



Tank terminal with loading arms: Innovative and more flexible pumping systems can make big contributions to a flexible, smooth and cost- efficient operation of oil and tank farms.

Photo: Fotolia / Ralf Gosch

## Screw pumps in tank farms



Oil and tank farm installations have experienced a real boom over the past few years. New tank farms are being built worldwide to cover the growing demand for crude and refined oil products. And there seems to be no end in sight to this trend. Innovative and more flexible pumping systems can make big contributions to a flexible, smooth and cost-efficient operation of oil and tank farms.



Apart from conventional centrifugal and gear pumps, an increasing number of screw pumps are being used to transport stored oil products. The big advantage is that oil products with various qualities and viscosities, different back pressures and suction conditions such as presence of entrained air or gas can be pumped without difficulties by just one pump. The versatility of the screw pump and its use in low, medium and high-pressure applications up to 100 barg is a huge advantage. Pump speeds of up to 3,500 rpm are acceptable, depending on the individual application. Screw pumps are found in services like

- transfer pumps for different flow rates and pressures
- loading/unloading pumps for tanks / trucks / trains / ships / tank barges
- circulation pumps (tank-to-tank circulation / in-tank circulation)
- tank draining pumps / stripping pumps

The pumping of stored and refined oil products are done by various pump types. Most familiar are double-flow, self-priming, rotating positive-displacement twin-screw pumps, having totally four spindle profiles. These pumps are axially and radially fully balanced so as to avoid the need of special thrust bearings and to guarantee for long service life. The flow is split when entering the pump casing and transferred to each side of the double flow spindle package where it is pressurized to the common dis-

charge. The rotors have to be manufactured from one single piece of material which eliminates the risk of contact between the rotors and casing.

This feature increases the structural integrity and service life of the spindles resulting in a greater operational reliability. If necessary a spe-

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cial modification can be done to the spindle profile, which leads to lower pump noise. The drive spindle torque is transferred to the driven spindle via oil-lubricated timing gears. This ensures an operation of the pump without any contact between the spindles and the replaceable casing insert and the spindle profiles themselves.

An important feature of this type of pump is its ability to pump fluids in the viscosity range from 0.4 cSt to over 10,000 cSt. Furthermore, flow rates of up to 5,000 m<sup>3</sup>/h can be transported with just one pump. This type of positive-displacement pump also allows for dry running with fluids having low vapor pressure and when emptying tanks or pipelines.

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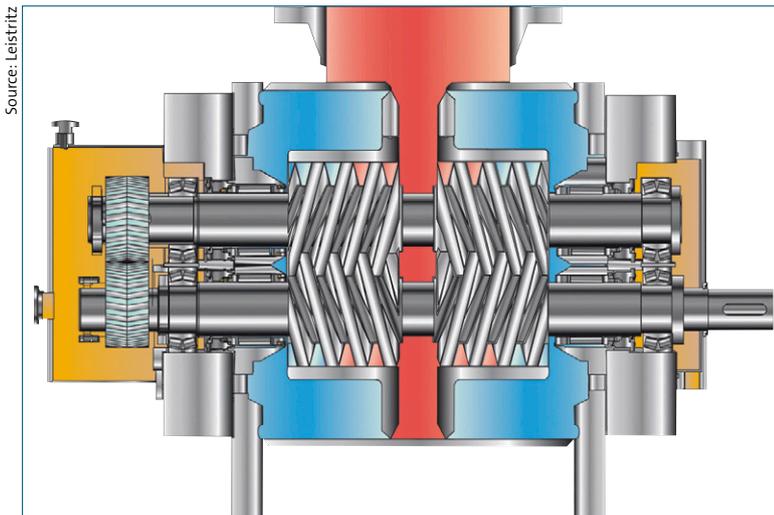
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Fig. 1: Sectional drawing of a double-flow twin-screw pump

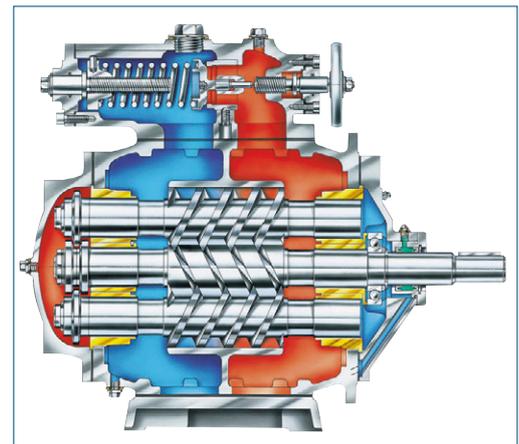
low-pressure operation of up to 16bar (232 psi) and can transport a wide variety of oil products, from low-viscosity fluids such as „light“ gas oil (VGO) to high-viscosity asphalt and bitumen. Fluids with a viscosity of 1 – 100,000 cSt with operating temperatures of up to 280°C can be pumped. The flow rate goes from a few litres per minute up to 1,700 m<sup>3</sup>/h depending on the pump size selected. One common use of these pumps is the circulation of fluids for mixing and heating of various oil products as well as transfer and loading pumps.

Their design is similar to the more familiar double-flow twin-screw pumps. For example, the casing of these pumps is also in steel with replaceable pump liner and the spindles are made from a single piece to ensure their struc-

Double-acting mechanical seals with a barrier fluid system are also used for applications where longer periods of dry running can be expected.

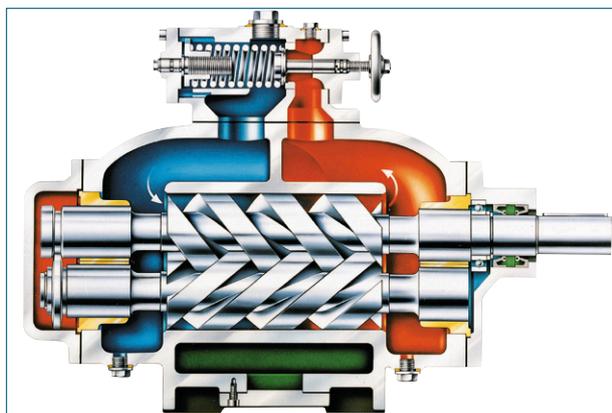
**Innovative, operator friendly and energy efficient pumping systems**

Over the past few years, the focus in pump developments have been on energy consumption, occupational safety and reduction of operating costs for the tank farm owners and operators. The self-priming, single-flow positive-displacement pumps with 2 or 5 spindle profiles can also be used to meet the new market requirements. These pumps are designed for a



Source: Leistriz

Fig. 3: Sectional drawing of a single-flow positive-displacement pump with 5 spindles



Source: Leistriz

Fig. 2: Sectional drawing of a single-flow positive-displacement pump with 2 spindle profiles

tural integrity. The pumps are also axially and radially balanced eliminating thrust bearings, which guarantees a long service life. What is special about these pumps is the fact that the idler spindle is not driven by gears. The torque is transmitted hydraulically by the flanks of the drive spindle’s profile. The special profile of the spindle ensures the perfect closure of the pumping chambers so that the fluids are conveyed in an axial direction with no pulsations. This pump design ensures a greater pumping efficiency with reduced power consumption, as result, leading to lower cost of ownership, as pump procurement cost as well is low. It should



also be pointed to the biggest difference in design to the double-flow twin-screw pump: the mechanical seals to the atmosphere are reduced from four to only one seal. The single-flow positive-displacement pumps have no separately oil-lubricated gears or bearings. This permits the use of single-acting mechanical seals with an oil quench on the atmospheric side of the seal to ensure an oil film is present between the rotating parts of the seal when operating with negative suction pressure. Optionally, a double-acting mechanical seal can be used. This seal should be provided with an external barrier system that is adapted to the pump system and supplies the mechanical seal independently of the pumped fluid.

**Simplified maintenance**

When considering the aspects of maintenance and service, the single-flow pumps are very cost efficient and stand out positively. The following bullet points really hold true for these pumps.

- **Fewer spare parts:** An innovative and parts-saving pump design guarantees simplified stocking of spare parts by the operator or service contractor. The operator can thus calculate the benefits of an optimal stock keeping of parts with a lower service budget and capital tie-up.
- **Simplified service and faster overhaul:** This means in the field service! In the majority of cases, service work can be carried out with less work and with smaller and lighter components directly on site, without the pumps having to be brought to an external shop.
- **Less downtime for servicing (longer running times):** Only pumps that are in operation contribute to the operating company's profit. Thus, less downtime during servicing have a direct impact on the company's financial result.

Completely preassembled and tested cartridge units are available to speed service work even more. The operator only has to change the cartridge or the „pump's entire internals“ at the time of service. The cartridge is simply slid out of the pump casing. A new cartridge can then be slid back into the pump casing and the pump is ready for operation again. The pump does not have to be removed from its base for this work.



Photo: Leistritz

**Fig. 4: Crude Transfer Pump**

The pipe connections on the inlet and outlet side does not have to be removed.

**Advantages over conventional centrifugal pumps**

Tank terminals around the world are getting bigger and bigger and an increasing number of

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**Centrifugal Pump Viscosity Correction Factors (related to water in %)**

Viscosity (cSt)	50	100	160	220
Flow reduction	-8	-14	-19	-23
Head reduction	-5	-11	-14	-18
Power increase	+20	+30	+50	+65



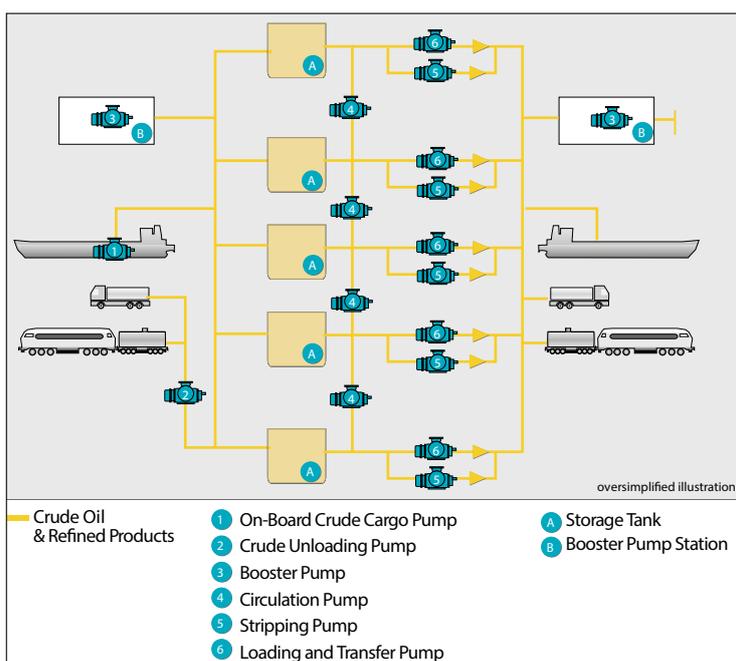
Fig. 5: Pump „suction side view“

Photo: Leistriz

different oil products are being stored and transported. Striving for the maximum flexibility of facility use, it is the job of the pump manufacturer to implement this flexibility in his pump design. This kind of flexibility is not always possible to achieve with a centrifugal pump. With a typical limited operating window, a centrifugal pump can very quickly run into undesirable operating points, leading to cavitation, vibrations and increased wear or simply stop working. A single-flow or double-flow positive-displacement pump with variable speed control, on the other hand, can cover much wider and demanding conditions of operation. Another advantage is that these pumps are always self-priming. The change of speed results in

change of pump flow which can be controlled automatically. No bypass to control flow is required which eliminates loss of energy and overheating (which would be the case with a throttled centrifugal pump). This means that tanks and pipelines can be quickly and efficiently drained and stripped using speed control to lower axial velocities.

With typical centrifugal pumps operating with viscous fluids, the following correction factors related to water data have to be taken into account. Ignoring these correction factors can lead to selecting an incorrect pump size, which will operate outside of its best efficiency point in most cases.



Source: Leistriz

Abb. 6: Flow chart for the distribution, storage and transport of oil products in tank farms



It is very important that the vapour pressure and NPSH are taken into account when designing the pumping system. The NPSH available by the facility can be influenced by several factors. In tanks with a floating roof the liquid level can only go down to a certain minimum without endangering the structure of the tank. That is normally the lowest static liquid column or pressure available. The pressure drop from piping, strainers and valves has to be deducted from this value. The vapour pressure and specific weight at a given liquid temperature are further corrections. The pump has to be able to operate under such conditions which is referred to the lowest NPSH available operating point at a given viscosity.

Of these variables, the relationship between vapor pressure and temperature is the biggest element of uncertainty. Screw pumps, and in particular single-flow positive-displacement pumps are designed to operate with very low NPSH available. The risk of cavitation, vibration and vapor locking is greatly reduced and the operator can fully exploit the inherent properties of these pumps to his advantage.

#### Application examples:

- **Loading and unloading:** In tank terminals for ship loading, large volumes of oil products must be transferred in the shortest possible time. The pumps have to be able to operate quickly and reliably. That is also the case in bunker stations or bunker ships or barges.

The single-flow screw pump is ideal for this service. It can be installed vertically in the tank or on deck to save space. The flow rate is practically independent of backpressure and the transfer rate can easily be controlled by adjusting the pump speed, protecting the receiving tank from overflowing.

**Circulation and blending:** Screw pumps are also used to mix oil products with different viscosities in tank farms. A continuous, pressure-independent pumping rate using speed control is the guarantee to achieve predetermined blending ratios. This can be used particularly for heavy oils blending with light NAFTA or other light hydrocarbons to produce a desired commercial quality.

An increased production of very heavy crude oils, bitumen, asphalt, carbon black, pitch etc. is being supplied to the global market. Purposely built tank terminals and pump stations are required for trading these products. Centrifugal pumps cannot be used in these applications due to poor efficiencies with high viscosities and unpredictable operation characteristics. The speed-controlled, single-flow screw pump as well as the double-flow, positive-displacement twin-screw pump are the reliable alternatives.

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