy oil producers operating in the harsh

Figure 2. Leistritz twin screw pump in pipeline service.

environments of Canada, South America, China and Russ are economically producing and transporting heavy crude oils with the assistance of screw pumps.

When transporting lighter grades of crude oil, pipeline operators have traditionally utilised centrifugal and reciprocating pump technologies. These types of pumps have performed successfully for decades, but the times are changing. Heavy crude oils means higher viscosities (above 250 cSt), which prevent centrifugal pumps from operating at their best efficiency point and sometimes prevent them from operating at all. Reciprocating pumps can handle higher viscosity crude oils, but they require pulsation dampeners, complicated pipeline support systems and frequent maintenance due to their complex design and high number of moving parts.

Screw pumps

Screw pumps are frequently applied in pipeline applications because of their rugged design and suitability for pumping everything, from diluent to heavy oils. Screw pumps are positive displacement machines that move product from suction to discharge as if it were being pushed by an infinite piston. This smooth delivery of fluids is performed efficiently and without pulsations.

In the midstream oil and gas market, either twin screw or three screw pumps are now widely found in pipeline services. Three screw pumps are typically found boosting pressure from laterals to the main pipeline, while twin screw pumps are predominantly utilised in main pipeline boosting stations.

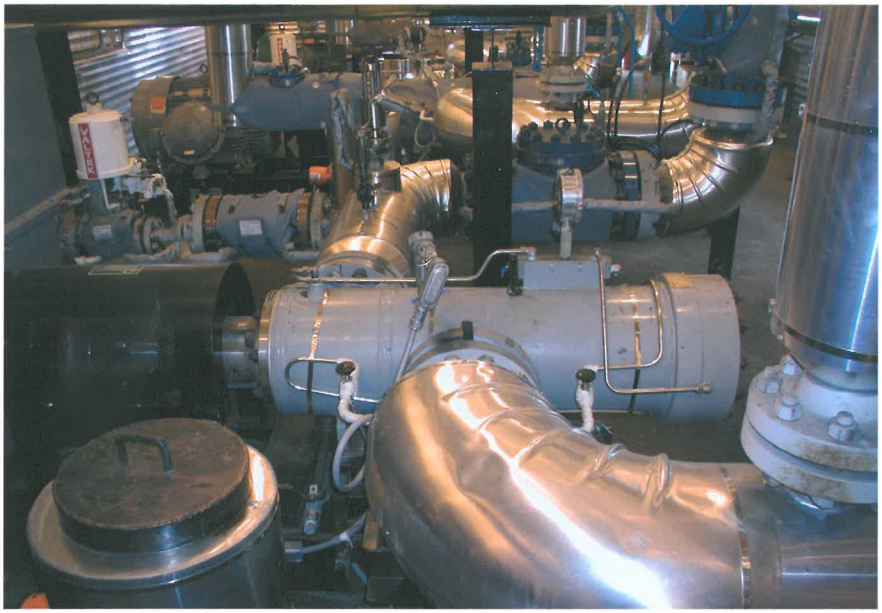


Figure 3. Leistritz three screw pump in pipeline service.

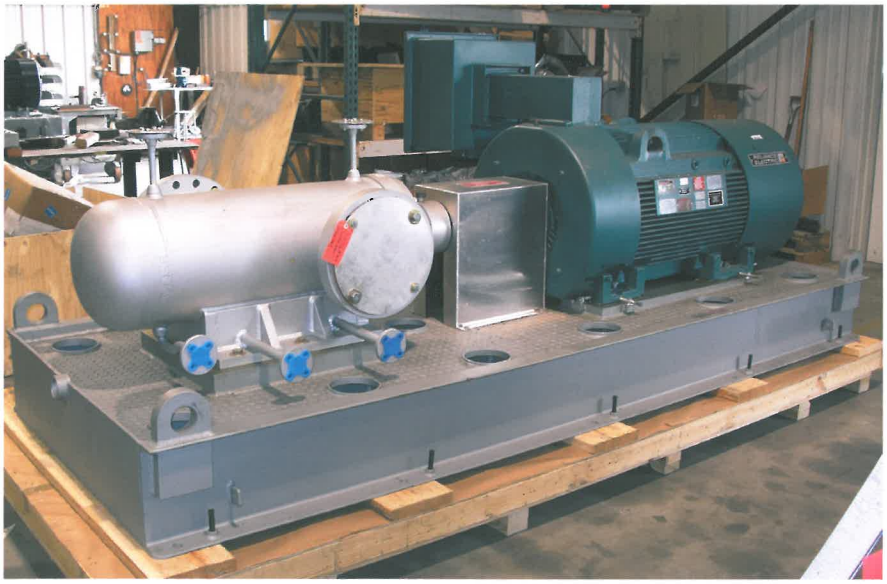


Figure 4. Leistritz three screw pump in LACT application.

Three screw pumps

Three screw pump designs are generally capable of flowrates exceeding 38 000 bpd and differential pressures up to 1700 psi. This pump type consists of three rotors, one power and two driven; an externally lubricated bearing, a balanced mechanical seal; a liner; a casing and a bearing/seal housing. The power rotor (coupled to driver) performs the pumping work, while the idlers act to seal off the pumping chambers. The torque is transmitted to the driven rotors by a rolling contact. The pumped fluid creates a barrier between the rotating elements, preventing metal-to-metal contact of the rotating elements. The liquid film also supports the rotors in the liner, eliminating contact between the rotors and the liners.

As crude oil enters a three screw pump, it fills the suction pumping chamber of the screw set. As the screws turn, crude oil is conveyed from suction to discharge.

In most cases, three screw pumps are used in applications where sand and particulate have been removed from the crude oil (pipeline grade crude oil). However, since some particulate may have survived the crude oil settling process, most pumps are available with

alternative liner coatings to prevent premature wear, and the rotors are normally hardened.

Three screw pumps usually boost pipeline lateral pressure to the main pipeline that flows to a refinery or terminal. The main pipelines usually require higher flowrates and pressures, which is best handled by large twin screw pumps. Today, twin screw pumps are capable of flowrates exceeding 600 000 bpd and differential pressures up to 2400 psi.

Twin screw pumps

Twin screw pumps are hydraulically balanced, pulsation free and deliver a given volume from suction to discharge, meeting whatever back pressure the system puts on the pump. The pump has two rotors, one drive and one driven, and relies on the pumped fluid to fill the clearances between the rotors and rotors and liner. The pumped fluid seals the individual pumping chambers of the screw profiles, allowing the pump to maintain prime. In a rigid rotor design, the liquid acts as a sealing mechanism only and does not act as a bearing support for the rotors.

The rotors are supported on both ends by bearings, and torque is transmitted from drive to driven rotor via timing gears. By eliminating rolling contact between rotors, as is the case with three screw pumps, twin screw pumps can handle everything from water to heavy crude oils.

In most designs, the timing gears and bearings are external to the pumped fluid. The timing gears are oil lubricated, while the bearings are lubricated by grease or oil. Depending on differential pressure requirements, the bearing and timing gears may require a forced lube oil system to properly dissipate heat and improve overall component reliability.

Since there are at least four bearings in a twin screw pump, there are four shaft penetrations and thus four mechanical seals. Mechanical seals are available in both single and double seal configurations, depending on the actual service. Single seals are typically used for crude pipeline services. However, double mechanical seals with a barrier fluid system are also utilised when operating temperatures are high and the pumped product cannot properly cool the seal faces.

Twin screw pumps are increasingly popular in the midstream market, where their ability to handle high viscosities allows operators to pump fluids at colder temperatures or use less diluent. This is especially evident in ongoing pipeline projects bringing heavy Canadian crude oil to the US market.

Twin screw pumps in operation

A Canadian operator is currently installing two twin screw pumps (in parallel operation) to move heavy crude oil from the gathering facilities to the upgrader via a 30 km pipeline. The twin screw pumps each have a flow capability of 135 700 bpd, reaching differential pressures up to 1305 psi and a maximum temperature rating of 302 °F.

Twin screw pumps were selected for this service, not only for their ability to efficiently move high viscosity crude oil, but also for another unique feature that centrifugal pumps cannot match - they have what the operator affectionately labelled a 'Plug busting option.' By taking advantage of the twin screw pump's positive displacement characteristics, the pumps can push against crude oil plugs in the pipeline if they lose heating and allow the operator to flow, without any additional plug removal remedies. This offers a tremendous advantage to the operator, especially given the harsh winter conditions of Alberta, Canada.

Another major oil company operating in Africa utilises large twin screw pumps to transport heavy emulsions from gathering facilities to their central process facility. The two pumping stations deliver 204 000 bpd and 180 000 bpd with an emulsion viscosity of 83 cSt. Each pumping station utilises three large twin screw pumps operating in parallel, plus an installed spare. The pumps have a differential pressure capability of 106 psi and 800 psi respectively.

Twin screw pumps were chosen for their ability to handle emulsions, without creating foaming or frothing issues. Screw pumps are low shear machines and will not agitate or mix an emulsion.

Due to a number of factors, including: nature of the emulsion, remoteness of the installation, lack of skilled labour and large diameter seal faces; the operator preferred double mechanical seals with a Plan 54 buffer system. This ensured that the seal faces would be properly lubricated and cooled at all times without depending upon the emulsion.

Additionally, a forced lube oil system was recommended and installed to cool and lubricate the pump bearings and timing gears. The heat generation of these components was sufficient enough to warrant a forced lube oil system, since an oil sump or cooling by convection would have been insufficient (especially given the ambient temperatures of North Africa).

By using twin screw pumps, the operator also avoided another potential problem - vapour locking. Since entrained gas will periodically break out of the oil, free gas can pass through a twin screw pump. If a centrifugal pump was installed, free gas would cause vapour locking, leading to potential pump damage and most certainly down time. Twin screw pumps are the basis for Multiphase Pump Technology, which displaces up to 99%+ gas and is therefore not susceptible to vapour locking.

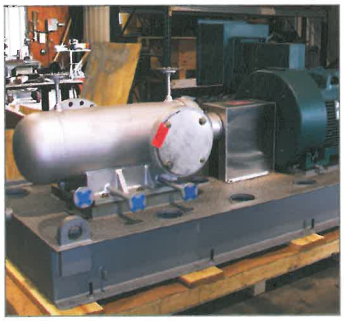
These pumps have operated reliably for over five years with little down time. In fact, the operator has yet to perform maintenance on the units.

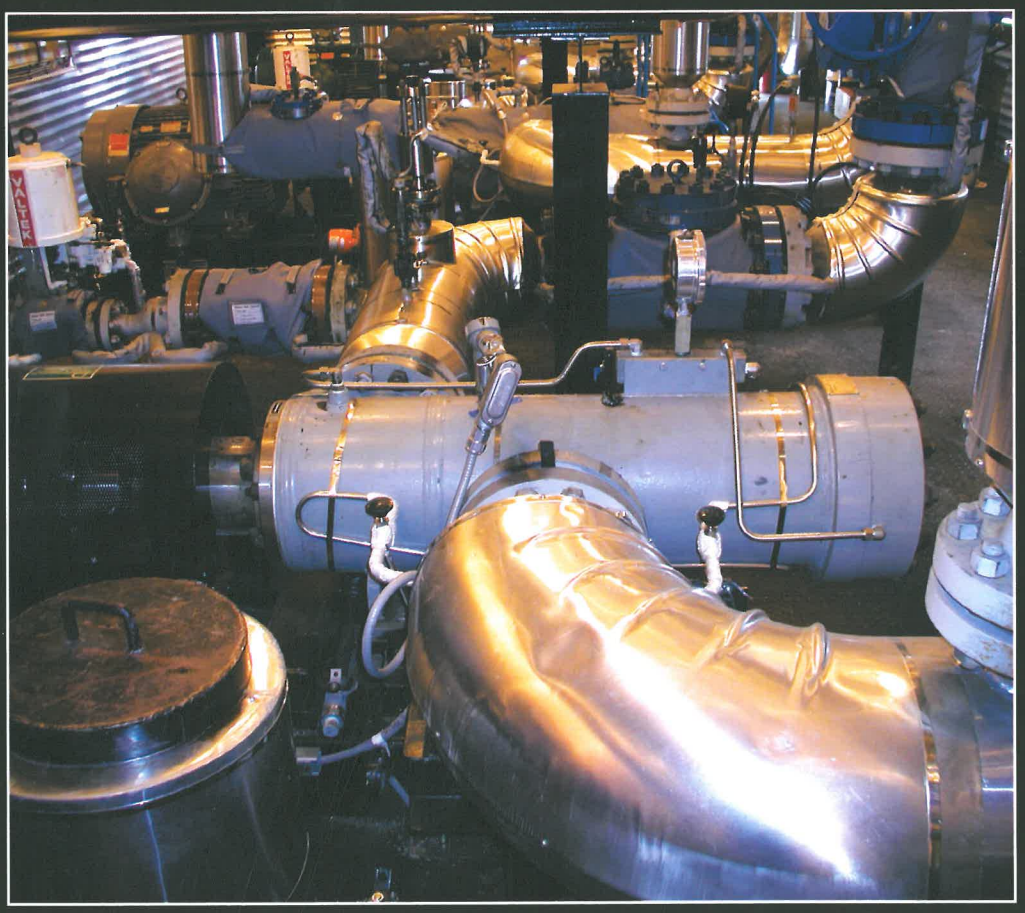
Conclusion

Leistritz manufactures two, three and five screw pumps, as well as Multiphase Production Systems for the oil and gas industry. The company has been doing so since the early 1920s. Current flow capabilities exceed 600 000 bpd and differential pressures up to 2400 psi. A worldwide distribution network provides local support and turnkey pumping solutions.

Leistritz

PIPELINE APPLICATIONS





MODERN HEAVY CRUDE OIL PUMPING